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An empirical analysis of the macroeconomic effects of government purchases

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AN EMPIRICAL ANALYSIS OF THE MACROECONOMIC EFFECTS OF GOVERNMENT PURCHASES

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To my mother, father, brother, and Sarah.

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ABSTRACT

This dissertation investigates the implications of different methods of identifying exogenous shocks to defense purchases for estimating the macroeconomic effects of shocks to government purchases. Four identification schemes are examined: the narrative approach of Ramey and Shapiro (1997), a more comprehensive narrative approach that tries to isolate exogenous reductions in defense purchases as well as exogenous increases in defense purchases, the Choleski decomposition, and long-run restrictions.

The effects of alternative methods of identifying policy shocks are examined within two common VAR systems estimated over specific sample periods. The benchmark model includes four lagged values of defense purchases, real GDP, the three month interest rate on Treasury bills, and the GDP deflator. The alternative model includes six lagged values of the same variables and a "Perron-type" time trend.

The effects of a shock to defense purchases reported for the narrative approach of Ramey and Shapiro (1997) and the more comprehensive narrative approach are similar in terms of patterns; however, they differ in terms of magnitudes. Furthermore, results presented using the narrative approaches are consistent with the shocks identified being exogenous. Finally, some of the key results reported using the narrative approaches, in particular for interest rates and non-residential investment, are sensitive to small perturbations in the dates of some of the shocks identified.

The IRFs reported for a shock to defense purchases using the Choleski decomposition and long-run restrictions are problematic. However, when new orders of defense products are substituted for defense purchases in the models estimated, the IRFs reported using the Choleski decomposition and long-run restrictions appear better than the IRFs reported for a shock to defense purchases.

The IRFs presented using the narrative approaches, the Choleski decomposition, and long-run restrictions differ greatly. Furthermore, the IRFs reported using the different identification schemes are not sensitive to perturbations in the list of variables used; however, they are sensitive to perturbations in the sample period used. As a result, in spite of methodological advances in estimating the effects of exogenous shocks to government purchases, there is still no consensus on the effects of these shocks.

CHAPTER 1. LITERATURE REVIEW AND METHODOLOGY

1.1 Introduction

From the traditional IS-LM models presented in undergraduate macroeconomic textbooks to the more complex real business cycle (RBC) models recently introduced in the literature, many theoretical macroeconomic models predict that fiscal policy, in particular changes in government expenditures, has significant effects on the economy. Furthermore, it has long been believed among policymakers and many economists that fiscal policy can be used to affect private demand and output.

However, there is little agreement on even the basic effects of fiscal policy among the multitude of theoretical studies available in the literature. For instance, following a temporary increase in government purchases, many RBC models predict diametrically different responses for consumption and investment than do the traditional IS-LM model or the standard one-sector neoclassical model.

In order to determine which of the theoretical models presented in the literature best describe the actual behavior of U.S economy, a plethora of empirical studies of the effects of fiscal policy have been published. Different approaches have been applied that have generated very different estimates. Traditionally, reduced form equations are estimated, and the impact effects and/or long-run effects of fiscal policy are estimated. By and large, this framework has failed to provide robust empirical evidence.

Therefore, since the publication of a recent study by Ramey and Shapiro (1997), dynamic models, especially vector autoregressive (VAR) models, have been used in a small but influential literature to estimate the macroeconomic effects of exogenous shocks to fiscal policy. A key element of this literature is the identification of exogenous fiscal policy shocks, and a variety of methods have been used to identify these shocks.

Ramey and Shapiro (1997) apply a narrative approach in the spirit of Hamilton (1983) and Romer and Romer (1989,1994) to identify exogenous increases in defense purchases, and hence government purchases. Using historical records and current accounts, they identify three geo-political events in the post-World War II era that marked the onsets of large and sustained increases in defense purchases. Then, they construct a dummy variable that takes the value one at the onsets of the increases in defense purchases, and zero in other periods.

To estimate the effects of an exogenous increase in government purchases, Ramey and Shapiro (1997) include the dummy variable as an exogenous variable in a series of univariate equations. However, they acknowledge that including their dummy variable in VAR systems would provide further insight on the effects of an exogenous increase in government purchases. This is done by Eichenbaum and Fisher (1998) and Edelberg, Eichenbaum and Fisher (1999), who include the Ramey-Shapiro dummy variable as an exogenous variable in a series of VAR systems and compute impulse response functions (IRFs) that present the effects of an average Ramey-Shapiro episode on a number of aggregate variables.

Blanchard and Perotti (1999) and Fatas and Mihov (2000) advocate alternative identification schemes that impose contemporaneous restrictions on the estimated residuals of a VAR to identify exogenous shocks to defense policy. Following Bernanke and Mihov (1998) who use a structural approach to identify exogenous monetary policy shocks, Blanchard and Perotti (1999) use institutional information about tax and transfer systems as well as the timing of tax collections to identify structural fiscal policy shocks.

More simply, Fatas and Mihov (2000) use a Choleski decomposition to identify structural shocks to government purchases.

Among other things, Perotti (2000) compares the effects of shocks to government purchases estimated within the frameworks presented by Blanchard and Perotti (1999) and Edelberg, Eichenbaum, and Fisher (1999). He argues, "…Contrary to what the policy discussion seems to take as granted, there is clearly no consensus even on the basic effects of government spending on output and its components" (Perotti 2000, p. 22).

In fact, the evidence reported using the narrative approach of Ramey and Shapiro (1997) and VAR-based approaches, i.e. contemporaneous restrictions, differ greatly. However, since the studies cited above differ in terms of the method of identifying the exogenous policy shocks, the variables in the model estimated, and the sample period over which the model is estimated, the source of the different results across studies has remained unknown.

The focus of this dissertation is on the implications of different methods of identifying exogenous shocks to fiscal policy. In order to investigate these implications, the effects of alternative methods of identifying policy shocks are examined within a common VAR system estimated over a specific sample period. The identification schemes examined include the narrative approach of Ramey and Shapiro (1997), a more comprehensive narrative approach that tries to isolate exogenous reductions in defense expenditures as well as exogenous increases in defense expenditures, a Choleski decomposition, and long-run restrictions.

Since different issues have arisen with regard to each approach, the dissertation also examines issues specific to each approach. First, the small numbers of shocks identified using the narrative approaches may be problematic. Therefore, a methodology presented by Edelberg, Eichenbaum, and Fisher (1999) is modified to assess the relative influence of the individual shocks identified on the results reported for the narrative approaches.

Furthermore, the exogeneity of the shocks identified using the narrative approach of Ramey and Shapiro (1997) has been questioned. Therefore, a methodology used by Leeper (1997) to study the exogeneity of Romers' monetary policy dummy variable is applied to investigate the exogeneity of the shocks identified using the narrative approach of Ramey and Shapiro (1997). It is also applied to investigate the exogeneity of the shocks identified using the comprehensive narrative approach.

Finally, it has been argued that the shocks identified using VAR-based approaches may not be exogenous and economic agents may know of changes in defense purchases before they are recorded in quarterly data. Therefore, models in which suitable alternative variables replace defense purchases are estimated when the implications of the Choleski decomposition and long-run restrictions are investigated.

The plan of the remainder of this chapter is as follows. Section 1.2 presents a review of the effects of fiscal policy within several theoretical models. It focuses on the channels through which shocks to government purchases may affect the economy without any attempt to provide a full coverage of the existing literature. Section 1.3 discusses the recent empirical literature in which VAR models are estimated to investigate the effects of fiscal policy. Section 1.4 lays out the remaining structure of the dissertation.

1.2 Theoretical Models

There is an abundant literature in which theoretical models of the effects of shocks to government purchases on the economy are analyzed. Generally, the predictions of the different theoretical models differ if the shocks to government purchases are temporary or permanent and if the economy is closed or open. This subsection discusses the effects of a temporary shock to government purchases within several closed economy theoretical models, and focuses on the channels through which shocks to government purchases affect the economy.

1.2.1 IS-LM Model

A framework commonly used to present the effects of fiscal policy to students of macroeconomics is the sticky-wage/price aggregate demand-aggregate supply-type model, in which aggregate demand is determined by IS and LM functions. The short-run aggregate supply is upward sloping and the long-run run aggregate supply curve is vertical. Within this framework, a temporary increase in government purchases affects the economy mainly through the government purchases multiplier.

At the initial level of interest rates, an increase in government purchases shifts the IS curve outward, and a higher equilibrium level of real income and aggregate expenditures is established. As real income increases, so does the demand for money. Therefore, interest rates rise. Furthermore, as aggregate expenditures increase, the aggregate demand curve shifts outward. Thus, excess demand appears on the product market at the initial price level, and the price level rises to clear the market.

The rise in the price level reduces the real money supply. Therefore, the LM curve shifts inward, and interest rates are pushed upward further. In addition, given the existence of rigid wages, the rise in the price level initially leads to a reduction in real wages, and therefore, an increase in employment. Then, real wages gradually return toward their original level. The speed at which they adjust depends on the way expectations are formed and the degree of rigidity in wages.

Assuming that private consumption is a function of disposable income and the tax rate is unchanged, an increase in government purchases will lead to a rise in private consumption. Furthermore, assuming that the level of investment rises as the level of output increases, it will yield an increase in private investment. However, since an increase in government purchases forces interest rates upward, it may also crowd out private investment.

If the increase in government purchases is temporary, the level of real income and aggregate expenditures ultimately return to their original values, and the increase in government purchases has no permanent effect on the economy. In contrast, within the standard one-sector neoclassical model, a persistent increase in government purchases has a permanent effect on some variables. Furthermore, it generates very different results than the IS-LM model in the short-run.

1.2.2 One-sector Neoclassical Model

The main features of the standard one-sector neoclassical model include an optimizing representative agent who faces an intertemporal budget constraint as well as flexible prices and wages. Furthermore, two "goods," leisure and a consumption good, are assumed to be available in the economy. Within this framework, a temporary increase in government purchases affects the economy mainly through the wealth effect on the representative agent.

As government purchases increase, the representative agent faces a higher present discounted value (PDV) of taxes and its wealth decreases. Therefore, if leisure and the consumption good are normal goods, the representative agent consumes less of both leisure and the consumption good. Assuming that the representative agent knows that the increase in government purchases is temporary, the decrease in private consumption is smaller than the increase in government purchases so that the level of aggregate expenditures initially rises.

As in the IS-LM model, the rise in aggregate expenditures pushes both the price level and interest rates upward. Furthermore, since consumption of leisure declines, the labor supply increases, real wages fall, and employment rises. Therefore, the effect of the increase in government purchases on private investment may be either positive or negative. Whereas the rise in interest rates pushes investment down, the increase in employment pushes it upward since labor and capital are complements in production.

Since the wealth effect is permanent, while consumption of leisure and the private good decline permanently, labor supply and employment increase permanently. Furthermore, as Perotti (2000) argues, because the capital stock should increase to maintain the ratio of labor to capital in the economy constant in the long run, gross investment should be permanently larger after an increase in government purchases. However, real wages should gradually return to their original level.

With regard to the size of the effects of a temporary increase in government purchases within the standard one-sector neoclassical model, Aiyagari, Christiano, and Eichenbaum (1992) argue that the wealth effect is larger as the increase in government purchases is more persistent. Therefore, the impact of the increase in government purchases on labor supply, investment and output is stronger as it is more persistent.

Furthermore, it is assumed that taxes are lump-sum in the standard one-sector neoclassical model; however, Baxter and King (1993) have shown that the effects predicted by the standard one-sector neoclassical model can be very sensitive to whether taxes are assumed as lump-sum or not. Perotti (2000) argues, "…Even a moderately distortionary taxation can overturn the key signs of the effects of fiscal policy in the neo-classical model" (Perotti 2000, p. 4).

1.2.3 Two-sector Neoclassical Models

Ramey and Shapiro (1997) demonstrate that increases in government purchases in the United States have been concentrated in a few industries, and the government has been the primary purchaser of goods from these industries since the end of World War II. Therefore, they argue that it is better to investigate the effects of changes in government purchases within a two-sector neo-classical model, in which public and private sectors coexist.

In fact, Ramey and Shapiro (1997) present several models in which different functions for technology and preferences are used. They fundamentally differ from the standard one-sector neoclassical model by incorporating not only two consumption and capital goods but also imperfect capital mobility. Within the framework used by Ramey and Shapiro (1997), the frictions caused by imperfect capital mobility play a fundamental role in generating the results predicted.

To estimate the effects of a shock to government purchases on the economy, Ramey and Shapiro (1997) calibrate their models so that they match key aspects of the U.S economy. In particular, sector 1 of the economy is assumed to be seven times larger

than sector 2. Then, they compute numerical simulations for an increase in government purchases in sector 2. The initial shock to government purchases is assumed to be unforeseen; however, the time path of government purchases, which is of the magnitude and composition of the Korean War, is assumed to be perfectly foreseen afterward.

The results of the simulations carried out by Ramey and Shapiro (1997) can be summarized as follows. After an increase in government purchases in sector 2 of the economy, the demand for consumption and investment goods increases in this sector; however, the demand for consumption and investment goods decreases in sector 1. Overall, Ramey and Shapiro (1997) argue that whereas consumption decreases persistently, investment rises temporarily.

The responses of consumption and investment in sector 2 of the economy push interest rates up; however, the responses of consumption and investment in sector 1 drive interest rates down. Therefore, since sector 1 is much larger than sector 2, Ramey and Shapiro (1997) argue that interest rates may decline in the short run. Then, they gradually increase as capital shifts from sector 1 to sector 2.

Furthermore, the relative price of goods, which is defined as the ratio of the price of good 2 to the price of good 1, increases persistently in response to an increase in government purchases in sector 2. Product wages, which are defined as wages in a sector divided by the price of the good produced in this sector, decrease persistently and employment increases persistently. Finally, output rises strongly initially, and then declines slightly. However, it remains at a new permanently higher level.

Edelberg, Eichenbaum, and Fisher (1999) also present a two-sector neo-classical model in their study. Their model fundamentally differs from the standard one-sector neo-classical model by distinguishing between non-residential and residential investment. It also differs from the model presented by Ramey and Shapiro (1997) because markets are assumed to be perfectly competitive. Within the model presented by Edelberg, Eichenbaum, and Fisher (1999), a persistent increase in government purchases affects the economy mainly through the wealth effect on the representative agent; however, it generates different results than the standard one-sector neo-classical model does because of the existence of two investment goods in the economy.

To estimate the effects of a shock to government purchases on the economy, Edelberg, Eichenbaum, and Fisher (1999) calibrate their model so that it matches the data for the U.S economy in the post-World War II era. Then, they compute numerical simulations for an increase in government purchases. The results reported for their simulations are qualitatively similar to the ones reported by Ramey and Shapiro (1997). They can be explained as follows.

Since a representative household faces higher taxes when a persistent increase in government purchases takes place, it reduces its consumption and increases the number of hours worked. As a result, the marginal product of labor and real wages decrease, and employment increase. Since hours worked and market capital are complements in production, non-residential investment increases. Moreover, if residential investment is considered as an investment in consumer durables similar to investment in other consumer durables, residential investment declines because a representative household reduces its level of consumption.

In spite of the negative responses of consumption and residential investment to an increase in government purchases, Edelberg, Eichenbaum, and Fisher (1999) argue that

output rises strongly and persistently after an increase in government purchases. Furthermore, they claim that interest rates increase immediately and persistently.

Overall, the different theoretical models examined above predict that the price level, interest rates, and employment rise in response to an increase in government purchases. They also predict that the level of output rises and real wages decline. However, it should be noted that the level of output can decrease in some neo-classical models and real wages can increase in some RBC models.

Furthermore, the different theoretical models examined above yield very different results with regard to the effects of an increase in government purchases on consumption and investment. Therefore, the macroeconomic effects of an increase in government purchases should be determined empirically.

1.3 Recent Empirical Studies

In the late 1980s, as vector autoregressions (VARs) became increasingly predominant in the empirical literature on the effects of monetary policy, several studies used VAR systems to investigate the macroeconomic effects of exogenous fiscal shocks (Garcia-Mila (1989), Christiano (1990)). However, after that, VAR models were essentially ignored in the fiscal policy literature until Ramey and Shapiro (1997) published their recent study.

In order to estimate the effects of the episodes Ramey and Shapiro (1997) identify, they construct a dummy variable that takes the value one at the onsets of military build-ups, and zero otherwise. Although they include the dummy in a series of univariate equations, they note, "… In his discussion of this paper, Martin Eichenbaum presents estimates of the effect of our military build-up dummy by including it in a vector autoregression. Such an analysis could supply further insight into the effects of military shocks" (Ramey and Shapiro 1997, p. 45).

Shortly after the publication of the paper by Ramey and Shapiro (1997), Eichenbaum and Fisher (1998) and Edelberg, Eichenbaum and Fisher (1999) investigated the implications of including the Ramey-Shapiro dummy variable as an exogenous variable in VAR systems. Furthermore, several studies were published in which VAR systems are used to estimate the effects of fiscal policy (Yuan and Li (1999), Blanchard and Perotti (1999), Fatas and Mihov (2000), Perotti (2000)).

The following sub-sections present the different methodologies used to identify exogenous shocks to government purchases and the main findings reported in the recent studies cited above. First, the narrative approach is examined, and then contemporaneous restrictions are considered. Finally, the empirical evidence reported is briefly discussed.

1.3.1 The Narrative Approach

As was mentioned before, Ramey and Shapiro (1997) use historical records and current accounts to identify three geo-political events in the post-World War II era that marked the onsets of large and sustained increases in defense purchases. They focus on military build-ups because, "…[They] occur rapidly and unexpectedly, so they are naturally modeled as shocks" (Ramey and Shapiro 1997, p. 39). Furthermore, they claim that military buildups are driven by geo-political shocks and imperatives of foreign policy; therefore, "… [They] are likely to be exogenous with respect to macroeconomic variables" (Ramey and Shapiro 1997, p. 39).

Defense purchases have long been used as a proxy for government purchases in empirical studies of the macroeconomic effects of government purchases (Barro (1981),

Kormendi (1983)) because defense purchases are widely believed to present several relative advantages over other components of government purchases.

First, defense purchases as well as changes in defense purchases have been large in the post-World War II era. Therefore, they are more likely to have substantially affected the U.S. economy than smaller components of government purchases. Furthermore, the level of defense purchases at any given time is largely determined by geo-political considerations, in particular the level of threat to the nation. Therefore, it can be argued that defense purchases, or changes in defense purchases, are independent of current or recent economic conditions, and thus are exogenous with respect to the economy. Finally, quarterly data on defense purchases are widely available in the post-World War II era.

Ramey and Shapiro (1997) estimate a series of univariate equations and compute IRFs that present the effects of an "average" Ramey-Shapiro episode on a number of aggregate variables. These equations include a contemporaneous and eight lagged values of their dummy variable and eight lagged values of each variable whose response is under study. Furthermore, a "Perron-type" time trend is added to their equations, which means two linear time trends are included. The first trend starts in the first quarter of 1947 and the second trend starts in the second quarter of 1973.

Ramey and Shapiro (1997), who estimate their equations over the sample period from 1948:2 to 1996:1, argue that total GDP increases significantly for several periods in response to a shock to government purchases episode. They also claim, "…Residential investment falls substantially and statistically significantly… Non-durables and service consumption falls modestly. Durables and housing expenditure fall significantly with little or no subsequent rebound… Non-residential investment rises significantly after the military shock" (Ramey and Shapiro 1997, pp. 54-55). Furthermore, they indicate that there is no evidence for an increase in real wages after a shock.

The IRF for the real interest rate reported by Ramey and Shapiro (1997) decreases significantly, and then it slowly rises. Finally, it returns to its original level. The IRF for the price of manufacturing relative to the GDP deflator rises significantly and temporarily. Overall, Ramey and Shapiro (1997) note that the results computed for univariate equations are similar to the evidence computed when VAR systems are estimated (Ramey and Shapiro (1997) p. 45).

Edelberg, Eichenbaum and Fisher (1999) include the Ramey-Shapiro dummy variable as an exogenous variable in a series of VAR systems. In addition to the Ramey-Shapiro episodes, the benchmark model they estimate includes four endogenous variables: real defense purchases, real total GDP, the net three month interest rate on Treasury bills (RTB), and the producer price for crude fuel. Four lagged values of the endogenous variables are used and a time trend is added to each equation in the benchmark model, which is estimated over the sample period from 1948:2 to 1996:1.

Edelberg, Eichenbaum and Fisher (1999) also compute IRFs that present the effects of an "average" Ramey-Shapiro episode on a number of aggregate variables. To compute the IRFs for any given variable, they add the variable to the benchmark model as an endogenous variable. Edelberg, Eichenbaum, and Fisher (1999) summarize their findings as follows,

"… In response to an expansionary shock in government purchases:

- defense expenditures as well as total government purchases rise,

- output rises, both in the aggregate and in all the sectors that we look at,
- real wages fall,
- non-residential investment rises sharply,
- residential investment declines sharply,
- after a delay, purchases and production of consumer durables and nondurables fall,
- real interest rates initially fall but then rise"

(Edelberg, Eichenbaum, and Fisher 1999 p. 3).

The benchmark model estimated by Eichenbaum and Fisher (1998) is identical to the one presented by Edelberg, Eichenbaum and Fisher (1999), except that no time trend is included. Furthermore, it is estimated over the sample period from 1948:1 to 1988:4. Since Eichenbaum and Fisher (1998) focuses on the effects of shocks to government purchases on real wages and productivity, the number of IRFs they present is more limited than Edelberg, Eichenbaum and Fisher (1999). More importantly, the empirical evidence they present is consistent with the results reported by Edelberg, Eichenbaum, and Fisher (1999).

The studies in which the Ramey-Shapiro dummy variable is used to identify shocks to government purchases generally claim that the narrative approach is superior to the VAR-based approaches (see Ramey and Shapiro 1997, p. 39; Edelberg, Eichenbaum, and Fisher 1999, pp. 2-3). In particular, it is argued that, since military build-ups are unlikely to be the results of feedback from the domestic economy, they are truly exogenous.

However, studies in which a VAR-based approach is used to identify shocks to government purchases, in particular Perotti (2000), often questions the validity of the narrative approach. Perotti (2000) argues that some of the assumptions implicitly or explicitly made when the Ramey-Shapiro episodes are used may be inappropriate (Perotti 2000, p. 7).

Among other things, Perotti (2000) questions whether the increase in military purchases were really unanticipated by economic agents, whether the different military build-ups were similar in the shape of their effects, and whether the increases in government purchases were the only large fiscal policy shocks that occur around the periods of the Ramey-Shapiro episodes.

1.3.2 Contemporaneous Restrictions

A decade before Eichenbaum and Fisher (1998) and Edelberg, Eichenbaum and Fisher (1999) integrated the narrative approach of Ramey and Shapiro (1997) in VAR systems, Garcia-Mila (1989) used a Choleski decomposition to identify exogenous shocks to government purchases. She broke down government purchases into three components: defense purchases, non-defense purchases, and state and local purchases. These components were included in a nine variable VAR system of real GNP that also included consumption of durables, consumption of non-durables and services, residential investment, non-residential investment, net export, and change in business inventory.

The VAR system was estimated using five lagged values of the variables over the sample period from 1948:2 to 1983:2. Then, IRFs that present the effects of shocks to the different components of government purchases were computed. In the Choleski decomposition used by Garcia-Mila (1989), the residuals of three components of government purchases were ordered after the residuals of other variables, which were

ordered as listed above. With regard to the IRFs computed for a shock to military purchases, Garcia-Mila (1989) reported,

> "The GNP response to military purchases is initially positive and significantly different from zero for the first four quarters. It declines after a year and becomes negative after about three years, although it is it is not significantly different from zero different from zero. The military purchase response to its own shock is positive, persistent, and highly significant for many periods" (Garcia-Mila 1989, p. 378).

Yuan and Li (1999) considered two measures of shocks to government purchases: shocks to federal government purchases and shocks to defense purchases. They stated, "The reason to consider military purchases is that it is usually regarded as an exogenous component in government spending" (Yuan and Li 1999, p. 5). They estimated two benchmark systems that included federal government purchases or defense purchases, real RTB, real total GDP, and employee hours worked in non-agricultural industries.

The systems were estimated using four lagged values of the variables over the sample period from 1948:1 to 1993:4. Then, IRFs that present the effects of shock to federal government purchases or defense purchases were computed. In the Choleski decomposition used by Yuan and Li (1999), the residuals of the variables were ordered as listed above.

The IRF for defense purchases reported by Yuan and Li (1999) increases significantly for three years following a shock to defense purchases and it reaches its maximum a year after a shock. The IRF for real total GDP increases modestly and it is significantly different from zero for less than a year. The IRF for real RTB is not significantly different from zero at any horizon.

The VAR systems estimated by Garcia-Mila (1989) and Yuan and Li (1999) are different in spirit from the VAR systems estimated by Eichenbaum and Fisher (1998) and Edelberg, Eichenbaum and Fisher (1999). Garcia-Mila (1989) did not include a measure of the price level or interest rates in her model. Yuan and Li (1999) did not include a measure of the price level in their benchmark models.

Fatas and Mihov (2000), who also use a Choleski decomposition to identify exogenous shocks to government purchases, estimate a benchmark model in the spirit of Edelberg, Eichenbaum, and Fisher (1999). It includes five endogenous variables: real government purchases, real private GDP, the GDP deflator, government receipts net of transfers, and real RTB. Four lagged values of the endogenous variables are included in each equation of the system, which is estimated over the sample period from 1960:1 to 1996:4.

Fatas and Mihov (2000) use economic theory to impose a recursive contemporaneous causal structure among the variables in their model. They assume that government expenditures are predetermined with regard to macroeconomic shocks. Furthermore, they assume that government expenditures are determined before decisions about taxes are taken and that government receipts may respond to contemporaneous changes in output and the price level. Therefore, in the Choleski decomposition used for the benchmark model, the residuals of the variables are ordered as listed above.

Fatas and Mihov (2000) report IRFs that present the effects of structural shocks to government purchases on numerous aggregate variables. In order to compute the IRFs for any given variable not included in the benchmark model, they simply add the variable to

the benchmark model. Overall, the evidence presented by Fatas and Mihov (2000), in particular with regard to consumption, are at odds with the results reported by Edelberg, Eichenbaum, and Fisher (1999). Fatas and Mihov (2000) summarize the main findings of their study as follows:

> "First and foremost, an increase in [government] spending leads to a persistent rise in private output, with consumption and residential investment being the driving factors. Second, the expansionary fiscal policy is also associated with rising manufacturing wages and increasing total private employment. The response of the real interest rate is always positive and significant" (Fatas and Mihov (2000), P. 3).

Blanchard and Perotti (1999) use a structural approach to identify exogenous shocks to fiscal policy. More specifically, they use institutional information about tax and transfer systems as well as the timing of tax collections to estimate the elasticity of government spending and taxes with respect to output. Then, they impose contemporaneous restrictions on the relations among the structural residuals of their VAR model.

Blanchard and Perotti (1999) estimate a benchmark model that includes four lagged values of government spending, net taxes and real GDP. A dummy variable is also entered as an exogenous variable to control for a sudden tax rebate that occurred in 1975:2. Finally, a deterministic or a stochastic time trend is added to each equation in the system, which is estimated over the sample period from 1960:1 to 1997:4.

Blanchard and Perotti (1999) compute IRFs that present the effects of various structural fiscal shocks, including government spending shocks, on several aggregate variables that added to their benchmark model. The evidence they present, in particular with regard to investment, is at odds with the results reported by Edelberg, Eichenbaum, and Fisher (1999). They summarize their findings as follows,

> "From the several specifications we have estimated and the different exercises we have performed, we reach the following conclusions: … when [government] spending increases, output increases… While private consumption increases following spending shocks, private investment is crowded out to a considerable extent" (Blanchard and Perotti 1999 p. 25).

The studies in which a VAR-based approach is used to identify shocks to government purchases generally argue that the restrictions imposed on the model estimated are appropriate (see Blanchard and Perotti (1999) pp.5-9, Perotti (2000) pp. 7-10, Fatas and Mihov (2000) p. 3-4). In particular, it is argued that shocks identified using quarterly data are likely exogenous with regard to the economy since there is little or no discretionary response of fiscal policy to unexpected economic developments within a quarter.

However, the studies in which the Ramey-Shapiro dummy variable is used to identify shocks to government purchases are often critical of the VAR-based approaches. Ramey and Shapiro (1997) claim that shocks identified with a VAR-based approach, "are due solely to timing effects on military contracts and do not represent unanticipated changes in military purchases" (Ramey and Shapiro 1997, p. 40). Furthermore, Edelberg, Eichenbaum and Fisher (1999) argue that the inference reported using VAR-based identification schemes appears, "quite fragile to perturbations in the sample period used

and the list of variables included in the VAR" (Edelberg, Eichenbaum, and Fisher 1999, p. 3).

1.3.3 Discussion of the Recent Studies

Perotti (2000) compares the effects of an increase in government purchases computed when the models presented by Blanchard and Perotti (1999) and Edelberg, Eichenbaum, and Fisher (1999) are estimated. For both models, he reports estimates of the short-run and long-run effects of a shock to government purchases on consumption, investment and wages.

Perotti (2000) stresses the fact that the evidence reported in the recent literature greatly differs across studies, and no consensus is likely to emerge on the effects of exogenous shocks to government purchases in the foreseeable future. He argues, "… Despite some methodological advances, there is absolutely no consensus on even the basic effects of fiscal policy on the macroeconomy" (Perotti, 2000 p. 1).

Still, like the other studies cited above, Perotti (2000) argues that VAR models represent an appropriate, indeed the best, framework available to study the effects of fiscal policy. He claims, "VAR's allow a relatively unstructured specification of the dynamics of the model, an especially attractive feature when, as in our case, one would like to first investigate the basic multivariate time series properties of the data" (Perotti, 2000 p. 5). Furthermore, he notes,

> "VAR's seem ideally suited to apply two of the main recent methodological innovations in the study of fiscal policy, namely... 1. The realization that any serious investigation of the effects of fiscal policy must first address the issue of the endogeneity of fiscal policy… 2. A new attention to the issue of anticipations of fiscal policy. Most theoretical arguments suggest that unanticipated changes in fiscal policy have very different effects from anticipated ones, but disentangling the two in a credible way had always proved difficult" (Perotti 2000, p. 6).

However, Perotti (2000) also points out, "… Of course, no model can do away with all *a priori* restrictions, and VAR's are no exceptions" (Perotti, 2000 p. 5, italics mine). In fact, as was mentioned before, a variety of identification schemes that have both strengths and weaknesses has been used to identify exogenous shocks to government purchases. Yet, the recent VAR studies have provided limited evidence on the implications of different approaches for estimating the effects of fiscal policy.

Surely, the evidence reported differs because different identification schemes are used to identify fiscal shocks. However, it is possible that they also differ because the variables included in the models estimated, the specifications of the models estimated, and the sample periods used for estimation differ across studies.

1.4 Structure of the Dissertation

The studies cited above differ in terms of the method of identifying the exogenous policy shocks, the variables in the model estimated, and the sample period over which the model is estimated. Consequently, it is of interest to determine the source of different results across studies. The focus of this dissertation is on the implications of different methods of identifying exogenous shocks to fiscal policy.

As was mentioned before, to investigate these implications, the effects of alternative methods of identifying policy shocks are examined within a common VAR system estimated over a specific sample period. The identification schemes examined include the Ramey-Shapiro narrative approach, a more comprehensive narrative approach

that tries to isolate exogenous reductions in defense expenditures as well as exogenous increases in defense expenditures, and two identifications schemes that use the estimated residuals from the VAR. One VAR-based identification scheme is a Choleski decomposition similar to that used by Fatas and Mihov (2000), and the other employs long-run restrictions to identify fiscal policy shocks.

The methodology implemented to investigate the implications of different methods of identifying exogenous shocks to fiscal policy follows in the footsteps of Perotti (2000) and McMillin (2001), who examines the implications of contemporaneous versus long-run restrictions for estimating the effects of monetary policy shocks.

McMillin (2001) notes that the estimates of the effects of monetary policy in VAR systems "often differ with regard to both timing and magnitude." Furthermore, he observes, "the studies generating these estimates frequently differ in terms of the variables constituting the model, the sample period for estimation, and the method of identifying policy shocks" (McMillin 2001, p. 618).

Therefore, he suggests estimating the same VAR model over a specific sample period. Then, for the different identification schemes under study, IRFs that present the effects of an exogenous shock to the monetary policy variable can be computed. Since the variables included in the system estimated, the specification of the system estimated, and the sample period used are held constant, it follows that discrepancies in the IRFs computed using different identification schemes can be attributed to the identification schemes.

For each identification scheme under study in the dissertation, the same benchmark model is estimated over the sample period from 1948:1 to 1999:2. The endogenous variables included in the benchmark model are defense purchases by the federal government, real total GDP, RTB, and the GDP deflator. They are identical to the variables used by Edelberg, Eichenbaum, and Fisher (1999), except that the GDP deflator replaces the PPI for crude fuel. Furthermore, when the narrative approach is used to identify shocks to defense purchases, a dummy variable is also entered in the benchmark model as an exogenous variable.

The studies of the different identification schemes follow the same structure in the following chapters. After presenting the IRFs computed for a unit shock to defense purchases for the endogenous variables of the benchmark model, the robustness of the results reported for the benchmark model to adding time trends and changing the lag length used is examined. Furthermore, the robustness of the results reported for the benchmark to substituting alternative measures of the price level for the GDP deflator and alternative measures of interest rates for RTB is investigated.

Next, since the specification of the equations selected by Edelberg, Eichenbaum, and Fisher (1999) may not be the best for the VAR system estimated, an alternative specification for the VAR system under study is selected based on the Akaike Information Criterion (AIC). Whether a dummy variable is included in the system estimated or not, it appears preferable to estimate an alternative model with six lagged values of the endogenous variables[1] and a "Perron-type" time trend. Therefore, IRFs that present the effects of a unit shock to defense purchases on the endogenous variables of the alternative model are computed.

[1] When the narrative approach is used to identify shocks to defense purchases, the contemporaneous value and six lagged values of a dummy variable are also included in the alternative models.

In addition, the robustness of the evidence reported for the narrative and VAR-based approaches to perturbations in the list of variables or the sample period used has been questioned. Therefore, the sensitivity of the results reported for the alternative model to adding, in turn, a series of exogenous and endogenous variables is examined. Moreover, to examine the relations between defense purchases and monetary policy or other fiscal policy components after a shock to government purchases, the IRFs for several fiscal and monetary variables are computed. Finally, the sensitivity of the results reported for the alternative model to using different sub-sample periods is examined.

In order to further investigate the implications of the different approaches under study for estimating the macroeoconomic effects of shocks to defense purchases, the dissertation also addresses issues specific to each approach. First, the number of shocks to defense purchases identified using the narrative approaches is limited, and they differ greatly in size. Therefore, the implications of abandoning the assumption that the Ramey-Shapiro episodes are of equal intensity are examined.

To account for the differences in size among the Ramey-Shapiro build-ups, a modified Ramey-Shapiro dummy variable whose values at the dates of the Ramey-Shapiro episodes vary according to the size of the military build-ups that follows them. Then, a system identical to the alternative model except that it includes the modified Ramey-Shapiro dummy variable is estimated.

Moreover, in order to assess the exogeneity of the shocks identified using the narrative approaches, a methodology used by Leeper (1997) to study the exogeneity of Romers' monetary shocks dummy variable is applied to the dummy variables constructed using the narrative approaches. First, a logit equation is estimated, and the probability the dummy variables constructed using the narrative approaches take the value one at the dates selected for the shocks is computed. Then, VAR systems in which the dummy variables constructed using the narrative approaches are treated symmetrically with the other endogenous variables included in the alternative model are estimated, and the IRFs computed for a shock to the dummy variables within this framework and for the alternative model are compared.

Finally, as was mentioned before, it has been argued that the changes in defense purchases recorded in quarterly data capture not only policy shifts but also developments in the private sectors such as strikes or changes in delivery schedules. As a result, when a VAR-based approach is used to identify shocks to defense purchases, the shocks identified may not be truly exogenous. Furthermore, since economic agents may know of changes in defense purchases before they are recorded in the data, it has been argued that shocks identified using a VAR-based approach may have been anticipated.

Therefore, a model in which defense purchases are replaced by new orders of defense products is estimated when the implications of the Choleski decomposition and long-run restrictions are examined. It is argued that new orders of defense products may yield a better measure of exogenous shocks to government purchases than defense purchases because new orders of defense products are recorded earlier in the data and are less likely to reflect shocks to the private sector than defense purchases.

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CHAPTER 2. THE NARRATIVE APPROACH

2.1 Introduction

In 1989, more than 40 years after Friedman and Schwartz published *A Monetary History of the United States* (1953), Romer and Romer re-introduced the narrative approach in the study of monetary policy. In 1997, Ramey and Shapiro used the narrative approach to identify exogenous shocks to government purchases, specifically exogenous increases in defense purchases.

As was mentioned in the previous chapter, Ramey and Shapiro (1997) identify three exogenous increases in defense purchases during the post-World War II era in the United States. These exogenous increases in defense purchases, which are hereafter referred to as the Ramey-Shapiro episodes, correspond to the onsets of the Korean War, the Vietnam War, and the Carter-Reagan military build-ups. They are dated as beginning in the third quarter of 1950, the first quarter of 1965, and the first quarter of 1980, respectively.

Ramey and Shapiro (1997) use the episodes they identified to construct a dummy variable that has the value one at the dates of the episodes, and zero otherwise. For each variable under investigation, they estimate a univariate equation that includes eight lagged values of this variable as well as the contemporaneous and eight lagged values of their dummy variable. Finally, they compute impulse response functions (IRFs) that present the effects of a unit shock to their dummy variable.

Edelberg, Eichenbaum, and Fisher (1999) include the Ramey-Shapiro dummy as an exogenous variable in VAR systems. They estimate a benchmark model and a series of extended models with four lagged values of the endogenous variables as well as the contemporaneous and four lagged values of the dummy variable. Then, they compute IRFs that present the effects of a unit shock to the Ramey-Shapiro dummy variable on macroeconomic variables. The results presented by Edelberg, Eichenbaum, and Fisher (1999) have served as references in all the recent empirical studies of the effects of shocks to government purchases.

This chapter presents further evidence on the implications of the narrative approach of Ramey and Shapiro (1997) for estimating the macroeconomic effects of fiscal policy. It focuses on two VAR systems that include the Ramey-Shapiro dummy variable, defense purchases, real GDP, the net three month interest rate on Treasury bills (RTB), and the GDP deflator.

The first system, which is hereafter referred to as the benchmark model, is identical to the benchmark model presented by Edelberg, Eichenbaum, and Fisher (1999) except that the GDP deflator is substituted for the producer price index (PPI) for crude fuel. The second system, which is hereafter referred to as the alternative model, is selected based on the Akaike Information Criterion (AIC). It includes the same variables as the benchmark model but the specification of the equations in the system is different.

Although several issues have emerged with regard to the narrative approach of Ramey and Shapiro (1997), they have not been examined in great detail. First and foremost, as Fatas and Mihov (2000) argue, “Robustness is an issue when policy shifts are measured only with three dummies” (Fatas and Mihov 2000, p. 7). Several exercises experiments are carried out hereafter to examine the robustness of the results reported using the Ramey-Shapiro dummy variable.

First, after the IRFs computed for the benchmark model are presented, the sensitivity of these IRFs to adding a time trend and changing the lag length is investigated. Second, after the IRFs computed for the alternative model are presented, the sensitivity of these IRFs to perturbations in the list of variables and the sample period used is investigated.

Furthermore, Ramey and Shapiro (1997) and Edelberg, Eichenbaum, and Fisher (1999) assume that no other major shock to the economy occurred during the periods of the Ramey-Shapiro build-ups. However, as Perotti (2000) points out, other major macroeconomic shocks did occur at periods close to the Ramey-Shapiro episodes, in particular the Carter-Reagan episode. Romer and Romer (1989, 1994) identify a major exogenous monetary contraction the quarter before the date selected by Ramey and Shapiro (1997) for the onset of the Carter-Reagan episode. Moreover, Hamilton (1983) identifies a large exogenous increase in oil price the same quarter.

Since other macroeconomic shocks occurred at periods close to the Ramey-Shapiro episodes, the evidence reported using the episodes may reflect, at least partially, the effects of these other shocks. To address this issue, the effects of the Ramey-Shapiro episodes in models that alternatively include Hamilton's oil price dummy variable and the Romers' monetary policy dummy variable are examined.[1]

Similarly, since the Ramey-Shapiro build-ups may coincide not only with increases in government purchases but also changes in other components of fiscal policy or changes in monetary policy, the effects of the Ramey-Shapiro episodes in models that alternatively include additional monetary or fiscal variables are examined.

Next, the increases in defense and government purchases that follow the episodes identified by Ramey and Shapiro (1997) differ greatly in size and shape. However, the Ramey-Shapiro dummy variable has an identical value at the dates of the episodes. To control for the differences in the size of the episodes, a model is estimated in which the intensity of the shocks included in the Ramey-Shapiro dummy variable is proportional to the increases in defense purchases that follow them.

Finally, although Ramey and Shapiro (1997) argue that the episodes they identify are exogenous, there is little evidence in the recent literature to support this claim. Edelberg, Eichenbaum, and Fisher (1999) show that the Ramey-Shapiro episodes are special relative to other dates in their sample periods and conclude, "In our view what is special is that [the military build-ups] coincide with the onset of exogenous increases in government purchases" (Edelberg, Eichenbaum, and Fisher 1999, p. 17).

However, the methodology presented by Edelberg, Eichenbaum, and Fisher (1999) does not necessarily imply that the Ramey-Shapiro episodes are exogenous and further evidence on this issue is needed. In this chapter, a statistical methodology used by Leeper (1997) to study the exogeneity of the Romers' monetary policy dummy variable is applied to thoroughly investigate whether the Ramey-Shapiro episodes are exogenous.

The plan of this paper is as follows. Section 2.2 of this chapter presents a cursory analysis of the evolution of defense purchases in the post World War II era. Section 2.3

[1]The Romers' monetary policy dummy variable has the value one at the dates of exogenous monetary policy contractions and zero otherwise. The dates for the monetary policy shocks correspond to the ones identified by Romer and Romer (1989, 1994). Hamilton's oil price dummy variable has the value one at the dates of oil shocks and zero otherwise. The dates selected for the oil shocks are the ones used by Ramey and Shapiro (1997). They correspond to the dates identified by Hamilton (1983) and Hoover (1994) and updated for the Iraqi invasion of Kuwait.

reproduces the results from Edelberg, Eichenbaum, and Fisher (1999) and presents the results computed for the benchmark model. Section 2.4 discusses the robustness of the results computed for the benchmark model to adding a time trend and changing the lag length. Section 2.5 presents the results computed for the alternative model.

Sections 2.6 and 2.7 discuss the robustness of the results computed for the alternative model to perturbations in the list of variables and the sample period used, respectively. Section 2.8 presents the results computed for a model in which the assumption that the Ramey-Shapiro episodes are of equal intensity is abandoned. Section 2.9 presents evidence on the exogeneity of the Ramey-Shapiro dummy variable. Finally, Section 2.10 provides a brief summary and conclusion.

2.2 Casual Empiricism

The first panel of Figure 2.1 presents the evolution of defense purchases, which are defined as real military consumption and investment by the federal government, over the period 1947:1 to 1999:2.[2] Since Ramey and Shapiro (1987) include eight lagged values of their dummy variable in the equations they estimate, eight quarters after the onsets of the Ramey-Shapiro episodes are highlighted. A cursory examination of this panel suggests that the evolution of defense purchases is characterized by the existence of three major cycles in the post-World War II era.

The onsets of the first two cycles appear to begin in 1950:3 and 1965:1, respectively. They correspond to the dates selected by Ramey and Shapiro (1997). The onset of the last cycle appears to begin several years before 1980:1, the date selected by Ramey and Shapiro (1997). Quarterly defense purchases reached their lowest value since the breakout of the Korean War in 1977:4. However, it seems sensible to date the onset of the Carter-Reagan build-up in 1980:1 since defense purchases increase only modestly and intermittently in 1978 and 1979.

Although defense purchases increase steadily after the onset of every episode, the magnitude of the change in defense purchases appears to be greatly reduced with each episode. The maximum increase in defense purchases within eight quarters after the onset of the Korean War episode is $232 billion. The maximum increases after the Vietnam War and Carter-Reagan episodes are $56 and $29 billion, respectively. Moreover, the increases in defense purchases appear shallower with each episode. In particular, the increase in defense purchases during the Carter-Reagan build-up is much more gradual than during the Korean and Vietnam build-ups.

A potential explanation for the difference in the behavior of defense purchases after the onset of the Carter-Reagan build-up is the difference in the political and strategic circumstances surrounding the episodes. The Korean and Vietnam buildups were driven by a massive U.S. military intervention abroad. The Carter-Reagan build-up was driven by the tense but peaceful arms race with the Soviet Union.

The second panel of Figure 2.1 presents the evolution of the ratio of defense purchases to real GDP. This ratio increases rapidly and greatly during the Korean War build-up. In comparison, the Vietnam War and the Carter-Reagan buildups are modest. In fact, the increase in the ratio of defense purchases to real GDP during the Carter-Reagan

[2] Most variables are in billions of chained (1992) dollars and seasonally adjusted. The real federal government deficit and receipts are in current dollars but are deflated by the CPI.

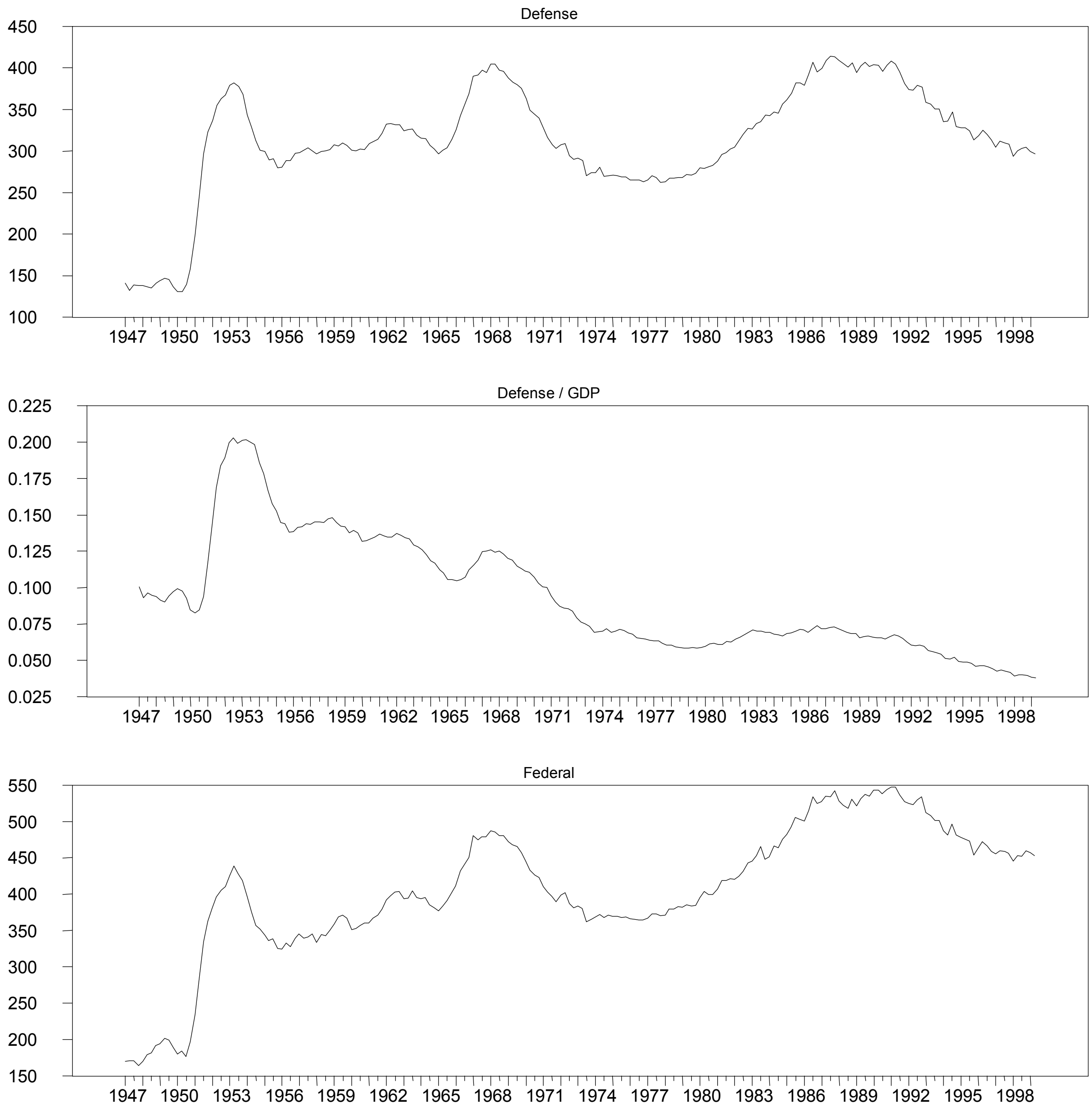

Figure 2.1: Real Federal Government Purchases in the Post-World War II Era
Sample period: 1947:1-1999:2

build-up is very similar in magnitude to the increases that occurred in the middle of the 1950s and early 1960s.

Since the Ramey-Shapiro episodes are used to investigate the macroeconomic effects of fiscal policy in this chapter, it is of interest to present the evolution of federal government purchases, which are defined as real non-military and military consumption and investment by the federal government. Like the increase in defense purchases, the increase in government purchases following the Korean War episode is very large; however, the increases after the Vietnam War and Carter-Reagan episodes are relatively modest.[3]

In conclusion, the evolution of defense purchases in the post-World War II era is characterized by three large and sustained military build-ups, which correspond to the Korean War, the Vietnam War and the Carter-Reagan build-ups. These military build-ups are followed by military retrenchments, which are not included in the study by Ramey and Shapiro (1997) because they are more gradual than the military build-ups (see Ramey and Shapiro (1997), fn. 14, p. 39).

Although the military build-ups appear to coincide with large increases in defense purchases and government purchases, it should be noted that the increases in defense purchases and government purchases are considerably smaller and shallower with each Ramey-Shapiro episode. In fact, the Korean War build-up appears much larger than the following build-ups identified by Ramey and Shapiro (1997).

2.3 Benchmark Model

This section presents the IRFs computed for Edelberg, Eichenbaum, and Fisher's benchmark model and the benchmark model selected for this chapter, which is almost identical to Edelberg, Eichenbaum, and Fisher's benchmark model. First, Edelberg, Eichenbaum, and Fisher's benchmark model is estimated over the sample period from 1948:1 to 1999:2,[4] and IRFs that present the effects of a unit shock to the Ramey-Shapiro dummy variable are computed for the endogenous variables included in the system.

Following Edelberg, Eichenbaum, and Fisher (1999), four lagged values of defense purchases, real GDP, RTB, and the PPI for crude fuel are included as endogenous variables. A constant and four lagged values of the endogenous variables are included in each equation of the system. The contemporaneous value and four lagged values of the Ramey-Shapiro dummy are entered as exogenous variables. The logarithmic values of the variables are used except for interest rates. Data from 1947:1 to 1947:4 are used as pre-sample data.

The reduced form of the VAR systems estimated when the narrative approach of Ramey and Shapiro (1997) is used to identify shocks to government purchases has the following general specification:

$$X_t = A(L)\, X_{t-1} + B(L)\, D_t + U_t \qquad (1)$$

[3] Non-defense purchases do not exhibit a consistent pattern in the periods following the Ramey-Shapiro episodes. They drop the quarter of the outbreak of the Korean War, and then they exhibit an upward trend for three years. Non-defense purchases do not exhibit a clear trend during the Vietnam War and the Carter-Reagan build-up.

[4] The sample period ends in 1999:2 because some data such as federal government receipts and deficit were not available after 1999:2 when the dissertation was begun.

X_t is a vector that includes the endogenous variables and D_t is the Ramey-Shapiro dummy variable. A(L) and B(L) are finite-order vector polynomials in non-negative powers of L. U_t is the vector of reduced form residuals.

Since the Ramey-Shapiro dummy variable is added as an exogenous variable, it is possible to estimate the effects of shocks to government purchases when the reduced form VAR systems are estimated. More specifically, consistent point estimates of the IRFs for the endogenous variables at time t + k are given by an estimate of the coefficient on L^k in the expansion of $[I-A(L)]^{-1} B(L)$.

In Figure 2.2, the solid lines display the point estimates of the IRFs for defense purchases, real GDP, RTB, and the PPI for crude fuel computed when Edelberg, Eichenbaum, and Fisher's benchmark model is estimated. The dashed lines display the lower and upper bounds of sixty-eight percent confidence intervals.[5] The IRFs computed for defense purchases and real GDP are nearly identical to the IRFs reported by Edelberg, Eichenbaum, and Fisher (1999), who estimate their model over the period from 1948:1 to 1996:4.

Following a Ramey-Shapiro episode, the IRF for defense purchases increases sharply for about two years, and then it slowly returns to its original level. It is still significantly different from zero four years after an episode. Immediately after the onset of a Ramey-Shapiro episode, the IRF for real GDP rises significantly for a quarter. After two quarters, it rises significantly for two years.

The IRF for RTB is similar to the IRFs for various measures of interest rates reported by Edelberg, Eichenbaum, and Fisher (1999). Following an exogenous shock to the Ramey-Shapiro dummy variables, it drops significantly for several periods, then it quickly increases for several periods, and finally it slowly returns toward its initial value. Overall, the delayed rise in RTB is significant for more than a year.

Ramey and Shapiro (1997) and Edelberg, Eichenbaum, and Fisher (1999) argue that the IRF for RTB is consistent with the response of interest rates to a positive shock to government purchases in their two-sector neoclassical macroeconomic models that were presented in the previous chapter. However, the IRF for the PPI for crude fuel reported in Figure 2.2 is inconsistent with the theoretical two-sector models of Ramey and Shapiro (1997) and Edelberg, Eichenbaum, and Fisher (1999) as well as the more traditional theoretical IS-LM and one-sector neoclassical models.

Within most theoretical models of fiscal policy, the price level is expected to rise following a persistent increase in government purchases; however, the IRF for the PPI for crude fuel is negative at all horizons following a Ramey-Shapiro episode, and it is significant after three years. It is possible that the anomalous response of the price level may be caused by the inclusion of a measure of a fuel price instead of a more aggregative price index in the model estimated. Specifically, it is hypothesized that the evolution of

[5] The lower and upper bounds of the confidence intervals represent the 80th lowest and 420th highest values across 500 impulse response coefficients computed using a bootstrap Monte Carlo procedure identical to the one presented by Edelberg, Eichenbaum, and Fisher (1999).

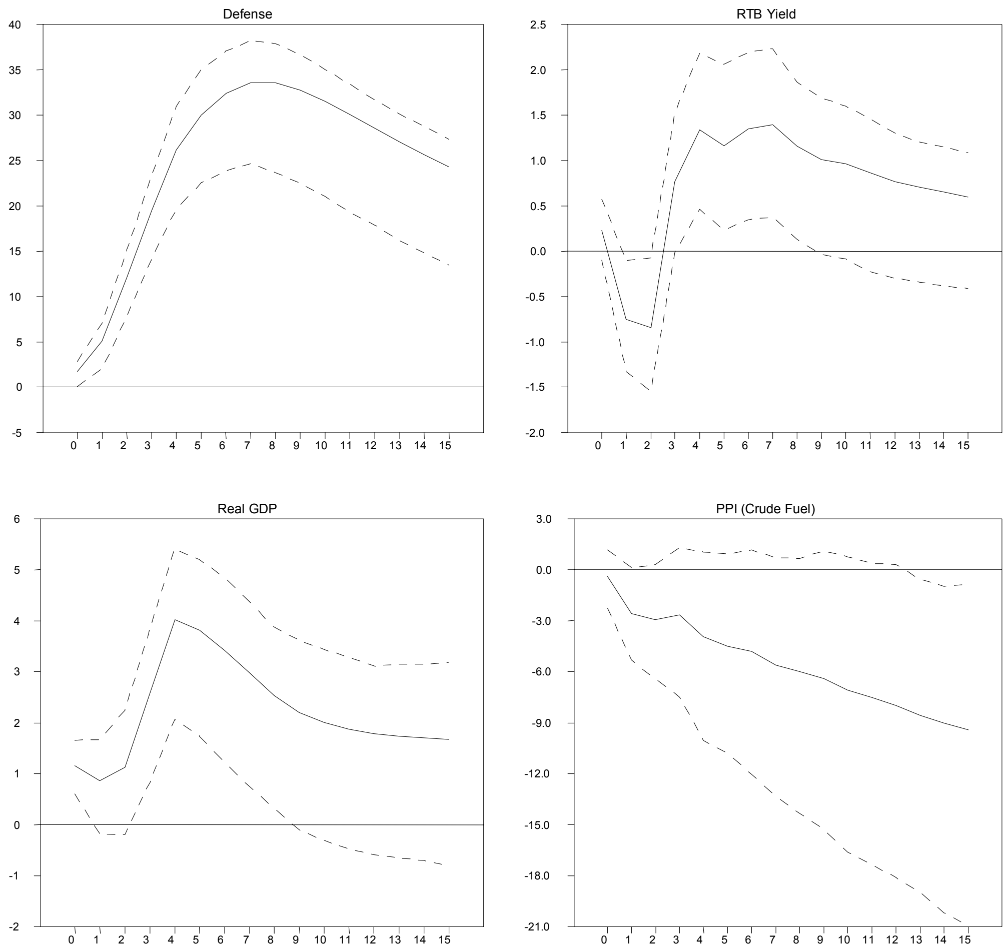

Figure 2.2: Edelberg, Eichenbaum, and Fisher's Model
Sample period: 1948:1 to 1999:2

the PPI for crude fuel is determined in world oil markets, and it is unlikely to be affected by movements in defense purchases.[6]

Therefore, Edelberg, Eichenbaum, and Fisher's model is re-estimated using more aggregative measures of the price level. The consumer price index for all urban consumers (CPI), the producer price index for commodities (PCOM), the producer price index for finished goods (PPI for finished goods), and the GDP deflator are substituted, in turn, for the PPI for crude fuel in the model estimated. Then, IRFs that present the effects of a unit shock to the Ramey-Shapiro dummy variable are computed.

In Figure 2.3, the solid lines display the point estimates of the IRFs computed when the systems with the CPI, PCOM, and the PPI for finished goods are estimated. In Figure 2.4, the solid lines display the point estimates of the IRFs computed when the system with the GDP deflator is estimated. In both figures, the dashed lines display the lower and upper bounds of sixty-eight percent confidence intervals. When alternative measures of the price level are used, the IRFs for defense purchases, real GDP, and RTB are similar to the ones reported for Edelberg, Eichenbaum, and Fisher's model.

However, the IRFs for all four measures of the price level are very different from the IRF computed for the PPI for crude fuel. The IRFs for the CPI, PCOM, the PPI for finished goods, and the GDP deflator rise sharply for several periods after the onset of an episode, and then they slowly return to their original values. In each case, they are significantly different from zero for roughly two years after the onset of a Ramey-Shapiro episode.

Overall, the IRFs for defense purchases, real GDP, and RTB reported when Edelberg, Eichenbaum, and Fisher's benchmark model is estimated over the period from 1948:1 to 1999:2 are similar to the IRFs presented by Edelberg, Eichenbaum, and Fisher (1999). Following a Ramey-Shapiro episode, defense purchases rise very persistently, output rises temporarily, and interest rates initially fall and then they rise significantly.

In conclusion, the IRF for the PPI for crude fuel reported for Edelberg, Eichenbaum, and Fisher's benchmark model, which decreases persistently and significantly after a Ramey-Shapiro episode, is inconsistent with most theoretical models of the effects of fiscal policy. When more aggregative measures of the price level are substituted for the PPI for crude fuel in the system estimated, the IRFs for defense purchases, real GDP, and RTB are left unaffected. However, the IRFs for the different measures of the price level are positive and persistently significant.

This chapter focuses on the implications of the Ramey-Shapiro episodes for estimating the effects of fiscal policy within a VAR system that includes the Ramey-Shapiro dummy, defense purchases, real GDP, RTB, the GDP deflator, which is referred to as the benchmark model, for two reasons. First, if the study that follows is carried out using the PPI for crude fuel, the various IRFs computed for the PPI for crude fuel remain as problematic as, if not more problematic than, the IRF reported in Figure 2.2. Second, since real GDP is included in the model, it is more natural to include the GDP deflator than other measures of the price level.

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[6] Hamilton (1983) identifies the major exogenous increases in crude oil price in the post-World War II era and investigates their causes. He does not identify any of the Ramey-Shapiro episodes, or the ensuing increases in defense purchases, among the reasons for the increases in crude oil price he identifies (see Hamilton (1983), p. 231).

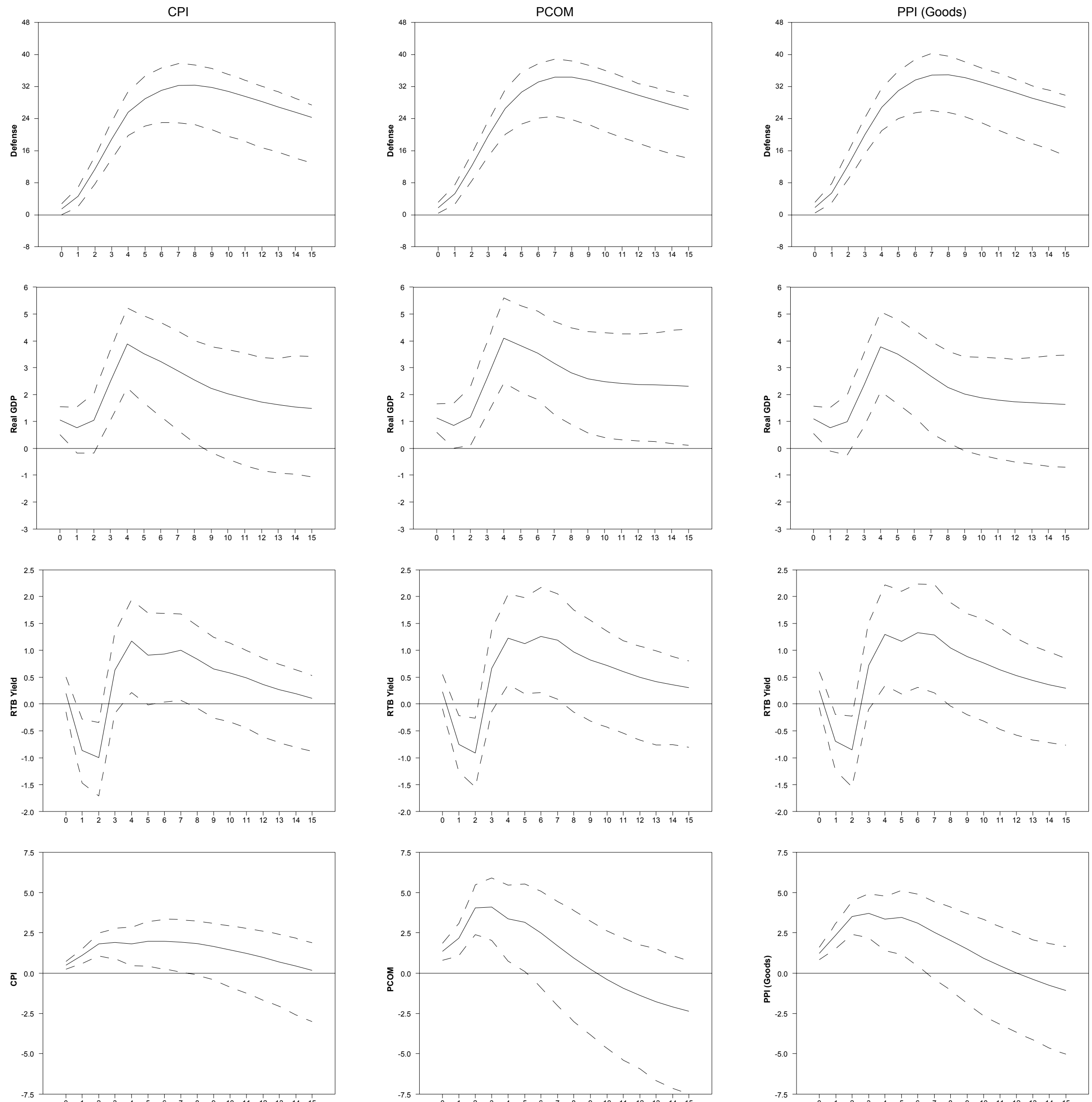

Figure 2.3: Models With Different Measures of the Price Level
Sample period: 1948:1 to 1999:2

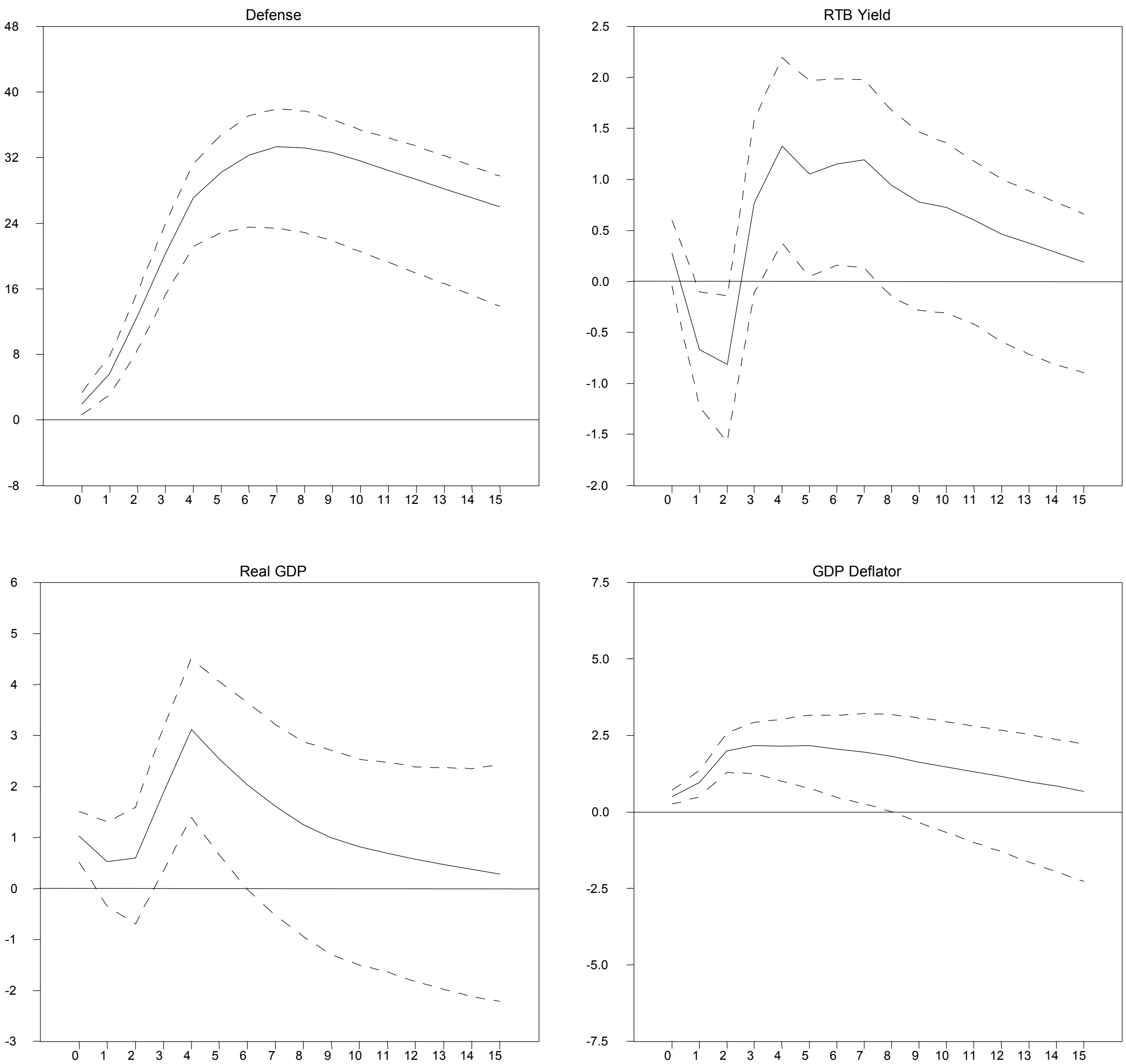

Figure 2.4: Point Estimates from Benchmark Model
Sample period: 1948:1 to 1999:2

2.4 Alternative Time Trends and Lag Lengths

This section presents statistical evidence on the selection of an appropriate time trend and an adequate lag length for the variables included in the VAR system under study. Furthermore, it examines the sensitivity of the results reported for the benchmark model to adding a time trend and changing the lag length used.

Edelberg, Eichenbaum, and Fisher (1999) do not include a time trend in the VAR systems they estimate. In contrast, Ramey and Shapiro (1997) include a "Perron-type" time trend in the equations they estimate, which means they include two linear time trends. The first trend starts in the first quarter of 1947 and ends in the last quarter of their sample period. The second trend starts in the second quarter of 1973 and also ends in the last quarter of their sample period.

By including a "Perron-type" time trend, Ramey and Shapiro (1997) presume that the series they used are trend stationary processes, and they allow the growth rates of the series to change in 1973:2 since the trend in productivity growth changed at this point (Perron (1990)). Neither Edelberg, Eichenbaum, and Fisher (1999) nor Ramey and Shapiro (1997) present evidence to support their selection.

Furthermore, Edelberg, Eichenbaum, and Fisher (1999) estimate VAR systems in which they include four lagged values of the endogenous and the Ramey-Shapiro dummy variables.[7] In contrast, Ramey and Shapiro (1997) estimate equations in which they include eight lagged values of the endogenous variables and their dummy variable. Neither study discusses the selection of the lag lengths used.

As is well known by now (Enders (1995) p. 313; Lutkepohl (1993), p. 118), selecting an adequate lag length for the variables included in any VAR system is an important issue. If the lag length selected is too long, degrees of freedom are wasted. If the lag length selected is too short, the system is mis-specified and yields biased coefficient estimates. Furthermore, even though the variables included in a VAR system may be non-stationary or cointegrated, maximum likelihood estimation yields consistent, although not efficient, estimates of all the parameters, provided that variables in levels and long enough lags are used (see Hamilton (1994), pp. 561-562, pp. 579-580; Weise (1996), p. 28).

VAR systems in which the variables are in levels rather than in differences are estimated even though the series may be non-stationary for three reasons.[8] First, it is difficult to distinguish between a unit root and an autoregression parameter close to one using unit root tests, and it may be concluded that the variables are non-stationary even though they are in fact stationary. In this case, a VAR system in which a unit root is imposed, and hence the variables are in first differences, is estimated; however the system is mis-specified and yields biased coefficient estimates (Hamilton (1994), p. 562, Weise (1996), p. 28).

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[7] Ramey and Shapiro (1997) also include the contemporaneous value of their dummy variable in the equations they estimate. Throughout this section, only the number of lagged values of the variables in the systems estimated is mentioned. It is understood that the contemporaneous value of the Ramey-Shapiro dummy variable, and other dummy variables, is also included.

[8] When first differences are used to estimate the benchmark model, the IRF for RTB is inconsistent with the two-sector models of Edelberg, Eichenbaum, and Fisher (1999) and Ramey and Shapiro as well as the more traditional IS-LM and one sector neo-classical models. It decreases significantly and briefly immediately after a Ramey-Shapiro episode, then it never rises significantly.

Second, even though the variables may be non-stationary, maximum likelihood estimation of a VAR system in levels yields consistent coefficient estimates of all the parameters. Third, the variables may not only be non-stationary but also may be cointegrated. In this case, a VAR system in first differences is also mis-specified and yields inconsistent coefficient estimates. However, as was mentioned above, a VAR system in levels yields consistent coefficient estimates, provided that long enough lags are used (Hamilton (1994), pp. 561-562, pp. 579-580, Weise (1996), p. 28).

2.4.1 Time Trend

To select an appropriate time trend for the VAR system under study, models in which different types of time trend are added, in turn, to each equation of the benchmark model are estimated, and the corresponding AIC and Schwartz Bayesian Criterion (SBC) values are computed. Systems with no time trend, a linear trend only, linear and quadratic trends, and a "Perron-type" time trend are considered. The preferred specification is the one that minimizes the AIC and SBC values.

Then, a series of likelihood ratio test statistics is computed. First, the null hypothesis of no time trend is tested against the alternatives of a linear trend only, linear and quadratic trends, and a "Perron-type" trend. Second, the null hypothesis of a linear trend only is tested against the alternatives of linear and quadratic trends and a "Perron-type" trend.

In order to test the null hypothesis of no time trend against the alternative of a linear trend only, a restricted model, which corresponds to the benchmark model, is estimated. Then, an unrestricted model, in which a linear trend is added to each equation of the benchmark model, is estimated. Finally, following Sims (1980), the likelihood ratio statistic is computed.[9]

This likelihood ratio statistic has an asymptotic χ^2 distribution with degrees of freedom equal to the number of restrictions in the system, which is four for this test. If, for the 5 percent significance level, the likelihood ratio statistic computed exceeds the critical value for the χ^2 distribution, the null hypothesis of no time trend can be rejected. Therefore, it is concluded that the model with a linear trend only is preferred. The same procedure is followed to carry out the other likelihood ratio tests.

The null hypothesis of a "Perron-type" trend against the alternative of linear and quadratic trends (or vice versa) cannot be tested using a likelihood ratio test because the unrestricted model would be constructed by substituting the quadratic trend for the second time trend included in a "Perron-type" trend, which starts in 1973:2. However, to carry out a likelihood ratio test, it is necessary to add a variable to the restricted model to construct the unrestricted model.

Table 2.1 reports the AIC and SBC values computed when the benchmark model is estimated under the alternative assumptions for the time trend. Both the AIC and SBC criteria imply that it is better to include a "Perron type" time trend in the VAR system under study.

[9] Following Sims (1980), the formula used to compute the likelihood ratio statistic is $(T\text{-}c)$ $(\log |\Sigma_r| - \log |\Sigma_u|)$ where T is the number of usable observations, c is the number of parameters estimated in each equation of the unrestricted model, $|\Sigma_r|$ and $|\Sigma_u|$ are the natural logarithm of the determinants of the variance/covariance matrices from the restricted and unrestricted models, respectively (see Enders 1995, pp. 313-314)

Table 2.1: AIC and SBC Values for Time Trend
Benchmark Model (1948:1-1999:2)

Type of time trend	Aikaike's Information Criterion	Schwarz's Criterion
No trend	-5885.04	-5592.19
Linear trend only	-5895.52	-5589.36
"Perron-type"	-5906.12	-5586.65
Linear and quadratic trend	-5848.50	-5556.07

Table 2.2 reports the results of the likelihood ratio tests carried out. In each case, the null hypothesis is rejected. Thus, it is concluded that including any type of time trend is better than including no time trend. Furthermore, it is concluded that including linear and quadratic trends or a "Perron-type" trend is better than including a linear trend only.

Table 2.2: Likelihood Ratio Tests for Time Trend
Benchmark Model (1948:1-1999:2)

Null hypothesis	Alternative	Test value	P-value
No time trend	Linear trend	16.42*	0.0025
No time trend	Linear and Quadratic trend	32.76**	0.0000
No time trend	"Perron-type" trend	38.72**	0.0001
Linear trend only	Linear and Quadratic trend	16.43*	0.0025
Linear trend only	"Perron-type" trend	22.39*	0.0002

* 4 restrictions are imposed. The critical value at a 5% significance level for a chi-square distribution with 4 degrees of freedom is 9.49.
** 8 restrictions are imposed. The critical value at a 5% significance level for a chi-square distribution with 8 degrees of freedom is 15.51.

While the statistical evidence reported above implies that it is better to include linear and quadratic trends or a "Perron-type" trend to the VAR system under study, the addition of time trends may not significantly affect the results reported for the benchmark model. In order to examine the effects of adding a Perron-type trend or linear and quadratic trends to the benchmark model on the results reported for the benchmark model, a methodology in the spirit of McMillin (2001) is applied.

If the results reported for the benchmark model are not sensitive to the addition of time trends, the IRFs computed for the models with time trends ought to lie within the corresponding confidence intervals reported for the benchmark model. In Figure 2.5, the solid lines display the point estimates of the IRFs for defense purchases, real GDP, RTB, and the GDP deflator computed when linear and quadratic trends and a "Perron-type" trend are added, in turn, to the benchmark model. The dashed lines display the confidence intervals computed for the benchmark model.

When linear and quadratic trends or a "Perron-type" trend are added to each equation of the benchmark model, all the IRFs computed lie within the corresponding confidence intervals reported for the benchmark model at all horizons. Therefore, it is concluded that the results reported for the benchmark model are not sensitive to adding time trends.

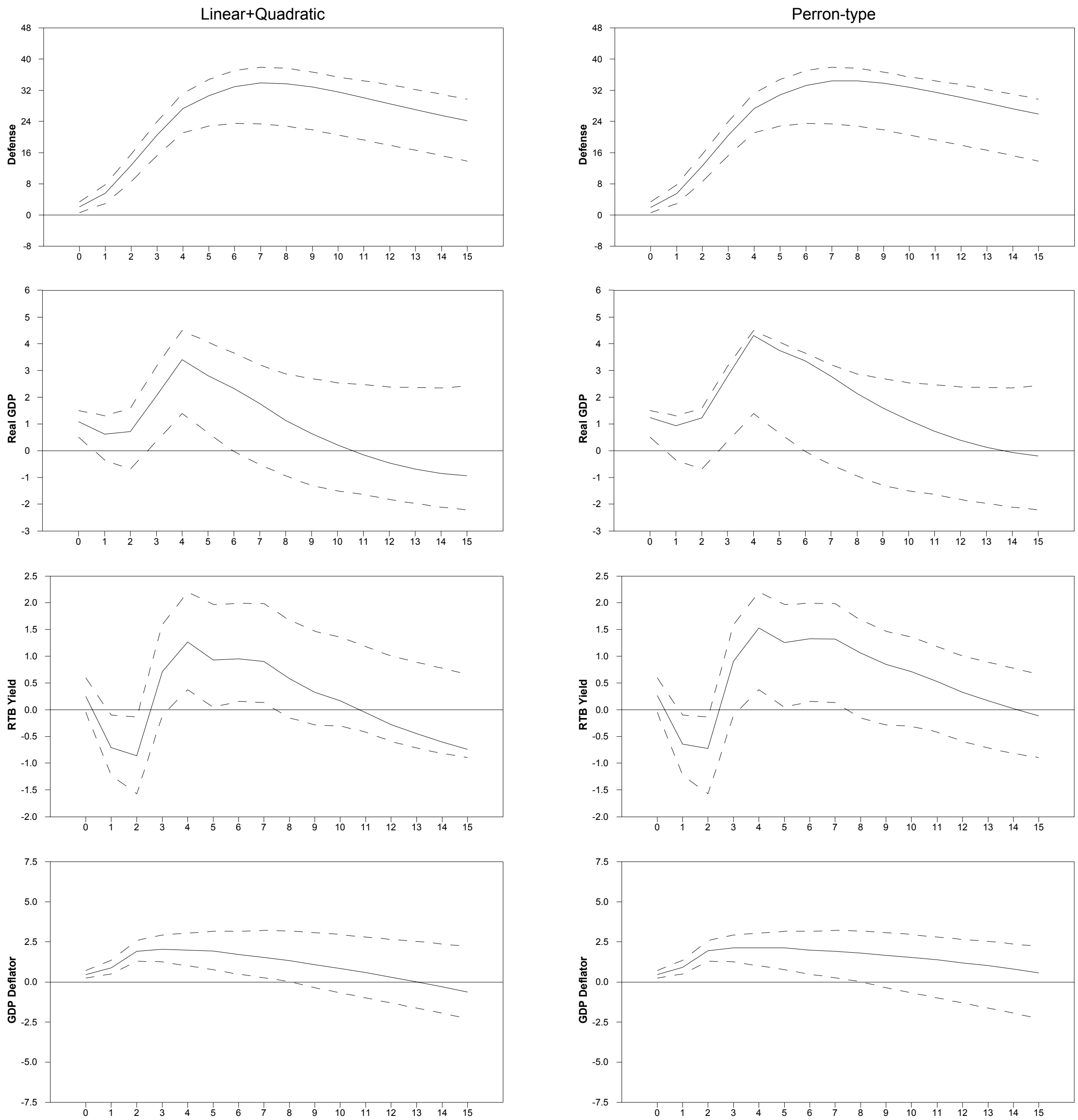

Figure 2.5: Point Estimates from Models with Alternative Time Trends
Confidence Intervals from Benchmark Model

2.4.2 Lag Length

To select an adequate lag length for the variables included in the VAR system under study, models identical to the benchmark model except for the lag length used are estimated, and the corresponding AIC and SBC values are computed. Systems with one to eight lags of the endogenous and the Ramey-Shapiro dummy variables are considered.[10] The preferred lag length is the one that minimizes the AIC or SBC values. A sequence of likelihood ratio tests is also computed. The null hypothesis of seven lags versus the alternative of eight lags, then the null hypothesis of six lags versus the alternative seven lags, and so on, are tested.

In order to test the null hypothesis of seven lags versus the alternative of eight lags, a restricted model that includes seven lagged values of the variables is estimated. Then, an unrestricted model that includes eight lagged values of the variables is estimated. Finally, the likelihood ratio statistic is computed. It has an asymptotic χ^2 distribution with 20 degrees of freedom.

If, for the 5 percent significance level, the likelihood ratio statistic exceeds the critical value for the χ^2 distribution, the null hypothesis of seven lags can be rejected, and the model with eight lags is preferred. Otherwise, the null hypothesis of seven lags cannot be rejected, and the null hypothesis of six lags against the alternative seven lags is tested. The same procedure is repeated until a null hypothesis can be rejected.

Table 2.3 reports the AIC and SBC values computed for the VAR systems in which one to eight lagged values of the variables are included.[11] According to the AIC criterion, it is better to include six lagged values of the variables. In contrast, the SBC values reported imply that including two lagged values of the variables is better.[12]

Table 2.3: AIC and SBC Values for Lag Length

Benchmark Model (1949:1-1999:2)

Number of lags	Aikaike's Information Criterion	Schwarz's Criterion
1	-5578.63	-5459.54
2	-5771.51	-5586.25
3	-5801.00.	-5549.57
4	-5814.30	-5496.71
5	-5813.93	-5430.17
6	-5861.80	-5411.87
7	-5844.52	-5328.43
8	-5833.64	-5251.38

Table 2.4 reports the results of the likelihood ratio tests carried out. It indicates that the null hypotheses of seven and six lags cannot be rejected; however, the null

[10] Only models for which the lag length used for the endogenous variables and the dummy variable are identical are considered.

[11] For comparison's sake, the AIC and SBC values and the likelihood ratio statistic are computed when the corresponding systems are estimated over the period from 1949:1 to 1999:2.

[12] In some circumstances, using a criterion such as the AIC, the SBC, or likelihood ratio tests to select the lag length may yield a model in which serial correlation of the residuals may be problematic. However, the q-statistic computed when the benchmark model is estimated with two, four, and six lags of the endogenous and dummy variables suggest that the residuals are serially uncorrelated for all lag lengths.

hypothesis of five lags can be rejected. Therefore, according to the likelihood ratio tests, it is better to include six lagged values of the variables.

Table 2.4: Likelihood Ratio Tests for Lag Length
Benchmark Model (1949:1-1999:2)

Null hypothesis	Alternative	Test value*	P-value
Lag length = 7	Lag length =8	21.71	0.3561
Lag length = 6	Lag length = 7	26.30	0.1561
Lag length = 5	Lag length = 6	66.84	0.0000

* For every test we impose 20 restrictions. The critical value at a 5% significance level for a chi-square distribution with 20 degrees of freedom is 31.41.

While the statistical evidence reported above implies that it is better to include either two or six lagged values of the variables in the VAR system under study, altering the lag length used may not affect the results reported for the benchmark model. Therefore, the effects of using two and six lagged values of the variables on the results reported for the benchmark model is examined.

If the results reported for the benchmark model are not sensitive to the lag length used, the IRFs computed for the models with two and six lags ought to lie within the corresponding confidence intervals from the benchmark model. In Figure 2.6, the solid lines display the point estimates of the IRFs for defense purchases, real GDP, RTB, and the GDP deflator computed for the models with two and six lagged values of the endogenous and dummy variables. The dashed lines display the confidence intervals computed for the benchmark model.

Beginning several periods after the onset of an episode, the IRF for RTB computed for the model with two lags lies below the lower bound of the confidence interval from the benchmark model for two and a half years and is negative. Therefore, the IRF for RTB computed for the model with two lags is significantly different from the one reported for the benchmark model. The IRFs for defense purchases, real GDP and the GDP deflator computed for the model with two lags lie within the corresponding confidence intervals from the benchmark model at all horizons. However, the IRF for real GDP exhibits a pattern very different from the one reported for the benchmark model. It does not exhibit a hump-shaped pattern but a very flat pattern.[13]

The IRF for RTB computed for the model with six lags is significantly different from the one reported for the benchmark model. Two years after the onset of a Ramey-Shapiro episode, the IRF for RTB computed for the model with six lags lies above the upper bound of the confidence interval from the benchmark model. The IRFs for defense purchases, real GDP, and the GDP deflator computed for the model with six lags lie on or within the confidence intervals from the benchmark model at all horizons, although the point estimate for defense purchases is consistently near the lower bound of the corresponding confidence interval.

[13]Furthermore, when confidence intervals are computed for the model with two lags, the IRF for RTB is negative and significant in the first year and in the fourth year after a Ramey-Shapiro episode. It is not significantly different from zero at other horizons. Moreover, the increase in the IRF for real GDP is very marginally and intermittently significant.

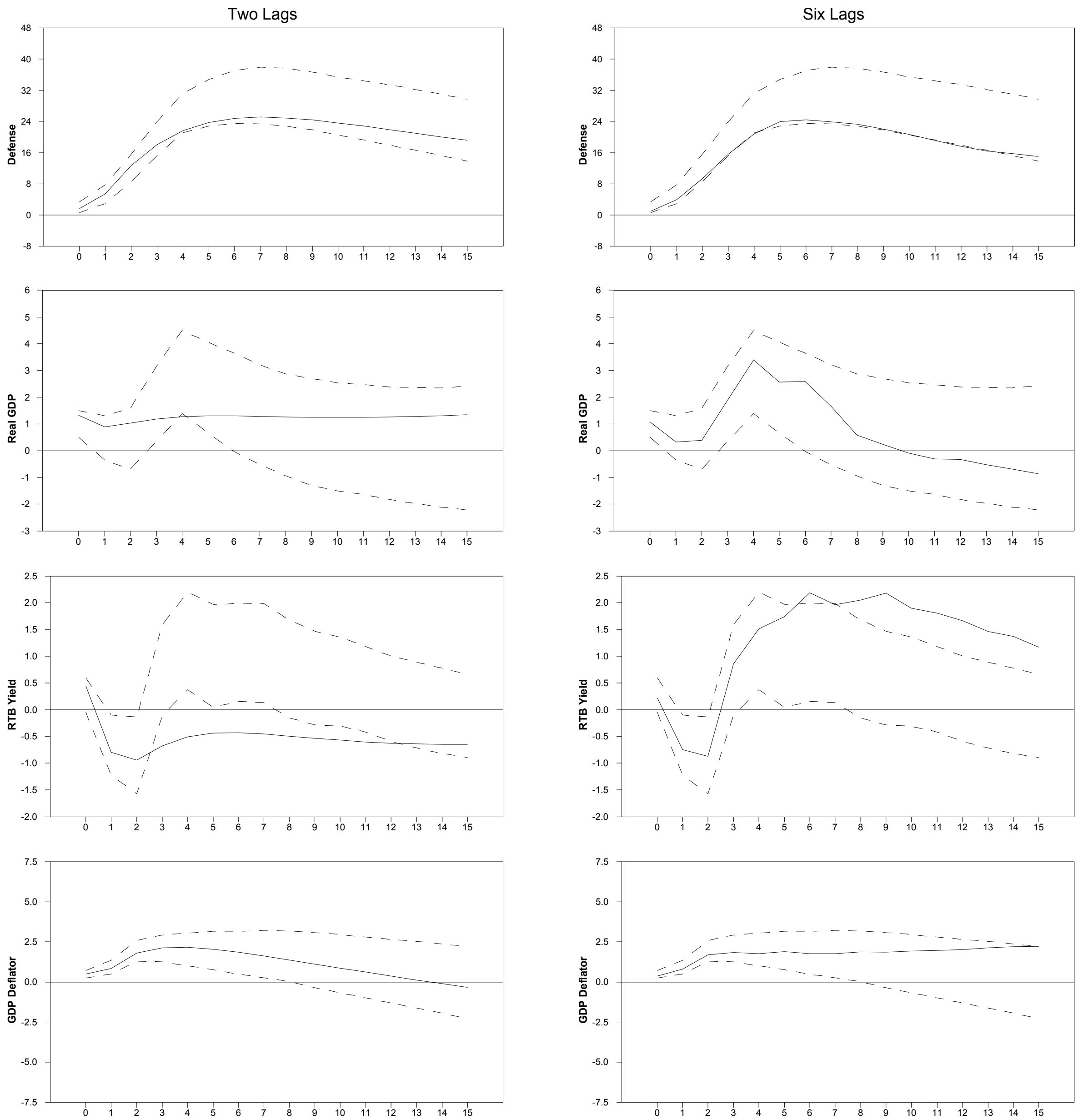

Figure 2.6: Point Estimates from Models with Alternative Lag Lengths
Confidence Intervals from Benchmark Model

Overall, the statistical evidence reported in this section imply that it may be more appropriate to estimate a VAR system in which each equation includes a "Perron-type" time trend. However, the IRFs presented when linear and quadratic time trends or a "Perron-type" trend are added to the benchmark model are not significantly different from the IRFs reported for the benchmark model.

Moreover, the statistical evidence reported in this section yield different conclusions with regard to the best lag length to use to estimate the VAR system under study. Based on the SBC criterion, it appears better to include only two lagged values of the endogenous and the Ramey-Shapiro dummy variables in each equation of the VAR system under study. However, the AIC criterion and the likelihood ratio tests carried out imply that it is better to include six lagged values of the variables.

The IRFs presented when two or six lagged values of the variables are used to estimate the VAR system under study indicate that altering the lag length affects the results reported for RTB, and to a lesser extent, defense purchases and real GDP. In particular, the IRFs for real GDP and RTB computed for the model with two lags are inconsistent with the theoretical two-sector neoclassical models presented by Ramey and Shapiro (1997) and Edelberg, Eichenbaum, and Fisher (1999) as well as the more traditional IS-LM and one-sector neoclassical models.

In conjunction with the statistical evidence reported above, the IRFs presented for the models with two or six lagged values of the variables suggest that the model with six lags is preferred. Furthermore, the appropriateness of estimating the model with six lags is reinforced by the evidence from a study by Kilian (2000), who examines the implications of using the AIC and other criteria for selecting the lag length used to estimate VAR systems.

Kilian (2000) presents a Monte Carlo study in which he shows that the AIC has better finite-sample properties than more parsimonious lag order selection criteria such as the SBC. He also provides evidence that the costs associated with underfitting a VAR system are disproportionately larger than the costs associated with overfitting the system. As a result, he argues, "… Less parsimonious lag order selection criteria such as the AIC may result in more accurate impulse response estimates compared to the highly parsimonious [SBC]" (Kilian 2000, p. 2).

2.5 Alternative Model

Edelberg, Eichenbaum, and Fisher (1999) include four lagged values of the variables in the equations of the VAR systems they estimate. Furthermore, they do not include a time trend. The evidence reported in the last section suggests that the specification of the equations selected by Edelberg, Eichenbaum, and Fisher (1999) may not be the best for the VAR system under study.

To select the best specification for the VAR system under study, AIC values are computed when twelve models that include defense purchases, real GDP, RTB, and the GDP deflator are estimated using with different lag lengths and time trends. Models with two, four, six and eight lagged values of the variables are considered as well as with no time trend, linear and quadratic trends, and a "Perron-type" trend.[14] The model that yields the lowest AIC value is selected as the alternative model.

The AIC values computed for the different models are reported in Table 2.5. They indicate that the model with six lags and a "Perron-type" time trend represents the best

[14] For comparison's sake, all the systems are estimated over the period from 1949:1 to 1999:2.

specification for the VAR system under study. This model is hereafter referred to as the alternative model. In the first column of Figure 2.7, the solid lines display the point estimates of the IRFs for defense purchases, real GDP, RTB, and the GDP deflator computed for a unit shock to defense purchases when the alternative model is estimated. The dashed lines display the lower and upper bounds of sixty-eight percent confidence intervals.

Table 2.5: AIC Values for Various Time Trends and Lag Lengths

Benchmark Model (1948:3-1999:2)

Number of lags	No Time Trend	Linear and Quadratic Trend	"Perron-type" Trend
2	-5743.73	-5572.04	-5771.51
4	-5784.08	-5805.34	-5814.30
6	-5830.51	-5858.14	-5861.79
8	-5807.84	-5832.64	-5833.64

For all the variables, especially RTB and the GDP deflator, the confidence intervals computed for the alternative model are narrower than the ones reported for the benchmark model, and it may be argued that the IRFs computed for the alternative model are more precisely estimated than the ones reported for the benchmark model. Furthermore, the patterns of the IRFs computed for the alternative model appear to differ only moderately from the ones reported for the benchmark model. The IRF for defense purchases exhibits a pattern similar to the one reported for the benchmark model; however, the peak effect of a Ramey-Shapiro episode on defense purchases computed for the alternative model is three-fourths of the peak effect reported for the benchmark model.

The IRFs for real GDP and RTB computed for the alternative model appear similar, but somewhat larger, than the ones reported for the benchmark model. Furthermore, the delayed increase in RTB reported for the alternative model is significant for more than two and a half years, compared to a year for the benchmark model. Finally, the IRF for the GDP deflator computed for the alternative model appears similar to the one reported for the benchmark model; however, it is more persistent. It increases significantly for four years after a Ramey-Shapiro episode, compared to two years for the benchmark model.

To further compare the results reported for the benchmark and alternative models, the IRFs for defense purchases, real GDP, RTB, and the GDP deflator computed for the benchmark model are plotted against the corresponding confidence intervals from the alternative model, which is the preferred model. If the IRFs computed for the benchmark model are not significantly different from the IRFs reported for the alternative model, they ought to lie within the corresponding confidence intervals from the alternative model. In the second column of Figure 2.7, the solid lines display the point estimates of the IRFs for defense purchases, real GDP, RTB, and the GDP deflator computed for the benchmark model. The dashed lines display the confidence intervals computed for the alternative model.

The IRF for defense purchases computed for the benchmark model is significantly, although modestly, larger than for the alternative model. Three periods after

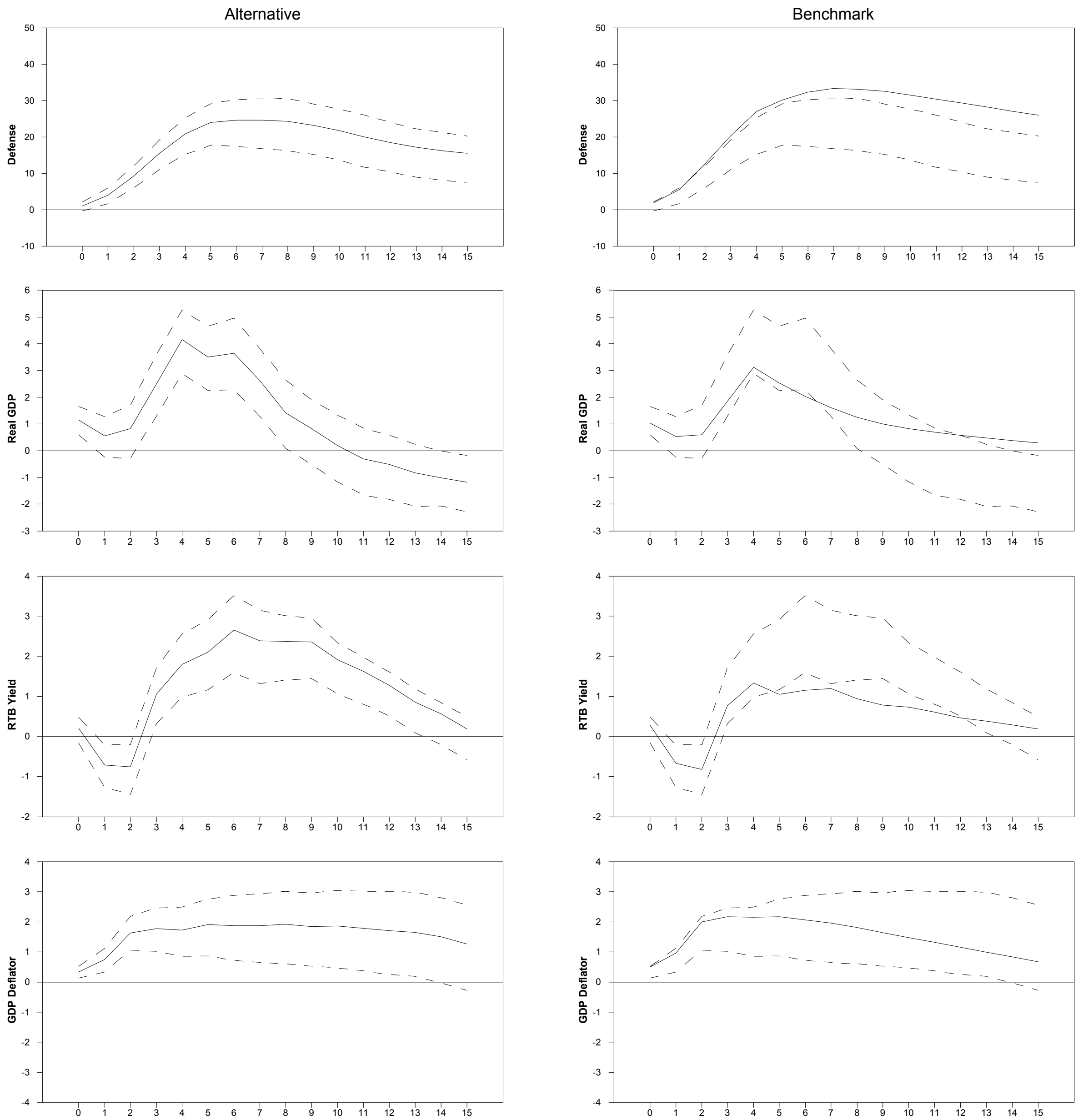

Figure 2.7: Point Estimates from Alternative Model and Benchmark Model
Confidence Interval from Alternative Model

the onset of a Ramey-Shapiro episode, it lies slightly above the upper bound of the confidence interval reported for the alternative model. The IRF for real GDP computed for the benchmark model is marginally different from the IRF reported for the alternative model. In the second year after the onset of an episode, it lies very slightly below the lower bound of the confidence interval from the alternative model for a single period. Three years after the onset of an episode, it lies slightly above the upper bound of the confidence interval.

The delayed rise in RTB computed for the benchmark model is significantly smaller than for the alternative model. A year after the onset of a Ramey-Shapiro episode, it lies slightly below the lower bound of the confidence interval from the alternative model for roughly two years. The IRF for the GDP deflator computed for the benchmark model is never significantly different from the IRF reported for the alternative model.

In conclusion, according to the AIC criterion, it appears preferable to estimate a VAR system with a "Perron-type" trend as well as six lagged values of the endogenous and dummy variables; this specification is referred to as the alternative model. The IRFs reported for the alternative model have narrower confidence intervals than the IRFs reported for the benchmark model, which corresponds to the specification of the systems estimated by Edelberg, Eichenbaum, and Fisher (1999).

Furthermore, the patterns of the IRFs computed for the alternative model are fairly similar to the ones reported for the benchmark model. However, the magnitudes of the effects of a shock to the Ramey-Shapiro dummy variable on defense purchases and RTB, and to a lesser extent real GDP, computed for the alternative model differ from the ones reported for the benchmark model.

2.6 Extended Models

Based on a study by Christiano (1990), Edelberg, Eichenbaum, and Fisher (1999) argue against using VAR-based identification schemes such as the Choleski decomposition to identify exogenous shocks to government purchases. They claim that inference reported using VAR-based innovations appears fragile to perturbations in the list of variables used (see Edelberg, Eichenbaum, and Fisher (1999), p. 3). Neither Edelberg, Eichenbaum, and Fisher (1999) nor Ramey and Shapiro (1997) present evidence on the sensitivity of the results computed with the Ramey-Shapiro episodes to perturbations in the list of variables included in their models.

This section investigates the sensitivity of the results reported for defense purchases, real GDP, RTB, and the GDP deflator to adding an additional endogenous variable or an additional exogenous dummy variable to the alternative model. Overall, seventeen variables are considered. To assess the sensitivity of the results reported for the alternative model to the addition of any given variable, an extended version of the alternative model is estimated that includes the Ramey-Shapiro dummy variable, defense purchases, real GDP, RTB, the GDP deflator, and the variable under consideration. Six lagged values of the additional variable under consideration are included if it is endogenous. The contemporaneous and six lagged values are included if it is an exogenous dummy variable.

Then, the IRFs for defense purchases, real GDP, RTB, and the GDP deflator are computed for a unit shock to the Ramey-Shapiro dummy variable. Finally, the point estimates of the IRFs computed for the extended model are plotted against the

corresponding confidence intervals reported for the alternative model. If the results reported for the alternative model are not sensitive to perturbations in the list of variables used, the IRFs computed for the extended model ought to lie within the corresponding confidence intervals reported for the alternative model.

First, the effects of the Ramey-Shapiro episodes are examined in models that alternatively include non-defense purchases, real federal government receipts, and the real federal government deficit. Then, the effects of the episodes in models that alternatively include consumption of non-durables and services, consumption of durables plus residential investment, and non-residential investment are considered.

Next, the effects of the Ramey-Shapiro episodes are examined in models that alternatively include total private employment, employment in the non-durables manufacturing sector, employment in the durables manufacturing sector, real wages in private industry, real compensation in the manufacturing sector, and real compensation in the business sector. Finally, the effects of the Ramey-Shapiro episodes in models that alternatively include the Romers' monetary policy dummy variable, the monetary base, Hamilton's oil price dummy variable, the PPI for crude fuel, and a measure of long-term interest rates are presented.

2.6.1 Additional Fiscal Variables

The Ramey-Shapiro episodes may be characterized not only by an increase in defense purchases but also by systematic changes in other dimensions of fiscal policy. If relevant dimensions of fiscal policy are not included in the VAR systems estimated in the previous sections, the point estimates of the IRFs reported might be biased. They may present not only the effects of an increase in defense purchases but also the effects of changes in other dimensions of fiscal policy.

Therefore, this sub-section presents evidence on the effects of the Ramey-Shapiro episodes in models that alternatively include non-defense purchases, real federal government receipts, and the real federal government deficit. The logarithmic values of the fiscal variables are used except for the deficit, which takes negative values. To construct the measures of the real federal government deficit and real federal government receipts, the current values of these variables in billions of dollars are deflated by the CPI. Non-defense purchases are in billions of chained (1992) dollars.

In Figure 2.8, the point estimates of the IRFs for defense purchases, real GDP, RTB, and the GDP deflator computed when the fiscal variables listed above are added, in turn, to the alternative model are plotted against the corresponding confidence intervals from the alternative model. The solid lines display the point estimates of the IRFs. The dashed lines display the confidence intervals, which were presented in the previous section.

Except for the IRF computed for RTB when the model with the real federal government deficit is estimated, the IRFs reported for the models with a fiscal variable lie within the corresponding confidence intervals from the alternative model at all horizons. The IRF for RTB reported for the model with the real federal government deficit lies within the confidence interval from the alternative model for more than three years, and then it lies very slightly below the lower bound of the confidence interval.

Overall, eleven out of twelve IRFs computed when the fiscal variables are added, in turn, to the alternative model are not significantly different from the corresponding IRFs reported for the alternative model at any horizon. Furthermore, the IRF for RTB

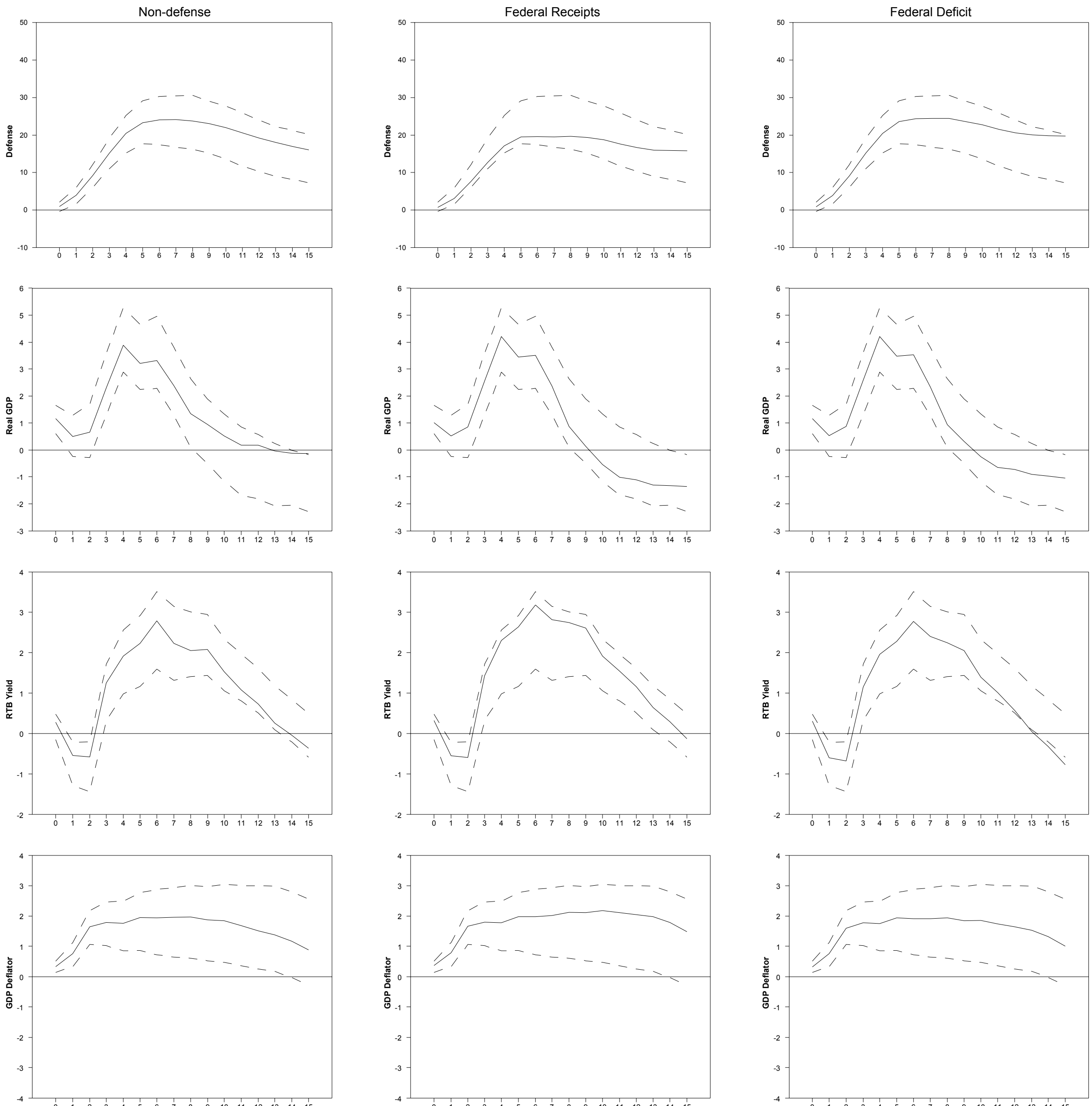

Figure 2.8: Point Estimates from Models with a Fiscal Variable.
Confidence Intervals from Alternative Model

computed for the model with the real federal government deficit is only marginally different at long horizons from the IRF reported for the alternative model. Therefore, it is concluded that the results reported for the alternative model are not sensitive to the addition of fiscal variables.

2.6.2 Additional Sectoral Variables

As was mentioned in the previous chapter, theoretical models differ on their predictions about the effects of a shock to government purchases on consumption, investment, employment and real wages. To present the effects of exogenous shocks to government purchases on these variables, many VAR systems in which they are included have been estimated in recent studies (Ramey and Shapiro (1997), Edelberg, Eichenbaum, and Fisher (1999), Perotti (2000), Fatas and Mihov (2000)).

This sub-section presents evidence on the effects of the Ramey-Shapiro episodes on defense purchases, real GDP, RTB, and the GDP deflator in models that alternatively include components of consumption and investment. Following Edelberg, Eichenbaum, and Fisher (1999), consumption and investment are broken down into three components: consumption of non-durables and services, residential investment plus consumption of durables, and non-residential investment.

This sub-section also presents evidence on the effects of the Ramey-Shapiro episodes on defense purchases, real GDP, RTB, and the GDP deflator in models that alternatively include measures of employment, real wages, and real compensation. First, employment in the private sector, employment in the non-durables sector and employment in the durables manufacturing sector are examined. Then, real wages in private industry, real compensation in the manufacturing sector, and real compensation in the business sector are considered. The logarithmic values of sectoral variables are included in the models estimated. To construct the measures of real compensation and real wages, the nominal values of these variables are deflated by the CPI. The other additional sectoral variables are in billions of chained (1992) dollars

A later chapter examines the effects of exogenous shocks to defense purchases on the sectoral variables considered in this section, which are interpreted in the context of the models discussed in the first chapter. However, in this chapter, only the robustness of the results for defense purchases, real GDP, RTB, and the GDP deflator with respect to the addition of the consumption, investment, and labor markets variables to the alternative model is examined.

In Figure 2.9, the point estimates of the IRFs for defense purchases, real GDP, RTB, and the GDP deflator computed when the consumption and investment variables listed above are added, in turn, to the alternative model are plotted against the corresponding confidence intervals from the alternative model. The solid lines display the point estimates of the IRFs and the dashed lines display the confidence intervals. All the IRFs reported for the models with a component of consumption and investment lie within or on the corresponding confidence intervals from the alternative model at all horizons.

In Figure 2.10, the point estimates of the IRFs for defense purchases, real GDP, RTB, and the GDP deflator computed when employment in private industry, employment in the non-durables manufacturing sector, and employment in the durables manufacturing sector are added, in turn, to the alternative model are plotted against the corresponding confidence intervals from the alternative model. The solid lines display the point estimates of the IRFs and the dashed lines display the confidence intervals.

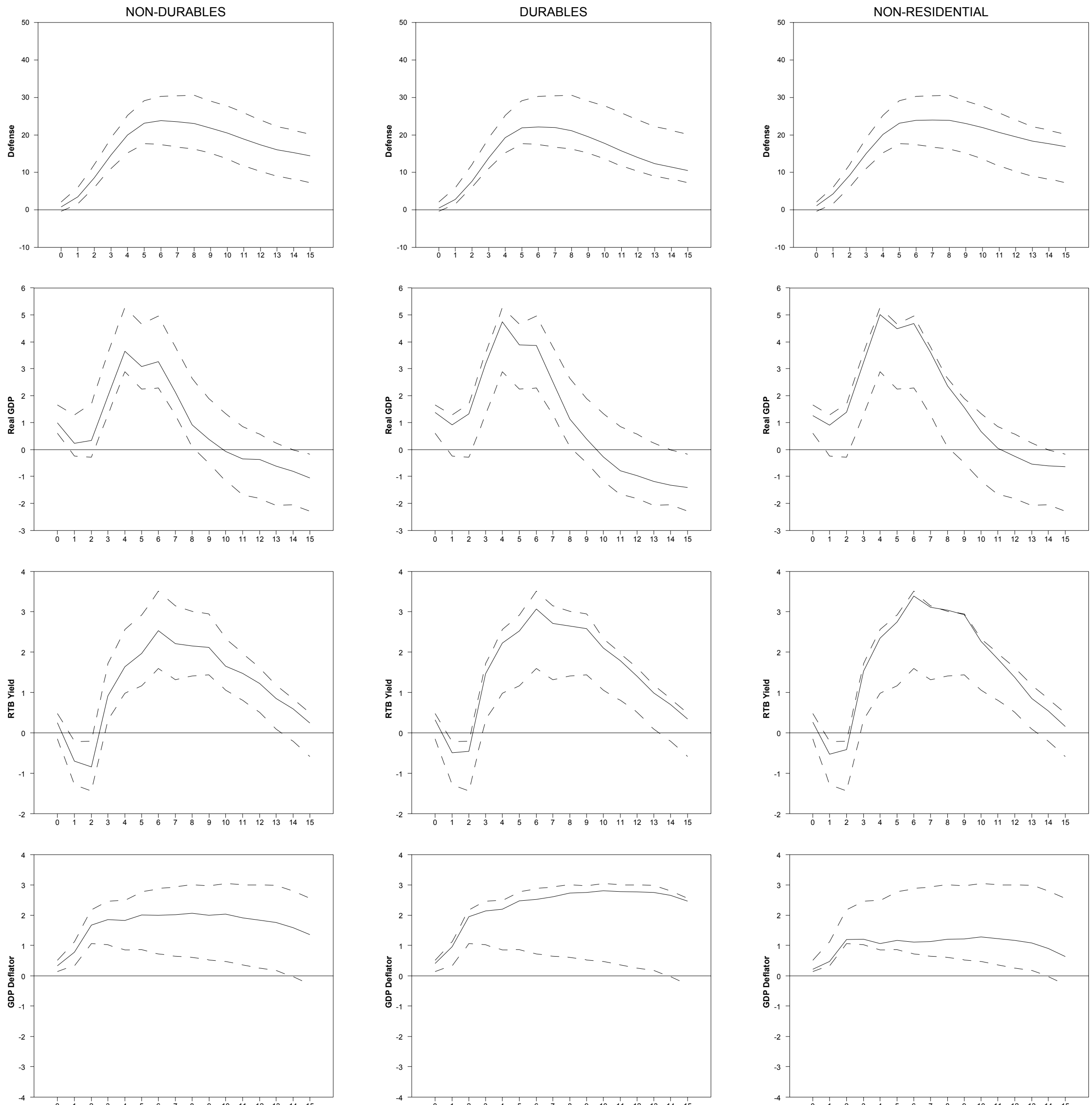

Figure 2.9: Point Estimates from Models with a Consumption or Investment Variable.
Confidence Intervals from Alternative Model

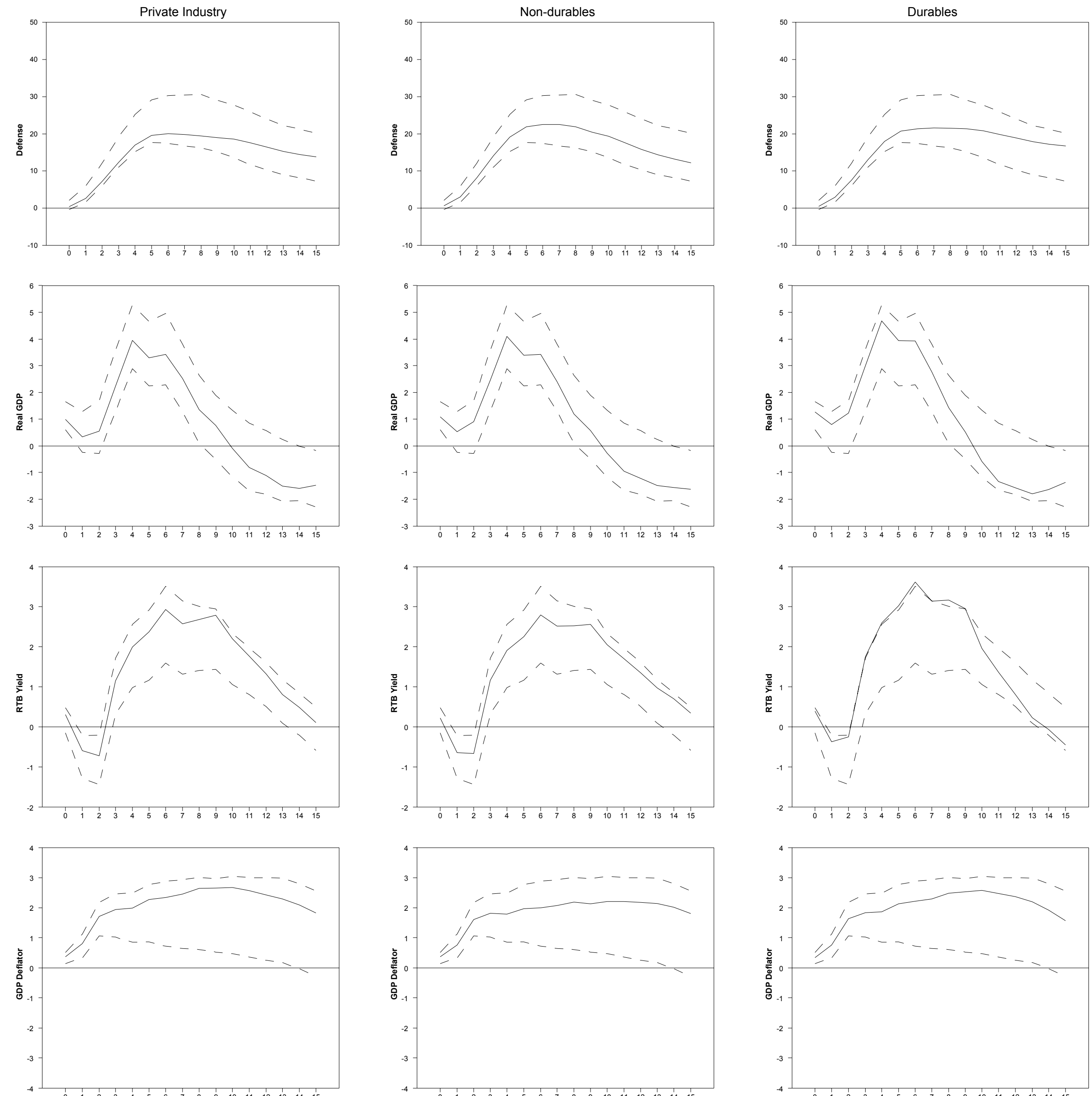

Figure 2.10: Point Estimates from Models with an Employment Variable
Confidence Intervals from Alternative Model

Except for the IRF computed for RTB when the model with employment in the durables manufacturing sector is estimated, the IRFs reported for the models with a measure of employment lie within the corresponding confidence intervals from the alternative model at all horizons. The IRF for RTB reported for the model with employment in the durables manufacturing sector lies on the upper bound of the confidence interval from the alternative model for a year, and then it lies very slightly above the upper bound for one and a half years

In Figure 2.11, the point estimates of the IRFs computed when real wages in private industry, real compensation in the manufacturing sector, and real compensation in the business sector are added, in turn, to the alternative model are plotted against the corresponding confidence intervals from the alternative model. The solid lines display the point estimates of the IRFs and the dashed lines display the confidence intervals.

Since the series for compensation in the manufacturing sector is not available before 1949:1, the model with real compensation in the manufacturing sector is estimated from 1950:3 to 1999:2. Thus, the IRFs computed for this model are plotted against the confidence intervals computed for the alternative model estimated over the same sub-sample period. All the IRFs reported for the models with a measure of real wages or real compensation lie within the corresponding confidence intervals from the alternative model at all horizons.

Overall, thirty-five out of thirty-six IRFs computed when consumption, investment, employment, real wages, and real compensation variables are added, in turn, to the alternative are not significantly different from the corresponding IRFs reported for the alternative model at any horizon. Furthermore, the IRF for RTB computed for the model with employment in the durables manufacturing sector is only marginally and temporarily different from the IRF reported for the alternative model. Therefore, it is concluded that the results reported for the alternative model are not sensitive to the addition of sectoral variables.

2.6.3 Additional Macroeconomic Variables

The recent literature on the effects of government purchases essentially ignores monetary policy. However, it has been recently argued that wars and military build-ups may be associated not only with expansionary fiscal policy but also with expansionary monetary policy. For instance, using a data set of 66 countries over the period from 1950 to 1992 and a data set of 15 countries over the from 1881 to 1988 period, Caplan (1999) shows that the money supply grows during wartime. Therefore, the IRFs computed using the Ramey-Shapiro episodes may appear to have real effects when they reflect, at least in part, the effects of monetary policy.

This sub-section presents evidence on the effects of the Ramey-Shapiro episodes in models that alternatively include the Romers' monetary policy dummy variable and the monetary base. The Romers' monetary policy dummy variable is considered since it provides a crude way to control for the effects of monetary policy shocks, specifically monetary contractions, on the economy. The monetary base is considered because it responds quickly to monetary policy actions; however, it should not be interpreted as a measure of monetary policy.[15]

[15] Although the federal funds rate is often used as a monetary policy variable, it is not included in the analysis of the sensitivity of the alternative model to adding monetary policy variables because, like RTB, it represents a measure of short-term interest rates. Furthermore, when the federal funds rate is substituted for RTB in the

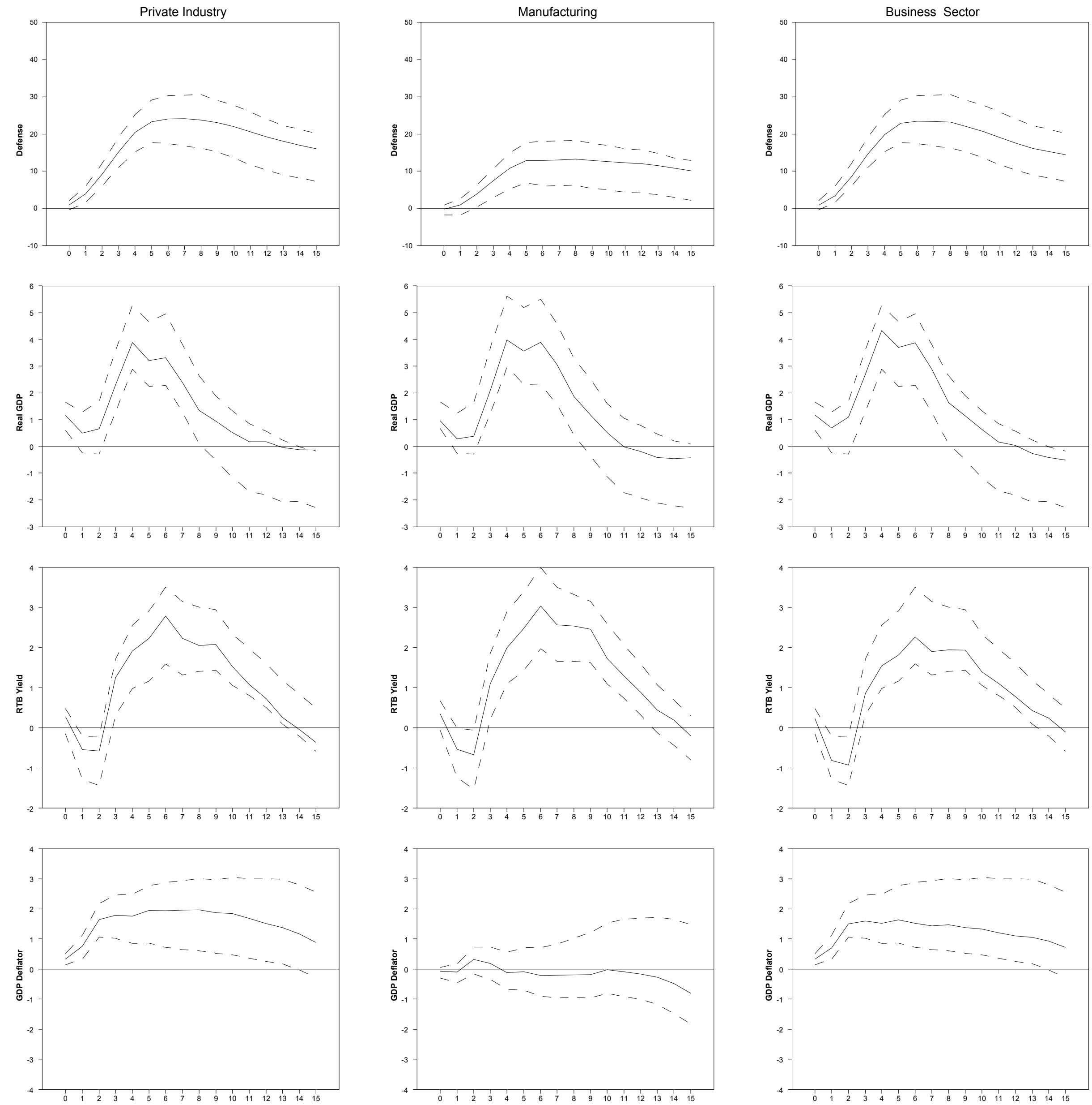

Figure 2.11: Point Estimates from Models with a Measure of Real Wages or Real Compensation
Confidence Intervals from Alternative Model

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alternative model, the IRFs computed are very similar to the ones reported for the alternative model.

Romer and Romer (1989, 1994) use a narrative approach to identify episodes in which the Federal Reserve attempted to exert a contractionary influence on the economy in order to reduce inflation. In the post-World War II era, the episodes are dated in 1947:4, 1955:3, 1968:4, 1974:2, 1978:3, 1979:4, and 1988:4. The Romers' monetary policy dummy variable has the value one at the dates of the episodes, and zero otherwise.

To examine the effects that exogenous supply shocks may have on the results reported for shocks to the Ramey-Shapiro dummy variable, this sub-section also presents evidence on the effects of the episodes in a model that includes Hamilton's oil price dummy variable and the PPI for crude fuel. Hamilton's oil price dummy variable provides a crude way to control for the effects of major oil price increases on the economy. Hamilton (1983) uses a narrative approach to identify exogenous increases in oil price. The dates of the shocks identified by Hamilton (1983) and subsequently updated by Hoover and Perez (1994) and Ramey and Shapiro (1997) are 1947:4, 1953:2, 1957:1, 1969:1, 1970:4, 1974:1, 1979:3, 1981:1, and 1990:3. Hamilton's oil price dummy has the value one at the dates of the shocks, and zero otherwise.

Finally, the interest rate channel is an important channel of transmission of fiscal policy, and long-term interest rates are considered a main determinant of interest sensitive expenditures. Therefore, this sub-section presents evidence on the effects of the Ramey-Shapiro episodes in a model that includes the constant maturity ten-year Treasury bond yield (LTR) in addition to RTB.

As was mentioned before, the contemporaneous and six lagged values of the additional dummy variables are entered as exogenous variables in the models with the Romers' monetary policy and Hamilton's oil price dummy variables. Six lagged values of the additional endogenous variables are entered in the models with the monetary base, the PPI for crude oil, and LTR. Furthermore, the logarithmic values of the monetary base and the PPI for crude fuel are included in the model with these variables.

In the first and second columns of Figure 2.12, the point estimates of the IRFs for defense purchases, real GDP, RTB, and the GDP deflator computed when the monetary variables listed above are added, in turn, to the alternative model are plotted against the corresponding confidence intervals from the alternative model. The solid lines display the point estimates of the IRFs and the dashed lines display the confidence intervals.

All the IRFs computed for the model with the Romers' monetary policy dummy variable lie well within the corresponding confidence intervals from the alternative model at all horizons. Except for real GDP, the IRFs reported for the model with the monetary base also lie within the corresponding confidence intervals from the alternative model at all horizons. The IRF for real GDP computed for the model with the monetary base lies within or on the confidence interval from the alternative model for more than two and a half years after a Ramey-Shapiro episode, and then it lies very slightly above the upper bound of the confidence interval.

In the third and fourth column of Figure 2.12, the point estimates of the IRFs for defense purchases, real GDP, RTB, and the GDP deflator computed when Hamilton's oil price dummy variable and the PPI for crude fuel are added, in turn, to the alternative model are plotted against the corresponding confidence intervals from the alternative model. The solid lines display the point estimates of the IRFs and the dashed lines display the confidence intervals.

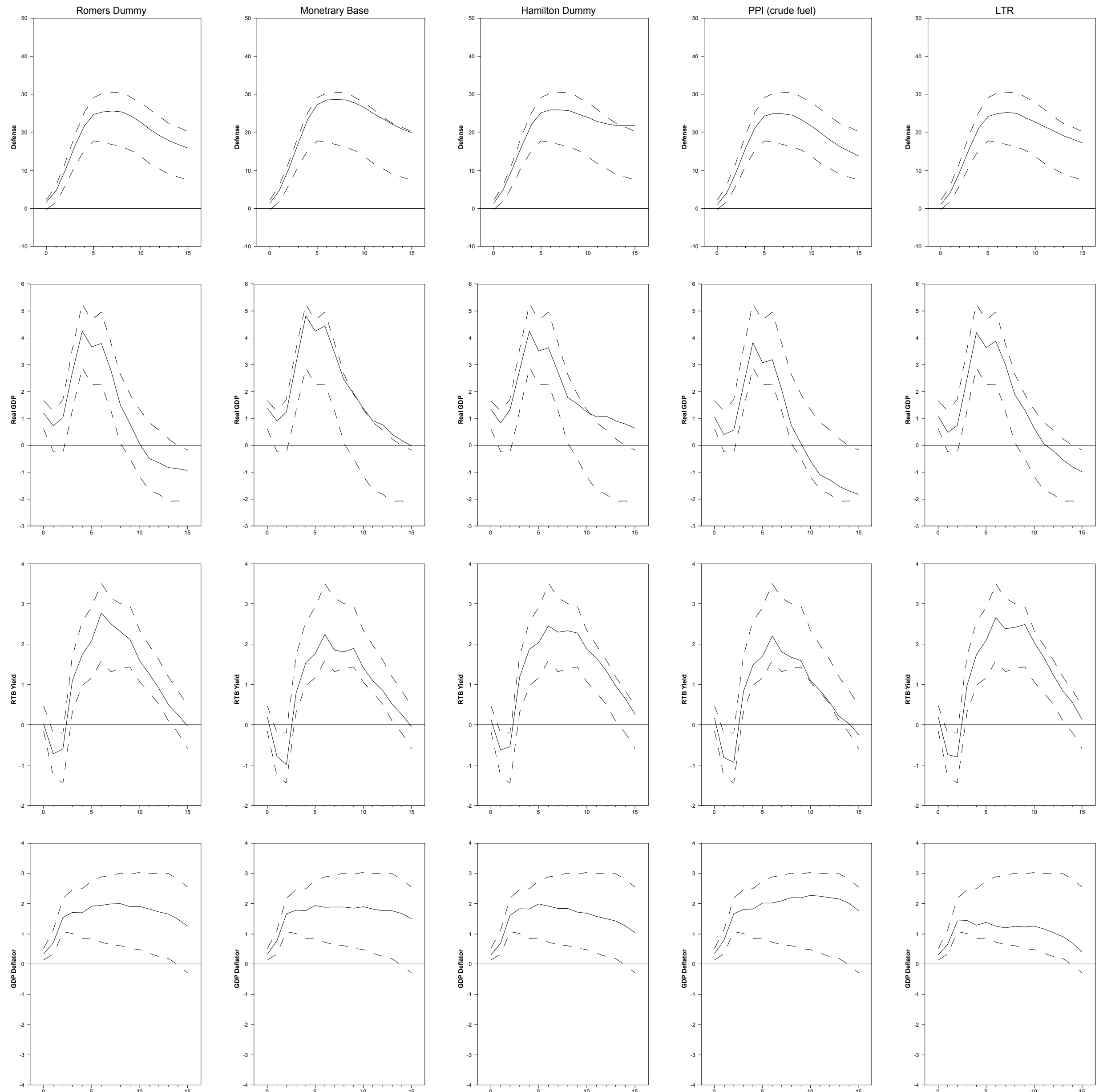

Figure 2.12: Point Estimates from Models with an Additional Macroeconomic Variable
Confidence Intervals from Alternative Model

The IRF for defense purchases computed for the model with Hamilton's oil price dummy variable lies within the confidence interval from the alternative model until the end of the fourth year after a Ramey-Shapiro episode. Then, it lies very slightly above the upper bound of the confidence interval. The IRF for real GDP lies within of the confidence interval from the alternative model for more than two and a half years after a Ramey-Shapiro episode. Then, it lies above the upper bound of the confidence interval.

The IRFs for RTB and the GDP deflator computed for the model with Hamilton's oil price dummy variable lie within the confidence intervals from the alternative model at all horizons. Furthermore, all the IRFs computed for the model with the PPI for crude fuel lie within the confidence intervals from the alternative model at all horizons, and their patterns are similar to the ones reported for the alternative model.

In the last column of Figure 2.12, the point estimates of the IRFs for defense purchases, real GDP, RTB, and the GDP deflator computed when LTR is added to the alternative model are plotted against the corresponding confidence intervals from the alternative model. The solid lines display the point estimates of the IRFs and the dashed lines display the confidence intervals. All the IRFs reported for the model with LTR lie within the corresponding confidence intervals from the alternative model at all horizons.

Overall, seventeen out of twenty IRFs computed when the Romers' monetary policy dummy variable, the monetary base, Hamilton's oil price dummy variable, and LTR are added, in turn, to the alternative model are not significantly different from the corresponding IRFs reported for the alternative model at any horizon.

The IRF for defense purchases computed for the model with Hamilton's oil price dummy variable differs significantly, although marginally, from the corresponding IRF reported for the alternative model at the end of the fourth year after a shock to the Ramey-Shapiro dummy variable. Moreover, the IRF for real GDP computed for the model with Hamilton's oil price dummy variable differs significantly and persistently from the corresponding IRF reported for the alternative model.

Therefore, it is concluded that the results reported for the alternative model are not sensitive to the addition of the macroeconomic variables examined in this sub-section, except for Hamilton's oil price dummy variable. In this case, the magnitude of the effect of a shock to the Ramey-Shapiro dummy variable differs significantly from the one reported for the alternative model at long horizons for defense purchases and real GDP, but the pattern of the effect is the same.

As was mentioned before, Perotti (2000) argues that the results reported using the Ramey-Shapiro episodes as measures of shocks to government purchases may be affected by other macroeconomic shocks occurring at periods close to the Ramey-Shapiro episodes. The sensitivity of the results reported for the model with Hamilton's oil price dummy may be attributed to the fact that a major shock to the price of oil took place the period before the date selected by Ramey and Shapiro (1997) for the onset of Carter-Reagan build-up.

Furthermore, the IRFs computed for the model with the Romers' monetary policy dummy indicate that the results reported for the alternative model do not reflect the effects of monetary policy actions,[16] and the addition of the monetary base to the

[16] The sensitivity of the results reported for the alternative model to the addition of other monetary variables was also examined. However, due to data availability, it was done over the sub-sample period from 1960:3 to 1999:2, which only includes the last two Ramey-Shapiro episodes. First, the sensitivity of the results reported for the

alternative model appears to marginally affect the results reported for a shock to the Ramey-Shapiro dummy variable. Thus, it does not appear the inclusion of monetary proxies alters the results to any substantial degree.

2.6.4 Responses of Fiscal and Monetary Variables

Previous sub-sections examined the sensitivity of the effects of a shock to the Ramey-Shapiro dummy variable on defense purchases, real GDP, RTB, and the GDP deflator to adding alternative fiscal variables and the monetary base to the alternative model. The results reported indicate that the Ramey-Shapiro episodes have a significant and persistent effect on defense purchases. It is of interest to determine whether the Ramey-Shapiro episodes altered dimensions of fiscal policy other than defense purchases or the monetary base.

This sub-section presents the effects of a shock to the Ramey-Shapiro dummy variable on non-defense purchases, real federal government receipts, the real federal government deficit, and the monetary base. Figure 2.13 displays the point estimates and the confidence intervals of the IRFs computed for the alternative fiscal variables and the monetary base when the extended models that include these variables are estimated. The solid lines display the point estimates of the IRFs. The dashed lines display the lower and upper bounds of sixty-eight percent confidence intervals.

The IRF for non-defense purchases is small and not significantly different from zero at any horizons. The IRF for real federal government receipts exhibits a hump shaped pattern. It increases significantly for almost two and a half years after an episode. It is consistent with the IRFs reported for real GDP and the GDP deflator. Indeed, as aggregate income and the price level rise persistently after a shock to defense purchases, government receipts are also expected to increase.

The IRF computed for the real federal government deficit is small and not significantly different from zero for two and a half years after the onset of a Ramey-Shapiro episode. Then, it deteriorates significantly and persistently. The pattern of the results computed for the real federal government deficit appears consistent with the evidence reported for federal government purchases and receipts.

Following a Ramey-Shapiro episode, government receipts increase significantly for more than two years, which allows the federal government to finance the military build-up without a significant deterioration of its deficit. In the third year after an episode, defense purchases remain very high but the increase in federal government receipts comes to an end and non-defense purchases are unchanged. Therefore, at longer horizons a portion of the military build-up is financed through a government deficit.

At the end of the first year after a Ramey-Shapiro episode, the IRF for the monetary base increases significantly, although very marginally and for less than a quarter. It is not significantly different from zero at any other horizon. Therefore, it is

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alternative model was investigated when the monetary aggregates M1 and M2 are added, in turn, to the alternative model. Second, the sensitivity of the results reported for the alternative model was investigated when a modified version of the VAR model presented by Christiano, Eichenbaum, and Evans (1994) is estimated. The modified Christiano, Eichenbaum, and Evans' model includes real GDP, RTB, PCOM, the GDP deflator, non-borrowed reserves, total reserves, defense purchases, and the Ramey-Shapiro dummy. The IRFs for defense purchases, real GDP, RTB, and the GDP deflator computed for the models estimated over the sub-sample period from 1960:3 to 1999:2 lie within the corresponding confidence intervals computed for the alternative model over the same sub-sample period.

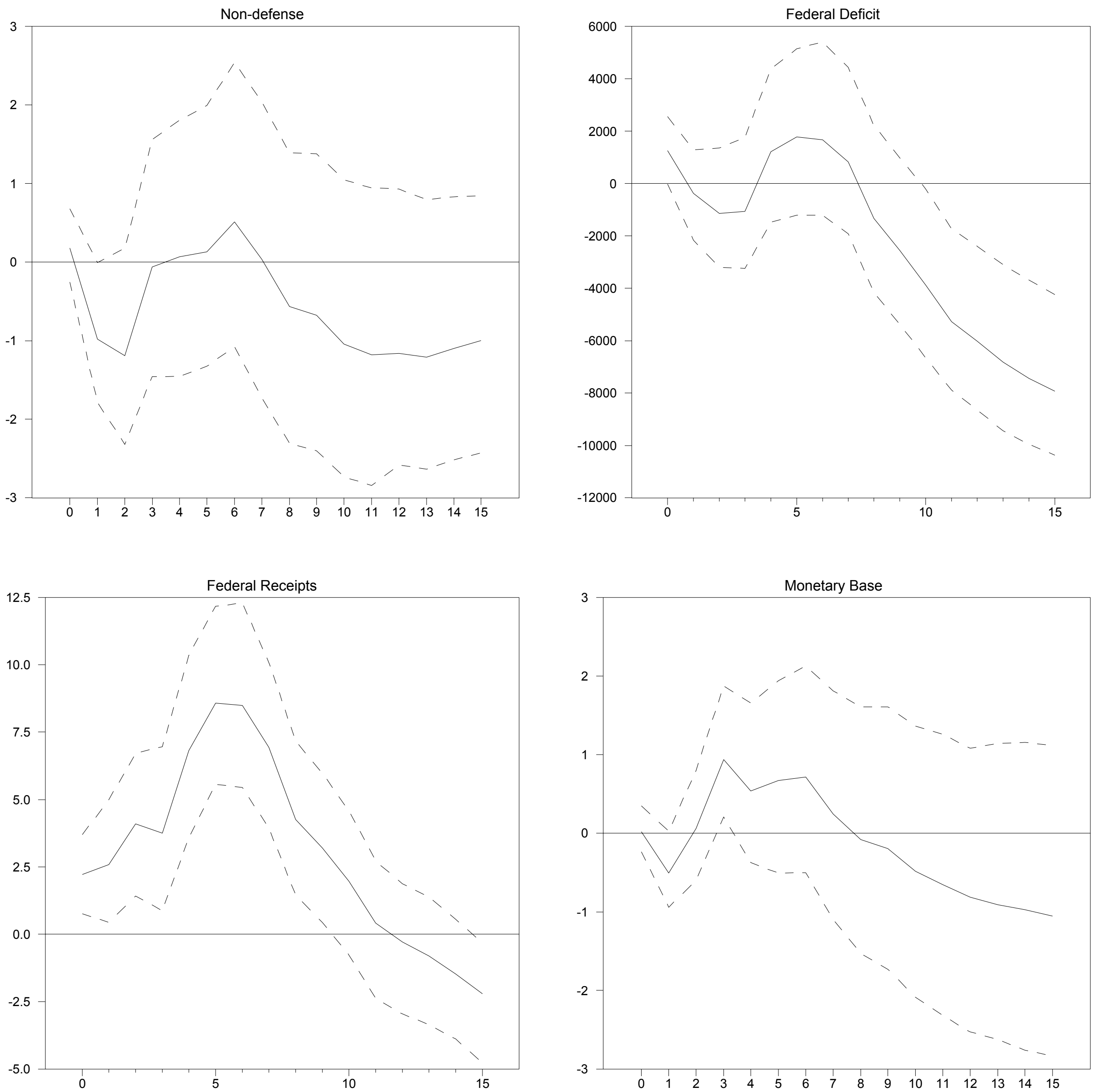

Figure 2.13: Point Estimates of the IRFs for Fiscal and Monetary variables
Sample Period: 1948:3-1999:2

argued that the Ramey-Shapiro episodes appear to have a very marginally significant and transitory effect on the monetary base.

Overall, the IRFs reported for the fiscal and monetary variables presented in this sub-section indicate that the Ramey-Shapiro episodes do not coincide with significant and persistent changes in non-defense purchases and the monetary base. It also implies that the government is initially able to finance the military build-up through an increase in revenues. However, once the increase in revenues comes to end, the government needs to finance the military build-up through a deficit.

2.7 Alternative Sample Periods

Edelberg, Eichenbaum, and Fisher (1999) claim that inference reported using VAR-based innovations to real defense purchases appears fragile to perturbations in the sample period used. However, neither Ramey and Shapiro (1997) nor Edelberg, Eichenbaum, and Fisher (1999) present evidence on the sensitivity of the results reported with the Ramey-Shapiro episodes to using different sample periods.

This section provides evidence on the sensitivity of the results reported for the alternative model to perturbations in the sample period used. First, the alternative model is estimated over four sub-sample periods that includes either two or three Ramey-Shapiro episodes. Then, the point estimates of the IRFs computed for defense purchases, real GDP, RTB, and the GDP deflator for the sub-sample periods are plotted along with the corresponding confidence intervals for the whole sample period. If the results reported for the alternative model are not sensitive to perturbations in the sample period used, the IRFs computed for the sub-sample periods ought to lie within the corresponding confidence intervals from the whole sample period.

First, the sensitivity of the alternative model to perturbations in the sample period used is examined for two sub-sample periods that include only two Ramey-Shapiro episodes. The first sub-sample period selected is 1948:1 to 1973:1, and is referred to as the early sub-sample period. It corresponds to the first half of the whole sample period and includes the first two Ramey-Shapiro episodes. It ends before the oil crisis of 1973-1974, which may have affected the structural relations among the variables in the VAR system under study. The second sub-sample period selected is 1960:1 to 1999:2, and is referred to as the late sub-sample period. It includes the last two Ramey-Shapiro episodes, and its' beginning coincides with a major turn in the Cold War brought about by the emergence of the doctrine of Mutual Assured Destruction (Ball (1980)).

The sensitivity of the alternative model to perturbations in the sample period used is also examined for two sub-sample periods that include all three Ramey-Shapiro episodes. The next sub-sample period selected is 1950:1 to 1999:2 and the final one is 1948:3 to 1989:4. In his extensive study of the defense budget for fiscal year 1950 (FY 1950), Schilling (1962) argues that no defense budget was designed from beginning to end through the organizations and institutions set up by the National Security Act of 1947 until FY 1950, and most decisions with regard to defense purchases were taken on an ad hoc basis until then. Therefore, it may beneficial to exclude the first one and a half years of data from the sample period used to estimate the alternative model. Furthermore, after the fall of the Soviet Empire, the U.S strategic environment, and hence U.S foreign and defense policy, dramatically changed. Therefore, it may be beneficial to exclude the data for the post-Cold War era, which began in the fall 1989, from the sample period used to estimate the alternative model.

In the first and second columns of Figure 2.14, the solid lines display the point estimates of the IRFs for defense purchases, real GDP, RTB, and the GDP deflator computed for a unit shock to defense purchases when the alternative model is estimated over the early and late sub-sample periods. The dashed lines display the confidence intervals reported for the whole sample period.

The IRFs for defense purchases and the GDP deflator computed for the early sub-sample period are marginally different from the ones reported for the whole sample period. After several quarters, the IRF for defense purchases lies very slightly above the upper bound of the confidence interval from the whole sample period for a year, and then it lies within the confidence interval. The IRF for the GDP deflator lies within the confidence interval from the whole sample period until the fourth year after a Ramey-Shapiro episode, and then it lies slightly above the upper bound of the confidence interval.

The IRFs for real GDP and RTB computed for the early sub-sample period are significantly and persistently different from the ones reported for the whole sample period. Except for two quarters, the IRF for real GDP lies above the upper bound of the confidence interval from the whole sample period at all horizons. The IRF for RTB is very small. Three quarters after a Ramey-Shapiro episode, it lies below the lower bound of the confidence interval from the whole sample period for three years.

The IRFs for defense purchases and the GDP deflator computed for the late sub-sample period are significantly and persistently different from the ones reported for the whole sample period. The IRF for defense purchases lies below the lower bound of the confidence interval from the whole sample period for two and a half years after a Ramey-Shapiro episode. The IRF for the GDP deflator lies below the lower bound of the confidence interval from the whole sample period for almost two years.

The IRF for real GDP computed for the late sub-sample period is not significantly different from the one reported for the whole sample period. The IRF for RTB is only marginally different from the one reported for the whole sample period. The IRF for real GDP lies within the confidence interval from the whole sample period at all horizons. The IRF for RTB lies very slightly and intermittently above the confidence interval from the whole sample period for three years, and then it lies within the confidence interval.

In the third and fourth columns of Figure 2.14, the solid lines display the point estimates of the IRFs for defense purchases, real GDP, RTB, and the GDP deflator computed for a unit shock to defense purchases when the alternative model is estimated over the sub-sample period from 1950:1 to 1999:2 and the Cold War era. The dashed lines display the confidence intervals reported for the whole sample period. The IRFs for defense purchases, real GDP, and RTB computed for the sub-sample period from 1950:1 to 1999:2 and for the Cold War era are not significantly different from the ones reported for the whole sample period. They lie within the corresponding confidence intervals from the whole sample period at all horizons.

However, the IRFs for the GDP deflator computed for the sub-sample period from 1950:1 to 1999:2 and for the Cold War era differ significantly from the IRF reported for the whole sample period. A year after the onset of a Ramey-Shapiro episode, the IRF for the GDP deflator computed for the sub-sample period from 1950:1 to 1999:2 begins to lie slightly below the lower bound of the confidence interval from the whole sample period. Three years after the onset of a Ramey-Shapiro episode, the IRF for the GDP deflator

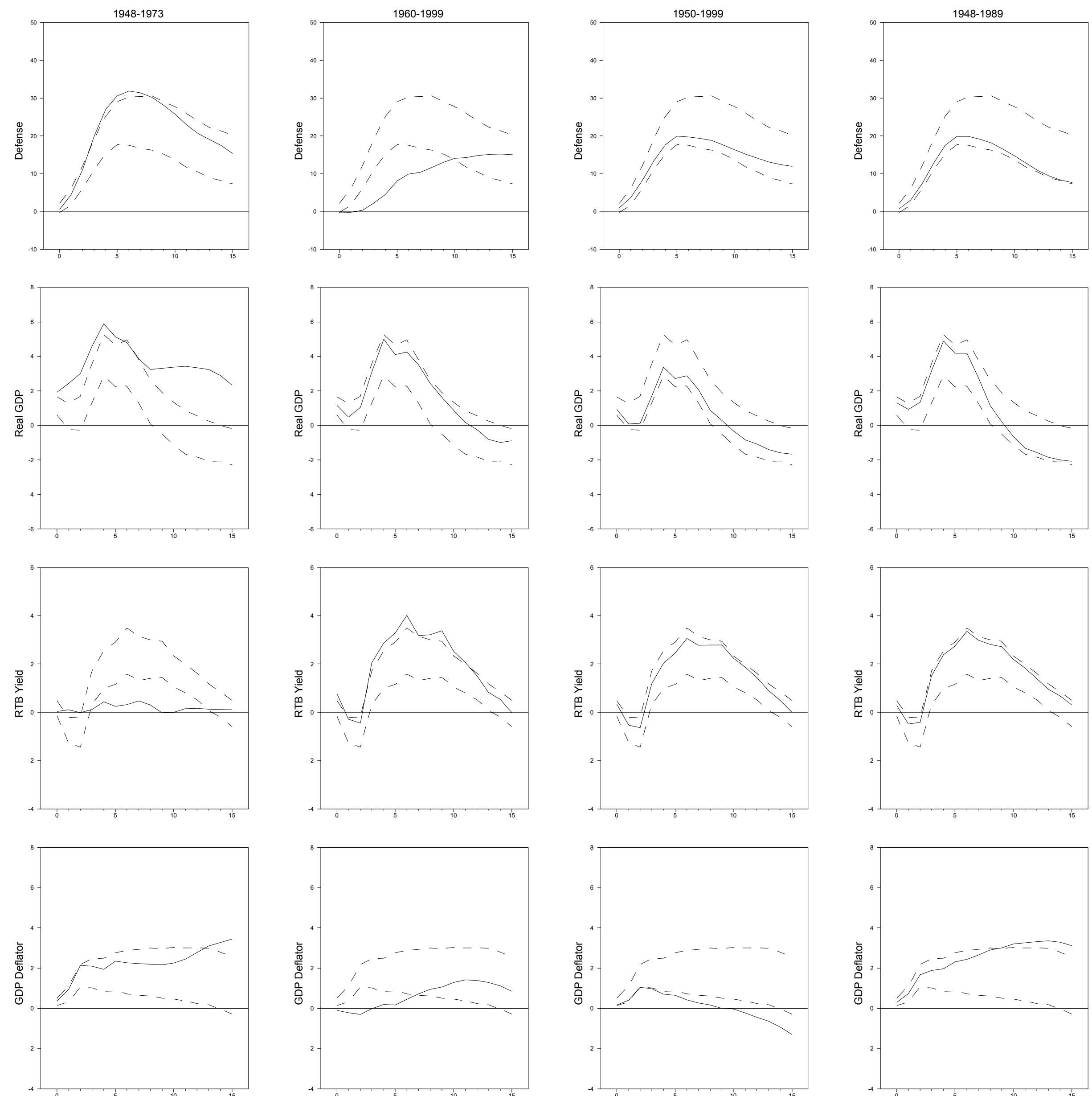

Figure 2.14: Point Estimates from Alternative Sample Periods
Confidence Intervals from Whole Sample Period

computed for the Cold War era lies slightly above the upper bound of the confidence interval from the whole sample period.

The sensitivity of the IRF for the GDP deflator to the subtraction of a small number of data at the beginning of the whole sample period may be explained by the unusual behavior of the GDP deflator during the period from 1948:3 to 1949:4. It increased by more than two percent in 1948:3. Such an increase only took place three other times from 1947:2 to 1974:2. Furthermore, it decreased three times consecutively from 1949:1 to 1949:3. It represents the only instance of consecutive decreases in the GDP deflator in the whole sample period.

To further examine the sensitivity of the results reported for the alternative model to perturbations in the sample period, Figure 2.15 presents the point estimates and confidence intervals of the IRFs for defense purchases, real GDP, RTB, and the GDP deflator computed for a unit shock to the Ramey-Shapiro dummy variable when the alternative model is estimated over the early and late sub-sample periods. The solid lines display the point estimates of the IRFs and the dashed lines display the lower and upper bounds of sixty-eight percent confidence intervals.

As the evidence presented in Figure 2.14 implies, the results computed for the early sub-sample period are very different from the ones reported for the whole sample period. In particular, the IRF for real GDP increases significantly at all horizons after a Ramey-Shapiro episode, compared to two and a half years for the whole sample period. Furthermore, the IRF for RTB is not significantly different from zero at any horizon.

Except for real GDP, the results computed for the late sub-sample period are different from the ones reported for the whole sample period. Specifically, the IRF computed for defense purchases increases much more gradually than for the whole sample period. The initial drop in RTB is not significantly different from zero. The IRF for the GDP deflator increases significantly after a delay of two years, although marginally and temporarily.

Overall, the results computed when the alternative model is estimated over sub-sample periods that include two Ramey-Shapiro episodes are very different from the ones reported for the whole sample period. They imply that the IRFs computed for the alternative model are sensitive to perturbations in the sample period used. Except for the GDP deflator, the results computed when the alternative model is estimated over sub-sample periods that include all three Ramey-Shapiro episodes are similar to the ones reported for the whole sample period. They imply that the IRFs computed for the alternative model are not very sensitive to perturbations in the sample period used.

The result computed for the alternative model may be expected to be sensitive to the exclusion of any episode from the sample period used since Ramey and Shapiro (1997) identify only three exogenous shocks to defense purchases. Furthermore, the results computed for the early and late sub-sample periods may differ because, as Blanchard and Perotti (1999) argue, "…The 1950s, with their large spending and tax shocks, do not appear generated by the same stochastic process as the post-1959 data" (Blanchard and Perotti 1999, p. 19).

2.8 Accounting for the Differences Among the Ramey-Shapiro Episodes

Following Ramey and Shapiro (1997) and Edelberg, Eichenbaum, and Fisher (1999), the Ramey-Shapiro dummy variable has an identical value of one at the onsets of each of the Ramey-Shapiro episodes in the models estimated thus far. However, as was

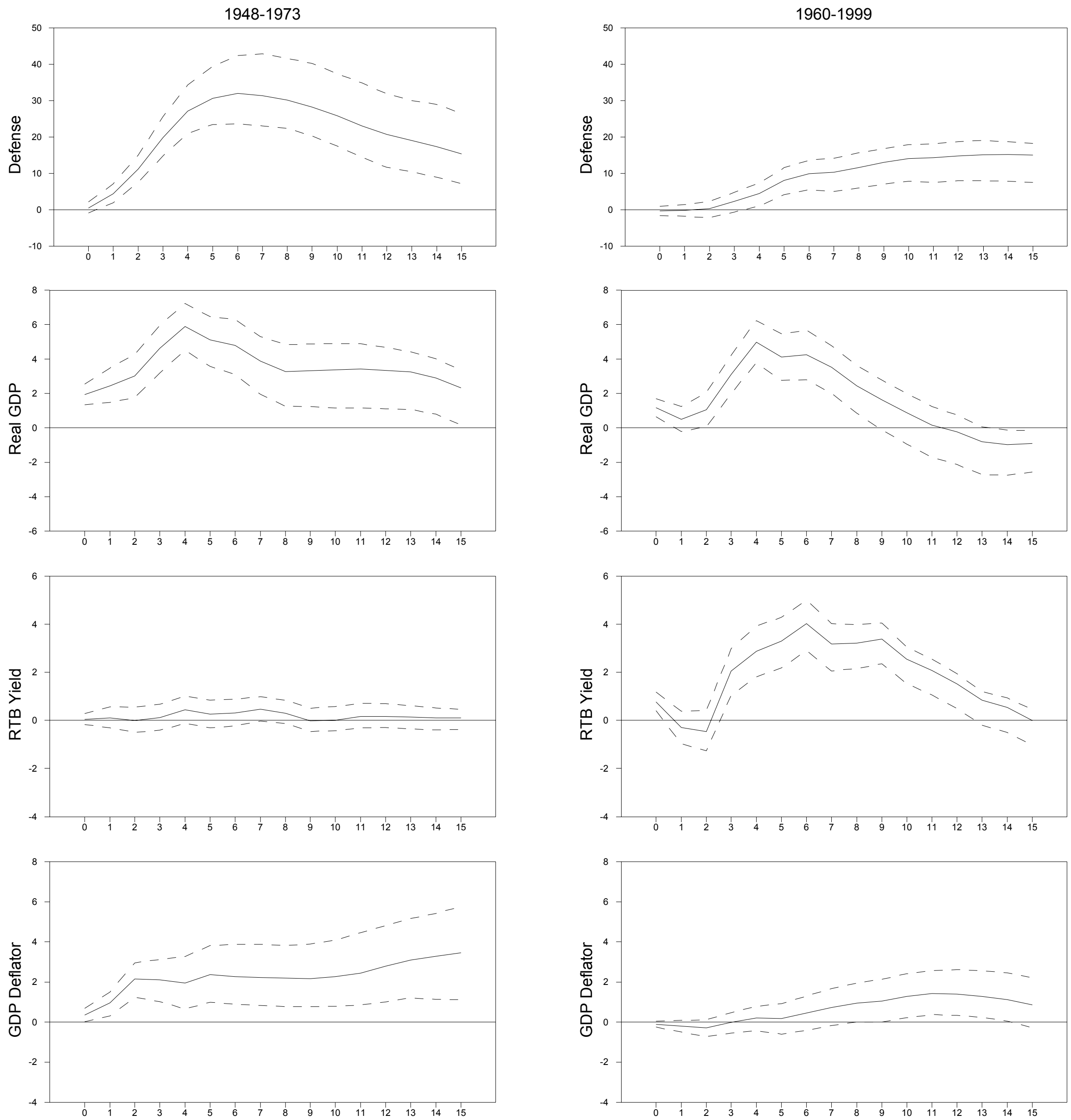

Figure 2.15: Point Estimates from Alternative Sample Periods
Confidence Intervals from Alternative Sample Periods

mentioned before, the increases in defense purchases and government purchases that follow the Ramey-Shapiro episodes differ greatly in size and shape. In particular, the Korean War build-up is much larger than the Vietnam War and Carter-Reagan build-ups.

To account for the differences in the size of the Ramey-Shapiro episodes, Burnside, Eichenbaum, and Fisher (2000) construct a dummy variable that has the value one at the date of the Korean War episode, and the values 0.20 and 0.38 at the dates of the Vietnam War and Carter-Reagan episodes, respectively. They indicate that the values of the Vietnam War and Carter-Reagan episodes are proportional to the relative intensities of these episodes; however, they do not explain specifically why the values 0.20 and 0.38 are selected.

Furthermore, Burnside, Eichenbaum, and Fisher (2000) limit their analysis to the effects of Ramey-Shapiro episodes on fiscal and labor market variables, and they do not discuss the implications of using identical or different values for the Ramey-Shapiro episodes. Therefore, it is of interest to examine the results reported for the alternative model when the values of the Ramey-Shapiro episodes differ according to the size of the military build-ups that follow them.

Following Burnside, Eichenbaum, and Fisher (2000), an alternative Ramey-Shapiro dummy variable is constructed that has the value one at the date of the Korean War episode. Then, the values of the Vietnam War and Carter-Reagan episodes are assigned according to the maximum increase in defense purchases within six quarters after the onsets of these episodes relative to the maximum increase after the onset of the Korean War episode.[17] The Vietnam War and Carter-Reagan episodes have the values 0.26 and 0.12, respectively.

Finally, a system identical to the alternative model except that it includes the modified Ramey-Shapiro dummy variable is estimated, and the IRFs for defense purchases, real GDP, RTB, and the GDP deflator are computed for a unit shock to the modified dummy variable. While the IRFs computed using the modified dummy variable reflect the differences in size among the Ramey-Shapiro episodes, it should be noted that the dynamics effects of the episodes on the variables under consideration are assumed to be identical, up to a scale factor.

In the first column of Figure 2.16, the solid lines display the point estimates of the IRFs computed for defense purchases, real GDP, RTB, and the GDP deflator using the modified Ramey-Shapiro dummy variable. The dashed lines display the lower and upper bounds of sixty-eight percent confidence intervals. Except for RTB, the patterns of the IRFs computed for a shock to the modified Ramey-Shapiro dummy variable are similar to the ones reported for the alternative model; however, their magnitudes are very different. The peak effects computed for defense purchases and the GDP deflator using the modified Ramey-Shapiro dummy variable are more than twice as large as the ones reported for the alternative model.

The IRF for RTB computed for the modified Ramey-Shapiro dummy variable declines significantly for almost three quarters after a Ramey-Shapiro episode, and then it is not significant from zero. It is inconsistent with the theoretical two-sector neoclassical

[17] The maximum increases in defense purchases within six quarters after each Ramey-Shapiro episode are considered because six lagged values of the Ramey-Shapiro dummy variable are included in the alternative model. The results computed if eight lags are considered are very similar to those reported for six lags.

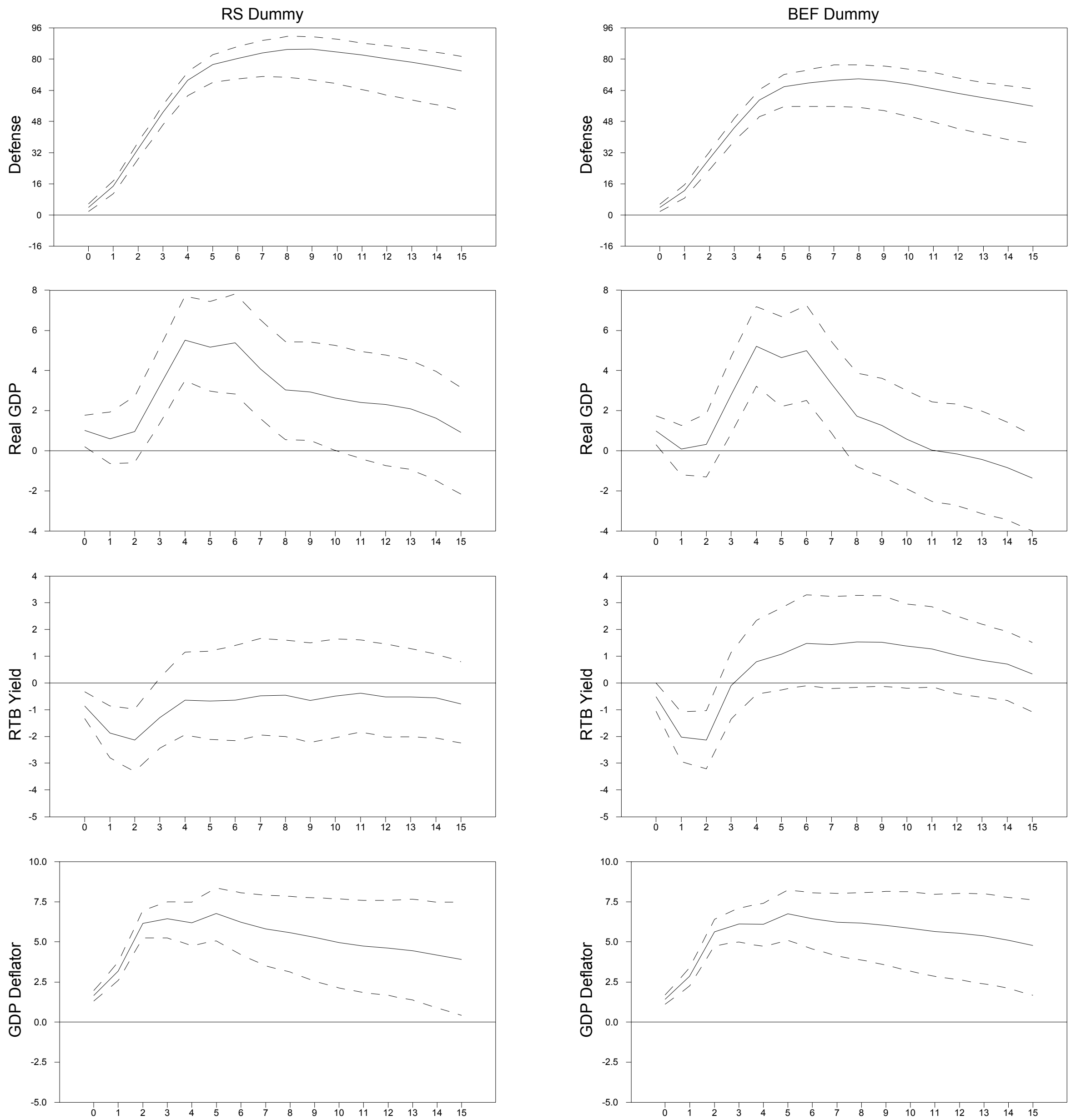

Figure 2.16: Point estimates from Models with Different Values for Each Ramey-Shapiro Episode
Modified Ramey-Shapiro Dummy Variable and Burnside, Eichenbaum, and Fisher's Dummy Variable

models presented by Ramey and Shapiro (1997) and Edelberg, Eichenbaum, and Fisher (1999) as well as the more traditional IS-LM and one-sector neoclassical models.

Since the values of the episodes selected for the modified Ramey-Shapiro dummy variable described above differ substantially from the values selected by Burnside, Eichenbaum, and Fisher (2000), it is of interest to examine whether the results reported for the modified Ramey-Shapiro dummy variable are sensitive by substituting the values of the episodes selected by Burnside, Eichenbaum, and Fisher (2000) for the values selected above.

Therefore, an alternative dummy variable is constructed that has the values selected by Burnside, Eichenbaum, and Fisher (2000) for the Ramey-Shapiro episodes. It is hereafter referred to as the Burnside, Eichenbaum, and Fisher's dummy variable. Then, a system identical to the alternative model except that it includes the Burnside, Eichenbaum, and Fisher's dummy variable is estimated, and the IRFs for defense purchases, real GDP, RTB, and the GDP deflator are computed for a unit shock to the Burnside, Eichenbaum, and Fisher's dummy variable.

In the second column of Figure 2.16, the solid lines display the point estimates of the IRFs computed for defense purchases, real GDP, RTB, and the GDP deflator using the Burnside, Eichenbaum, and Fisher's dummy variable. The dashed lines display the lower and upper bounds of sixty-eight percent confidence intervals. The IRFs for defense purchases, real GDP, and the GDP deflator are generally similar to the ones reported for the modified Ramey-Shapiro dummy variable.

The IRF for RTB computed for the Burnside, Eichenbaum, and Fisher's dummy variable declines significantly for more than two quarters after the onset of a Ramey-Shapiro episode. Then, unlike the IRF for RTB computed for the modified Ramey-Shapiro dummy variable, it is positive. However, it does not increase significantly at any horizon, although it is close to being significant.

Overall, since the increases in defense purchases and government purchases that follow the Ramey-Shapiro episodes differ, it could be argued that it is better to estimate a VAR system in which the assumption that the Ramey-Shapiro episodes are of equal intensity is abandoned. However, the IRFs computed when the modified Ramey-Shapiro dummy variable or Burnside, Eichenbaum, and Fisher's dummy variable is included in the alternative model are troublesome, in particular the IRF for RTB.

2.9 The Exogeneity of the Ramey-Shapiro Episodes

In order to investigate the macroeconomic effects of government purchases, Ramey and Shapiro (1997) focus on military build-ups because they are unlikely to be the result of feedback from the domestic economy. Similarly, Edelberg, Eichenbaum, and Fisher (1999) claim that the narrative approach is superior to VAR-based identification schemes because the Ramey-Shapiro episodes represent truly exogenous shocks to defense purchases.

Edelberg, Eichenbaum, and Fisher (1999) provide evidence that the Ramey-Shapiro episodes are special relative to other dates in their sample period. More specifically, they show that IRFs computed using the Ramey-Shapiro episodes are significantly different from IRFs computed using randomly selected episodes.
They conclude, "In our view what is special is that [the military build-ups] coincide with the onset of exogenous increases in government purchases" (Edelberg, Eichenbaum, and Fisher 1999, p. 17).

Edelberg, Eichenbaum, and Fisher (1999) examine the IRFs reported for the following variables: real GDP, residential investment, non-residential investment, after-tax manufacturing wages, residential investment plus consumption of durables, and residential investment minus residential investment. To determine if the IRFs computed for these variables using the Ramey-Shapiro episodes are significantly different from the corresponding IRFs computed using randomly selected episodes, they randomly select three dates from their sample period, and construct a synthetic dummy variable that has the value one at the dates randomly selected and zero otherwise.

Then, they estimate their benchmark model or an extended model in which the synthetic dummy variable is substituted for the Ramey-Shapiro dummy variable. Finally, they compute IRFs that present the responses of the variables under investigation to a unit shock to the synthetic dummy variable relative to the response of government purchases.[18]

For each variable under investigation, this procedure is repeated 500 times, and the 25th lowest and 475th highest values of the point estimates across the 500 IRFs are used to compute a synthetic confidence interval. If there is nothing special about the dates selected by Ramey and Shapiro (1997), the IRFs computed for the variables under investigation using the Ramey-Shapiro dummy variable ought to lie within the corresponding synthetic intervals.

Edelberg, Eichenbaum, and Fisher (1999) report that the IRF for non-residential investment lies within its synthetic interval after a delay of less than two quarters; however, all the other IRFs computed using the Ramey-Shapiro episodes are significantly and persistently different from the IRFs computed using randomly selected episodes. Therefore, they argue that the Ramey-Shapiro episodes are special relative to other dates in their sample period and coincide with exogenous increases in government purchases.

Leeper (1997), who presents a thorough study of the exogeneity of the Romers' monetary policy dummy variable, argues that it is necessary to measure the feedback from the domestic economy to the dummy variable in order to determine if the shocks identified by Romer and Romer (1989, 1994) are exogenous. Similarly, it is useful to measure the feedback from the domestic economy to the Ramey-Shapiro dummy variable in order to determine if the shocks identified by Ramey and Shapiro (1997) are exogenous.

The methodology presented by Edelberg, Eichenbaum, and Fisher (1999) does not allow them to measure the feedback from the domestic economy to the Ramey-Shapiro dummy variable, and the evidence they present does not necessarily imply that the Ramey-Shapiro episodes are exogenous. In fact, even though the Ramey-Shapiro episodes are special relative to other randomly selected dates, they may coincide, at least partially, with endogenous increases in defense and government purchases.

In this section, the exogeneity of the Ramey-Shapiro episodes is investigated following the methodology used by Leeper (1997) to study the exogeneity of the Romers' monetary policy dummy variable. First, a logit equation is estimated for the Ramey-Shapiro dummy variable that includes macroeconomic variables. Then, the probability that the logit equation has the value one at the dates selected by Ramey and Shapiro

[18] Edelberg, Eichenbaum, and Fisher (1999) focus on the responses of different variables relative to the response of government purchases " to emphasize the conditional comovements with government purchases that are induced by the onset of a Ramey-Shapiro episode" (Edelberg, Eichenbaum, and Fisher (1999), p. 16).

(1997), i.e. the conditional expectations for the Ramey-Shapiro episodes, are computed. If the episodes are truly exogenous, they should not be predicted by macroeconomic variables, and their conditional expectations ought to be low.

Second, two VAR systems are estimated in which the Ramey-Shapiro dummy variable is entered as an endogenous variable along with defense purchases, real GDP, RTB, and the GDP deflator. Then, the IRFs for defense purchases, real GDP, RTB, and the GDP deflator are computed for a unit shock to the Ramey-Shapiro dummy episode. If the Ramey-Shapiro episodes are exogenous, the IRFs computed when the Ramey-Shapiro dummy variable is entered as an endogenous variable or an exogenous variable ought to be similar.

2.9.1 Logit Equations

To examine the exogeneity of the monetary policy shocks identified by Romer and Romer (1989, 1994), Leeper (1997) estimates a logit equation for the Romers' monetary dummy variable, which allows him to measure the feedback from the economy to the shocks. Similarly, a logit equation is estimated for the Ramey-Shapiro dummy variable and the conditional expectations for the Ramey-Shapiro episodes are computed.

If x_t represents the list of independent variables included in the logit equation estimated, the expectation for the Ramey-Shapiro dummy variable (d_t) conditional on the information set Ω_t is given by

$$E(d_t/\Omega_t) = F(a_l,\beta(L)x_t)$$

Where F(.) is specialized to be the logistic function, $\beta(L)=\beta_1 L+\ldots+\beta_m L^m$, and a_l includes a constant and a "Perron-type" time trend.[19] x_t includes real GDP, RTB, and the GDP deflator. Four lagged values of the independent variables are included in the equation, i.e., m is equal to four, because the coefficients estimated do not converge when more than four lagged values are included.[20] The equation is estimated from 1948:1 to 1999:2 using a non-linear maximum likelihood method. Data from 1947:1 to 1947:4 are used as pre-sample data. Table 2.6 reports the coefficients computed when the logit equation described above is estimated.

None of the individual coefficients is significant at even the ten percent level of significance. Furthermore, when a Wald test statistic is computed to test the overall significance of the independent variables included in the equation estimated, the null hypothesis that the coefficients of the parameters in $\beta(L)$ are equal to zero cannot be rejected at the ten percent level of significance.

Since the logit equation estimated appears very imprecisely estimated, and the uncertainty about the values of the parameters in $\beta(L)$ carry out to the conditional expectations, the logit equation is not expected to provide meaningful evidence on the exogeneity of the Ramey-Shapiro episodes.

[19] Whether a "Perron-type" time trend is included or not, the conditional expectation computed for the Ramey-Shapiro episodes are very similar.

[20] Since lagged values of the variables are included in the alternative model, it may have been preferable to include six lagged values of the independent variables in the logit equation. However, the coefficients computed do not converge when six lagged values of the variables are included. Similarly, Leeper (1997) includes eighteen lags of the endogenous variables when he estimates monthly VAR systems; however, he includes only six lags of the independent variables when he estimates his logit equation. He does not explain why only six lags are used for the logit equation.

Table 2.6: Estimation Results from First Logit Equation (1948:1-1999:2)

Variables	Estimate	Standard Error
Constant	-177.47	322.86
Trend 1	-0.05	0.45
Trend 2	-0.17	0.26
RGDP{1}	-60.58	102.67
RGDP{2}	-208.80	182.83
RGDP{3}	-255.38	171.40
RGDP{4}	125.52	126.90
GDP deflator{1}	-11.50	291.59
GDP deflator{2}	-300.36	588.55
GDP deflator{3}	320.85	561.64
GDP deflator{4}	-30.12	239.18
RTB{1}	3.88	3.25
RTB{2}	-3.85	4.40
RTB{3}	2.28	3.37
RTB{4}	-1.76	2.08

The conditional expectations for the Korean War, the Vietnam War, and the Carter-Reagan episodes are 65.65 percent, 2.21 percent, and 8.62 percent, respectively. The result for the Korean War episode is puzzling. It implies that the outbreak of the Korean War, which is widely believed to have been unexpected and sudden (Stoessinger (1998)), was predicted by recent developments in the U.S economy.

The logit equation estimated appears very imprecisely estimated and yields troublesome results; and therefore, a second logit equation is estimated for the Ramey-Shapiro dummy variable in which defense purchases is added to the list of independent variables. This equation includes only two lagged values of the independent variables because the coefficients estimated do not converge when more than two lagged values are included.

Table 2.7 reports the coefficients computed when the second logit equation is estimated. Overall, this equation also appears very imprecisely estimated. None of the individual coefficients is significant at even the ten percent level of significance. Furthermore, when a Wald test statistic is computed, the null hypothesis that the coefficients of the parameters in $\beta(L)$ are equal to zero cannot be rejected at the ten percent level of significance.

The conditional expectations for the Korean War, the Vietnam War, and the Carter-Reagan episodes reported for the second equation are 32.03 percent, 2.53 percent, and 9.80 percent, respectively. Although the conditional expectation reported for the Korean War episode is lower than the one reported for the previous logit equation previously estimated, it remains difficult to interpret.

Other logit equations were also estimated for the Ramey-Shapiro in which the list of variables includes many different macroeconomic variables. In each case, the equation is very imprecisely estimated and the conditional expectation reported for the Korean War is puzzling. Therefore, it is concluded that estimating a logit equation does not provide meaningful evidence on the exogeneity of the Ramey-Shapiro episodes.

Table 2.7: Estimation Results from Second Logit Equation (1948:1-1999:2)

Variables	Estimate	Standard Error
Constant	-63.11	363.45
Trend 1	0.22	0.64
Trend 2	0.19	0.24
RGDP{1}	-9.14	67.45
RGDP{2}	15.78	52.02
Defense{1}	1.52	24.52
Defense{2}	-14.14	29.22
GDP Deflator{1}	-129.10	137.61
GDP Deflator{2}	88.91	138.44
RTB{1}	2.17	1.37
RTB{2}	-0.95	0.93

2.9.2 Linear Systems

To further investigate the exogeneity of the Romers' monetary policy dummy variable, Leeper (1997) estimates a VAR system in which the dummy variable is entered as an endogenous variable. He argues,

> "If the Romers' narrative approach has successfully separated endogenous policy responses from exogenous contractionary policy disturbances, then their results ought to be robust to embedding the dummy variable in a more general macro model that includes a behavioral equation for policy, which determines the dummy" (Leeper 1997, p. 2).

Similarly, two VAR systems are estimated in which the Ramey-Shapiro dummy variable is entered as an endogenous variable. These systems are identical to the alternative model except that in these models the dummy variable is not exogenous. They are hereafter referred to as the linear systems.

The linear systems include defense purchases, real GDP, RTB, the GDP deflator, and the Ramey-Shapiro dummy variable. Like the other equations in the linear systems, the equation for the Ramey-Shapiro dummy variable includes six lagged values of itself, defense purchases, real GDP, RTB, and the GDP deflator, plus a constant and a "Perron-type" time trend. The linear systems are estimated using OLS, and the IRFs for defense purchases, real GDP, RTB, and the GDP deflator that present the effects of a unit shock to the Ramey-Shapiro dummy variable are computed. If the Ramey-Shapiro episodes are truly exogenous, the IRFs computed for the linear systems and the alternative model should be similar.

The Choleski decomposition is used to identify the shocks to the Ramey-Shapiro dummy variable. For the first linear system, the Ramey-Shapiro dummy variable is ordered first, defense purchases are ordered second, real GDP is ordered third, RTB is ordered fourth, and the GDP deflator is ordered last. It is assumed that shocks to the Ramey-Shapiro dummy variable may have a contemporaneous effect on the other variables included in the system; however, shocks to the other variables are constrained not to have a contemporaneous effect on the Ramey-Shapiro dummy variable. This is consistent with the view that the onsets the military build-ups identified by Ramey and Shapiro (1997) are independent from current macroeconomic conditions.

For the second linear system, real GDP is ordered first, RTB is ordered second, the GDP deflator is ordered third, the Ramey-Shapiro dummy variable is ordered fourth, and defense purchases are ordered last. It is assumed that shocks to the Ramey-Shapiro dummy variable may be contemporaneously affected by shocks to real GDP, RTB, and the GDP deflator. Furthermore, it is assumed that shocks to the Ramey-Shapiro dummy variable do not have a contemporaneous effect on real GDP, RTB, and the GDP deflator; however, they may have a contemporaneous effect on defense purchases.

The assumptions underlying the second linear system may be difficult to justify. In particular, the Ramey-Shapiro episodes are likely to have a contemporaneous affect on macroeconomic variables. However, if the episodes are truly exogenous, the IRFs computed for the VAR systems in which the Ramey-Shapiro dummy variable is entered as an endogenous variable should not be sensitive to the ordering of the residuals in the Choleski decomposition used to identify shocks to the dummy variable.

In Figure 2.17, the short dashed lines display the IRFs for defense purchases, real GDP, RTB, and the GDP deflator computed for a unit shock to the Ramey-Shapiro dummy variable when the first linear system is estimated. The long dashed lines display the IRFs computed when the second linear system is estimated. The solid lines display the confidence intervals reported for the alternative model. If the Ramey-Shapiro episodes are truly exogenous, the IRFs computed for the linear systems ought to lie within corresponding confidence interval reported for the alternative model.

All the IRFs computed for the first linear systems lie within the corresponding confidence intervals from the alternative model at all horizons. Furthermore, they exhibit patterns very similar to the IRFs reported for the alternative model. After a delay of a year, the IRF for defense purchases computed for the second linear system lies slightly below the lower bound of the confidence interval from the alternative model for a year. The IRF for real GDP lies slightly below the lower bound of the confidence interval from the alternative model for less than a year after a shock to the Ramey-Shapiro dummy variable. The IRF for RTB lies within the corresponding confidence intervals from the alternative model at all horizons. The IRF for the GDP deflator lies slightly below the lower bound of the confidence interval from the alternative model for two and a half years after a shock to the Ramey-Shapiro dummy variable. Moreover, the patterns of the IRFs computed for the second linear system are similar to the ones reported for the alternative model, and except for the GDP deflator, the point estimates of the IRFs computed for the second linear system are close to the corresponding point estimates reported for first linear system.

Overall, the IRFs reported for the linear systems are consistent with the Ramey-Shapiro episodes being exogenous; however, they do not represent definitive evidence on the exogeneity of the Ramey-Shapiro episodes. Indeed, if the bias introduced by failing to model the endogeneity of the episodes in the alternative model is small, the IRFs computed for the linear models would appear similar to the IRFs reported for the alternative model even though the Ramey-Shapiro episodes are endogenous.

Furthermore, Leeper (1997) points out three additional potential problems with regard to the VAR system he estimates, which also apply to the VAR systems in which the Ramey-Shapiro dummy variable is endogenous. First, the predicted values for the Romers' monetary policy dummy variable may lie outside the [0,1] interval. Second, the linear equation for the dummy variable does not respect the dichotomous nature of the

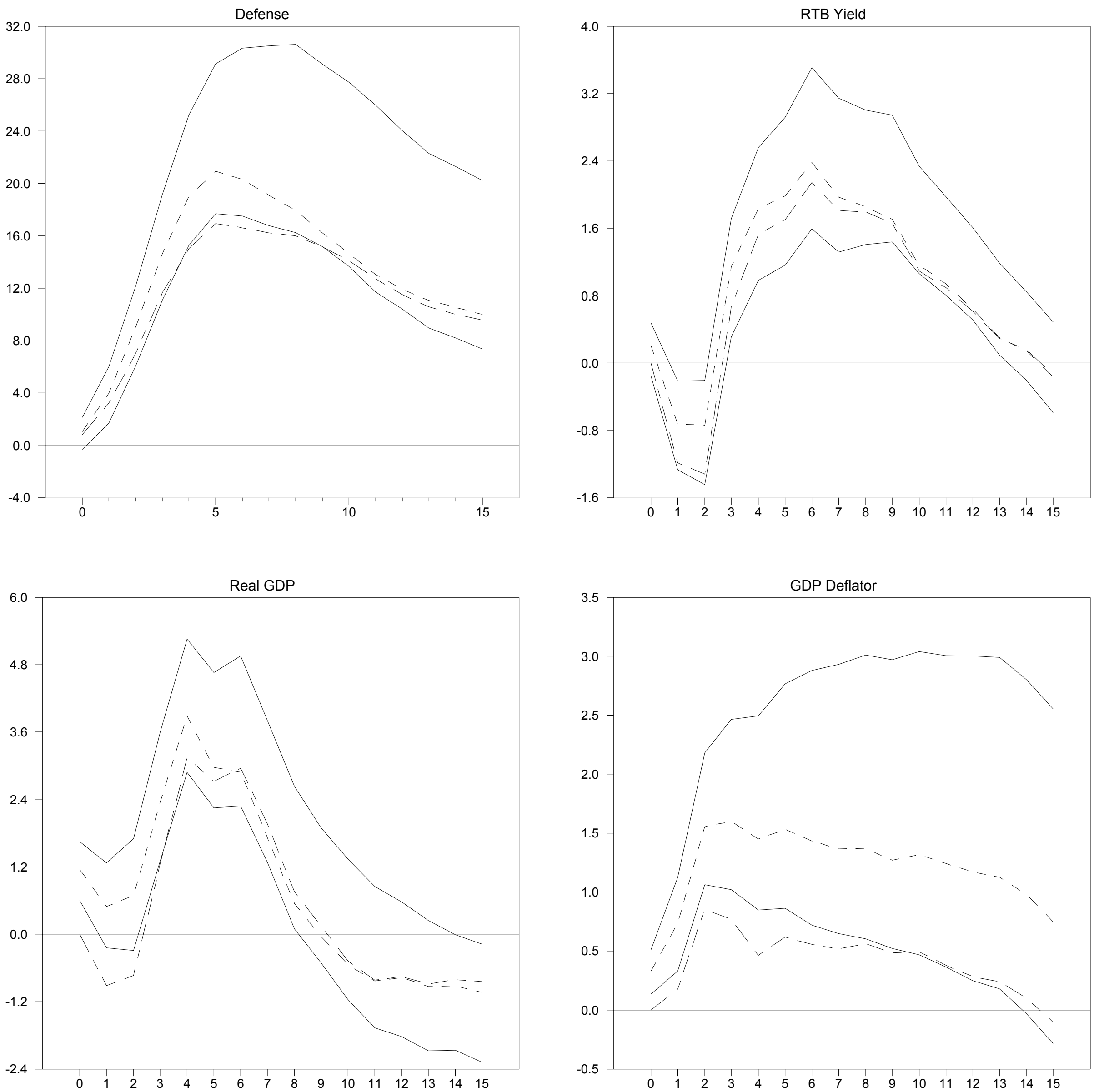

Figure 2.17: Point Estimates from Linear Systems
Confidence Intervals from Alternative Model

dummy. Finally, the relations between the dummy variable and the other variables included in the system may not be linear.

To address these potential problems with regard to the Romers' monetary policy variable, Leeper (1997) examines the sensitivity of the results reported for the linear system he estimates by substituting a logit equation for the linear equation for the Romers' monetary policy variable. If the potential problems mentioned above do not significantly affect the results reported for the linear system, the responses computed for the VAR system and the non-linear system should be similar.

To examine the first potential problem mentioned above with regard to the Ramey-Shapiro dummy variable, the predicted values for the dummy variable are computed when the two linear systems that include the Ramey-Shapiro dummy as an endogenous variable are estimated. For both linear systems, the predicted values lie within the [0,1] interval.

Furthermore, it would be of interest to investigate the sensitivity of the results reported for the linear systems in which the Ramey-Shapiro dummy variable is included by substituting a logit equation for the linear equation for the dummy variable. However, as the statistical evidence reported earlier in this section indicated, logit equations for the Ramey-Shapiro dummy variable are very imprecisely estimated. Therefore, it would be difficult to make any meaningful inference from the estimation of a non-linear system in which a logit equation for the Ramey-Shapiro dummy variable is included, and the responses computed for non-linear models are not presented in this chapter.

In conclusion, following a methodology implemented by Leeper (1997) to examine the exogeneity of the Romers' monetary dummy variable, this section provides mixed evidence on the exogeneity of the Ramey-Shapiro dummy variable. The logit equations estimated for the Ramey-Shapiro dummy variable are very imprecisely estimated, and the conditional expectation computed for the Korean War episode is puzzling. Therefore, it is concluded that the logit equations do not yield meaningful evidence on the exogeneity of the Ramey-Shapiro dummy variable.

However, when linear systems are estimated in which the Ramey-Shapiro dummy variable is entered as an endogenous variable, the IRFs reported are consistent with the Ramey-Shapiro episodes being exogenous. These results should be regarded as only suggestive since there are potentially serious econometric problems when an equation with a dichotomous dependent variable is estimated using OLS. Furthermore, due to the lack of significance of the logit equations estimated for the Ramey-Shapiro dummy variable, the sensitivity of the results reported for the linear systems by substituting a logit equation for the linear equation for the Ramey-Shapiro dummy variable is not presented.

2.10 Summary and Conclusions

This chapter provides evidence on the implications of using the narrative approach of Ramey and Shapiro (1997) for estimating the macroeconomic effects of exogenous shocks to government purchases. It focuses on two VAR systems in the spirit of Edelberg, Eichenbaum and Fisher (1999).

The benchmark model includes the contemporaneous and four lagged values of the Ramey-Shapiro dummy that are entered as exogenous variables as well as four lagged values of defense purchases, real GDP, RTB, and the GDP deflator that are entered as

endogenous variables. The alternative model, which is selected according to the AIC criterion, includes six lagged values of the variables and a "Perron-type" time trend.

The IRFs that present the effects of a unit shock to the Ramey-Shapiro dummy variable on defense purchases, real GDP, RTB, and the GDP deflator are computed for the benchmark and alternative models. The IRFs reported for the benchmark model imply that defense purchases increase very persistently in response to a shock to the Ramey-Shapiro dummy variable, output rises temporarily, the price level rises persistently, and interest rates initially fall and then they rise significantly. The IRFs reported for the alternative model are similar in pattern to the ones reported for the benchmark model; however, they are quantitatively different, especially for defense purchases and RTB.

This chapter has also presented evidence on the robustness of the results reported using the Ramey-Shapiro dummy variable, which is a particularly important issue since Ramey and Shapiro (1997) only identify three exogenous shocks to government purchases. First, the sensitivity of the results computed for defense purchases, real GDP, RTB, and the GDP deflator to adding time trends and changing the lag length used in the benchmark model is examined. It is shown that the results reported for the benchmark model are not sensitive to adding time trends. However, the results reported for RTB, and to a lesser extent, defense purchases and real GDP appear sensitive to changing the lag length used.

Then, the sensitivity of the results computed for defense purchases, real GDP, RTB, and the GDP deflator to perturbations in the list of variables included in the alternative model is examined. Seventeen endogenous and exogenous variables are added, in turn, to the alternative model and the IRFs computed for the extended models and the alternative model are compared. It is concluded that, except for Hamilton's oil price dummy variable, the results reported for the alternative model are generally robust to perturbations in the list of variables used.

As was mentioned in the introduction, Perotti (2000) argues that the evidence reported using the Ramey-Shapiro dummy variable may reflect not only the effects of exogenous increases in government purchases, but also the effects of other major macro-economic shocks that took place in the post-World War II era. Therefore, it is particularly interesting to examine the sensitivity of the results reported for the alternative model to adding the Romers' monetary policy dummy variable or Hamilton's oil price dummy variable.

The evidence presented for the extended model with the Romers' monetary policy dummy variable indicates that the results reported for the alternative model are not significantly affected by the addition of major monetary policy shocks in the model. However, the evidence presented for the extended model with Hamilton's oil price policy dummy variable reveals that the results reported for the alternative model are significantly affected by the addition of a variable designed to proxy for major supply shocks to the model.

Furthermore, the IRFs reported when alternative fiscal variables and the monetary base are added, in turn, to the alternative model indicate that the Ramey-Shapiro build-ups do not coincide with significant and persistent changes in non-defense purchases and the monetary base. Therefore, it is concluded that the results reported using the Ramey-Shapiro dummy variable do not appear to reflect the effects of systematic changes in

other components of government purchases than defense purchases or monetary policy; however, they may reflect, at least partially, the effects of major supply shocks.

Finally, the sensitivity of the results computed for the alternative model to perturbations in the sample period used is examined. The results computed for sub-sample periods in which two Ramey-Shapiro episodes are included differ significantly from the results reported for the whole sample period. Except for the GDP deflator, the results computed for sub-sample periods in which all three Ramey-Shapiro episodes are included do not differ significantly from the results reported the whole sample period.

In addition to presenting evidence on the robustness of the results computed for the benchmark and alternative models, this chapter investigates the implications of abandoning the assumption that the Ramey-Shapiro episodes are of equal intensity. Furthermore, it examines the exogeneity of the Ramey-Shapiro episodes.

To account for the differences in size among the Ramey-Shapiro build-ups, a modified Ramey-Shapiro dummy variable whose values at the dates of the Ramey-Shapiro episodes vary according to the size of the military build-ups that follows them. Then, a system identical to the alternative model except that it includes the modified Ramey-Shapiro dummy variable is estimated.

Then, the IRFs for defense purchases, real GDP, RTB, and the GDP deflator are computed for a unit shock to the modified Ramey-Shapiro dummy variable. The IRF for RTB is inconsistent with the theoretical two-sector neoclassical models presented by Ramey and Shapiro (1997) and Edelberg, Eichenbaum, and Fisher (1999) as well as the more traditional theoretical IS-LM and one-sector neoclassical models.

To examine the exogeneity of the Ramey-Shapiro episodes, a methodology used by Leeper (1997) to study the exogeneity of the Romers' monetary policy dummy variable is implemented. First, a logit equation that includes macroeconomic variable is estimated for the Ramey-Shapiro dummy variable, and the conditional expectations for the Ramey-Shapiro episodes are computed.

The logit equation is very imprecisely estimated. Moreover, the result reported for the Korean War episode, which implies that the outbreak of the Korean War was predicted by recent developments in the U.S economy, is puzzling. Therefore, it is concluded that the logit equation does not appear to provide meaningful evidence on the exogeneity of the Ramey-Shapiro episodes. An alternative logit equation is also estimated; it yields the same conclusion.

Second, two linear systems are estimated in which the Ramey-Shapiro dummy variable is entered as an endogenous variable along with defense purchases, real GDP, RTB, and the GDP deflator. Then, the IRFs for defense purchases, real GDP, RTB, and the GDP deflator for a unit shock to the Ramey-Shapiro dummy variable within these linear systems are computed. They are generally similar to the ones reported for the alternative model; and therefore, it is concluded that the results reported for the linear systems are consistent with the Ramey-Shapiro episodes being exogenous.

Two notable issues related to the narrative approach of Ramey and Shapiro (1997) have been left out of this chapter. First, the uncertainty about the actual dates of the Ramey-Shapiro episodes is not examined. Second, the implications of including military retrenchments and military build-ups for estimating the effects of shocks to government purchases is not investigated. These two issues are addressed in the next chapter using a more comprehensive narrative approach than Ramey and Shapiro (1997) that tries to

isolate exogenous reductions in defense purchases as well as exogenous increases in defense purchases.

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CHAPTER 3. THE NARRATIVE APPROACH REVISITED

3.1 Introduction

Ramey and Shapiro (1997) present the first and only study in which a narrative approach is used to identify exogenous shocks to government purchases. As was mentioned in the previous chapter of the dissertation, they identify the onsets of exogenous increases in defense purchase s during the post-World War II era. They argue that military build-ups are driven by “geo-political shocks” and “imperatives of foreign policy“ (Ramey and Shapiro 1997, p. 39); and therefore, military build-ups are truly exogenous. They do not consider military retrenchments because “[the] builddowns were much more gradual than the build-ups” (Ramey and Shapiro 1997, fn. 14, P. 39).

The Ramey-Shapiro episodes correspond to the onsets of the Korean War, the Vietnam War, and the Carter-Reagan military build-ups. They are dated as beginning in the third quarter of 1950, the first quarter of 1965, and the first quarter of 1980, respectively. Ramey and Shapiro (1997) provide a brief explanation of the methodology they use to select the dates for the episodes.

They indicate, “We use information from historical accounts, which give exact dates of events, and *Business Week*, which discusses relevant economic details of the events” (Ramey and Shapiro 1997, p. 40). Furthermore, they read “narratives around the time of the events” that provide information on the expectations of economic agents, which are critical to examine whether the episodes were unanticipated.

More specifically, Ramey and Shapiro (1997) try to isolate the dates at which key events took place that led to significant and persistent changes in U.S foreign policy and defense purchases. All the events they mention are actions by foreign nations. The chain of events leading to the Korean War build-up is fairly simple, which makes it easy to isolate the date of the onset this episode. However, the chronology and the nature of the events leading to the Vietnam War and Carter-Reagan build-ups are more complex, and it is more difficult to isolate the dates of the onsets of these episodes.

The Ramey-Shapiro episodes have been used in several studies to provide evidence on the implications of the narrative approach for estimating the effects of fiscal policy (Ramey and Shapiro (1997), Eichenbaum and Fisher (1998), Edelberg, Eichenbaum and Fisher (1999)). However, there exist several potential problems with the narrative approach of Ramey and Shapiro (1997) that have not been addressed yet.

First, Ramey and Shapiro (1997) discuss only the build-ups they include in their measure of exogenous shocks to government purchases. They do not explain for instance why the Kennedy military build-up is not included, although its similarities to the Carter-Reagan build-up have been often emphasized (U.S Defense Policy (1983), Kaufmann (1985), Cimbala (1986), Korb and Dagget (1988)).

Second, Ramey and Shapiro (1997) identify only three exogenous shocks to government purchases. It is shown later in this chapter that the major military retrenchments that follow the major military build-ups in the post-World War II era are not much more gradual than the build-ups. Furthermore, there is no theoretical reason to expect that military retrenchments have different effects on the economy than military build-ups. Therefore, it is interesting to use a narrative approach to construct a measure of exogenous shocks to government purchases that includes military build-ups and military retrenchments.

Third, Ramey and Shapiro (1997) fail to recognize that the defense policy process is driven by imperatives of domestic policy as well as foreign policy. As Garnett (1997) argues, "It is not that the international situation is irrelevant; but internal factors are at least as important… Any adequate explanation of defense policy must take this into account" (Garnett 1987, p. 25). Therefore, it is interesting to re-examine the dates selected by Ramey and Shapiro (1997).

The first objective of this chapter is to introduce a more comprehensive narrative approach than the one of Ramey and Shapiro (1997) that tries to isolate exogenous reductions as well as exogenous increases in defense purchases. A second objective is to reproduce the study of the narrative approach of Ramey and Shapiro (1997) presented in the previous chapter for the more comprehensive narrative approach.

The plan of the remainder of this chapter is as follows. Section 3.2 briefly explains the narrative approach used to identify exogenous shocks to defense purchases in this chapter. It also presents evidence to support the dates selected for the onsets of the shocks. Finally, it provides a brief discussion of the shocks identified. Section 3.3 examines the sensitivity of the results reported in the previous chapter to small perturbations in the dates of the Ramey-Shapiro episodes.

Section 3.4 presents the impulse response functions (IRFs) computed for the benchmark model introduced in the previous chapter of the dissertation when a defense purchases dummy variable is constructed using the narrative approach introduced in this chapter. Section 3.5 discusses the robustness of the results computed for the benchmark model to adding a time trend and changing the lag length used. Section 3.6 presents the results computed for the alternative model introduced in the previous chapter of the dissertation.

Sections 3.7 and 3.8 discuss the robustness of the results computed for the alternative model to perturbations in the list of variables and the sample period used, respectively. Section 3.9 presents the results computed for a model in which the assumption that the shocks identified are of equal intensity is abandoned. Section 3.10 presents evidence on the exogeneity of the Ramey-Shapiro dummy variable. Finally, Section 3.11 provides a brief summary and conclusion.

3.2 Defense Purchases Shocks in the United States from 1947 to 1999

3.2.1 Methodology

As is often done in the foreign and defense policy literature, Huntington (1981) describes the evolution of U.S. defense expenditures in the post-World war II era as a succession of "strategy-budget" cycles.[1] According to Cimbala (1986), each cycle is characterized by five phases, which can be summarized as follows:

1) Developing new strategic concepts and approaches (an upside strategy), in response to new perceptions of threat and needs;
2) Triggering one or more events to create public support for, and apolitical environment favorable to, a larger defense effort;
3) Initiating a defense build-up to reflect the concepts and priorities of the new strategy;
4) Increasing concern about the impact of defense build-up on other social needs, followed by a leveling off and decline in the defense effort; and

[1] See Ball (1980), Bobbit (1986), Cimbala (1986), Kaufmann (1990), and Williams (1987).

5) Formulating new strategic concepts (a downside strategy) appropriate for a reduced military effort (Cimbala 1986, p. 7).

Within this framework, to select the dates of the onsets of exogenous shocks to defense purchases consists in identifying the dates that correspond to the beginnings of the third and fifth phases of the "strategy-budget" cycles in the post-World War II era. This is done through an examination of historical accounts that present the sequences of events driving the "strategy-budget" cycles and a systematic analysis of contemporaneous evidence.

A key issue in selecting the dates of the exogenous shocks to defense purchases using a narrative approach is to find the dates at which the decisions to implement changes in defense purchases were taken and announced. Those dates do not necessarily correspond to the dates at which defense purchases actually began to change. Furthermore, it is possible that historical accounts presented in the foreign and defense policy literature are biased by the knowledge of the subsequent behavior of defense purchases.

Therefore, it is important to use not only historical accounts but also contemporaneous evidence to identify the dates of the shocks to defense purchases. The contemporaneous evidence presented hereafter consists of excerpts from *U.S. News and World Report.* This particular weekly magazine was chosen because it has regularly featured articles on defense policy and defense spending. Furthermore, until the mid-1980s, it featured a weekly newsletter entitled Tomorrow that presented forecasts on developing economic and political situations in the United States and abroad.

3.2.2 March 1948: The March Crisis Build-up

The first shock identify using the methodology described above marked the beginning of the Cold War and took place during the March Crisis of 1948. The events leading to this shock are presented by Shilling (1962), who provides an analysis of the events and developments that influenced U.S. foreign and defense policy from 1947 to 1950 in *The Politics of National Defense: Fiscal 1950*.

3.2.2.1 Historical Account

In the years following the end of World War II, U.S. foreign policy was greatly influenced by the strategic ideas of Defense Secretary James Forrestal, which are often referred to as "Forrestal's strategy". It emphasized the need for the United States to support the reconstruction of the Western European nations in order to restore the European balance of power.

In the short run, "Forrestal's strategy" implied a calculated risk for the United States. Even though the possibility of a military confrontation with the Soviet Union existed, U.S. defense spending was to be kept low in order to finance the economic and military recovery of Western Europe. At the beginning of 1948, it became increasingly apparent that the risks implied by "Forrestal's strategy" were unacceptably high as the Communists tightened their grip over Eastern Europe.

By March 1948, Czechoslovakia had fallen to a Communist coup, and the risk of war with Soviet Union had unexpectedly and dramatically increased. Furthermore, a Communist victory in China appeared inevitable. As a result of these developments, there was a clear sense of emergency among policy-makers. On March 17, President Truman went before Congress to recommend the re-enactment of the draft and request universal military training.

The next day, Defense Secretary Forrestal presented to Congress a $3-billion supplementary budget bill to be added to the budget for fiscal year 1949 (FY 1949), which was to begin on July 1, 1948. After negotiations, the Truman administration, Congress, and the armed forces agreed on a $3.1-billion supplementary budget bill, which was presented to and approved by Congress in June 1948.

The bill represented an addition of more than 30 percent to the original $10 billion defense budget for FY 1949 presented to Congress in January 1948. According to the figures from the Center for Strategic and Budgetary Assessments[2] (CSBA), actual defense outlays in current dollars, which are hereafter referred to as actual defense outlays, increased from $9.1 billion in FY 1948 to $13.2 billion in FY 1949. They added to $13.7 billion in FY 1950, which ended four days before the onset of the Korean War.

However, the evolution of defense purchases measured in billions of chained (1992) dollars, which are hereafter referred to as real defense purchases, implies that took place in March 1948 was much more modest that actual defense outlays suggest. Real defense purchases were $136.9 billion in 1948:2. They rise to $146.4 in 1949:2, but then they decline to $130.6 and $131.1 billion in 1950:1 and 1950:2, respectively.

3.2.2.2 U.S. News and World Report

In the newsletter Tomorrow published on March 12, 1948, a future increase in defense purchase s is mentioned for the first time. It is stated, "As a result of what's happening in the world right now… dollar needs of military services are being revised upward."

On March 19, after President Truman's address to Congress, an imminent and significant increase in defense expenditures—$ 4 billion—is reported. It is argued,

> "Under plans that U.S. is getting set, even now, to carry out*: military services will get more money, maybe a good deal more*. Air Force, in particular will be build-up. Aviation industry will be assured of big new orders… It is possible that military costs will approach $15, 000, 000, 000 a year in the period ahead, instead of the $11, 000, 000, 000 officially budgeted. The situation is changing and Congress is more interested in defense." (Italics mine).

The following week, an increase in military expenditures of an even larger magnitude is anticipated in the newsletter Tomorrow. It is stated,

> "These things are clear:… Rearmament, partial mobilization are being forced on U.S.… Armament costs, in any event, are due to skyrocket in the year ahead. Arms outlay, military spending, is scheduled at an $11, 000, 000, 000 rate. *Spending to meet plans as now shaping will rise above $16, 000, 000, 000*." (Italics mine).

On April 2, 1948, it is stated, "The developing situation shows this: military spending is to be raised at least $3, 000, 000, 000. That's before any promised land-lease aid to Europe, before any expanded stockpiling". On April 9, it is argued, "Armament spending on an expanding scale is coming, definitely." Finally, in the newsletter Tomorrow published on April 16, 1948, the administration plans are announced. It is projected, "Rearmament will add $3, 375, 000, 000 to planned arms spending. That is the minimum addition of dollars spent or orders actually to be placed."

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[2] The figures from CSBA presented for actual defense outlays and real defense purchases in this chapter are available online at http://www.csbaonline.org.

3.2.3 July 1950: The Korean War Episode

Hammond (1962) provides an analysis of the events and developments that led to the U.S. rearmament taking place in the early 1950s in *NSC-68: Prologue to Rearmament*. Like Ramey and Shapiro (1997), he identifies the beginning of the Korean War in June 26, 1950 as the key event that led to the Korean War military build-up.

Since the Korean War broke out only a few days before the end of June and the decision to commit U.S. troops in South Korea was not taken until the last day of June, the shock to defense purchase s is dated as beginning in July 1950. As a result, using quarterly data, the shock to defense purchase s would be dated as beginning in third quarter of 1950.[3]

3.2.3.1 Historical Account

In the days before the invasion of South Korea in June 26, 1950, the defense budget for FY 1951, which was to begin on July 1, was expected to remain under $14 billion. In fact, the House of Representatives had just passed a bill that set defense expenditures to $13.8 billion. Four days after the invasion of South Korea, American troops were committed to the Korean peninsula, and it was widely believed at the time that President Truman would request a supplement of $5 billion to be added to the defense budget for FY 1951.

In fact, between July 1950 and January 1951 the defense budget for FY 1951 increased by more than $30 billion, most of which was added to the existing defense budget through two supplementary budget bills. Congress approved a first bill for a supplement of $10 billion in September 1950. It approved a second bill for nearly $17 billion in January 1951.

As Hammond (1962) emphasizes, the first supplement represented a "stopgap measure" that "would merely get things going while longer run requirements were being estimated" (Hammond 1962, p. 353). In contrast, the second supplement represented,

> "An attempt to schedule for the long pull and to keep the immediate imperatives of Korea properly placed in a larger strategic picture. Of the nearly $17 billion requested, $9 billion would be for major procurement items. Part of the latter sum would be for material expended in Korea, but much of it would be for general rearmament" (Hammond 1962, p. 356).

According to the figures from CSBA, actual defense outlays increased less in FY 1951 than projected in the defense budget; however, they increased dramatically relatively to the previous fiscal year. Actual outlays added to $23.6 billion in FY 1951 compared to $13.7 billion in FY 1950. Then, they added to $46.1 billion in FY 1952 and $52.8 billion in FY 1953. The rise in real defense purchases is much sharper than the increase for actual defense outlays. Real defense purchases were $131.1 in 1950:2. They rose to $296.6 billion in 1950:3, and more than $382 billion in 1953:2.

3.2.3.2 U.S. News and World Report

After President Truman announced the engagement of American forces in South Korea, it is stated in the newsletter Tomorrow published on July 7, 1950, "War in Korea, if contained, will be irritating but not very costly… Defense without war is costing 13.5

[3] Stoessinger (1998) presents a detailed chronology of the decisions taken in the days after the invasion of South Korea. As Hammond (1962), he argues that the decision to commit U.S. troops in South Korea was taken on June 30, 1950 (see Stoessinger 1998, pp. 54-65).

billion dollars a year. War of the limited type is expected to add about 2 billions to that total, not much more."

> The following week, a different outlook for the future is given. It is argued, "These things seem to be reasonably clear:… Cost of little war, any war, will be substantial. War cost of at least 3 to 4 billions additional is likely as a result of the war in Korea…. Military orders, rather small recently, will enter a sharp rise… Costs for the smallest kind of war run high."

In the newsletter Tomorrow published on July 21, a yearly increase in defense expenditures of more than $10 billion is anticipated in the future. It is stated, "Defense, permanently, will cost 25 to 30 billions a year, with no big war…. Arms, weapons output will skyrocket." On July 28, it is projected,

> "Whatever happens, whether 'peace' returns or not: *Military spending for U.S. defense will not drop below 25 billions dollars in the foreseeable future*. Trend of military spending will be up… defense alone, in peacetime, will involve annual outlays of between 25 to 30 billions dollars." (Italics mine).

3.2.4 November 1952: The Eisenhower Retrenchment

Snyder (1962) provides an analysis of the events and developments that led to the military retrenchment implemented by the Eisenhower administration in *the "New Look" of 1953*. In his analysis, Snyder (1962) identifies one shock to defense purchase s. It corresponds to the election of President Eisenhower in November 1952, which marked the beginning of the Eisenhower retrenchment.

3.2.4.1 Historical Account

General Dwight D. Eisenhower himself stated, "A bankrupt America [was] more the Soviet goal than an America conquered on the field of battle" (cited in Snyder 1962, p. 390). He also believed that government spending in general and defense spending in particular should be curbed for the United States to win the Cold War.

During the presidential campaign of 1952, General Eisenhower—the Republican nominee—was very critical of the enormous growth in the federal budget that took place after the onset of the Korean War. He argued, "overall government spending, especially defense spending should be drastically reduced" (Snyder 1962, p. 389), and he promised to achieve a balanced budget by FY 1955.

As expected, as soon as President Eisenhower came to the White House, Budget Director Joseph M. Dodge ordered an extensive review of all government programs whose objective was to suggest reductions in government expenditures. Snyder (1962) notes, "It was clear that any substantial reduction would have to be taken very largely out of funds for national security" (Snyder 1962, p. 394).

However, the results of the review of the Defense Department suggested only modest economies in defense expenditures. Therefore, another review was ordered, and a revised defense budget for FY 1954, which was to begin on July 1, 1953, was finally presented to Congress in May 1953. The revised budget called for a reduction in planned expenditures from $45.4 to 43.2 billion. Since the Korean War was coming to a conclusion, Congress approved additional cuts in the revised budget to reduce the government deficit.

According to the figures from CSBA, the decrease in actual defense outlays was modest in FY 1954. They were $49.3 billion in current dollars, compared to $52.6 billion

in FY 1953. Then, they decreased to about $42 billion for two years. Real defense purchases kept rising for three quarters after the election of President Eisenhower. They were $367.6 billion in 1952:4 and 382.4 billion in 1953:2. Then, they declined continually for more than two years, and were $280.7 billion in 1956:1.

3.2.4.2 U.S. News and World Report

After General Eisenhower's electoral victory, the newsletter Tomorrow published on November 14, 1952, predicted that under an Eisenhower administration,

> "Armed forces, barring big war, will be reduced somewhat. A cut of 3.2 million, or even 3 million, from 3.6 million is probable.
> Armament must be reduced if Government finances are to be improved.
> Arms outlays will rise, budget troubles grow, during the first year of the Eisenhower Administration despite almost any cuts that can be tried. The money is committed, the orders placed, the wheels of industry rolling."

In the newsletter Tomorrow published the following week, it is argued,

> "You can be quite sure of these things, among others: …*Arms spending, in almost any event, will be stretched out further. Arm forces, probably, will be cut moderately in size…*
> Last year, ended June 30, 1952, national security cost 46.3 billions.
> This year, ending June 30, 1953, security is to cost 56.2 billions.
> Next year, under a Truman budget, security costs will approach a 65-billion-dollar level. Ike's advisors hope to cut it to 57 billions.
> It's to be the year starting July 1, 1954, before the trend in spending for defense can really turn downward unless war is ended in Korea." (Italics mine).

In the newsletter Tomorrow published on December 5, 1952, it is stated,

> "The Eisenhower Administration actually is functioning right now…
> Charles E. Wilson is moving into the Defense Department six weeks before he will take office. The oath will be little more than a formality…
> You can definitely count on the new Congress to look closely at spending. These tips come from representative Taber, to be in charge of appropriations:
> Military spending is not running much above 42.5 billions a year. So *the defense budget can be trimmed well below 50 billions.*"(Italics mine).

3.2.5 November 1960: The Kennedy Build-up

Ball (1980) provides an analysis of the events and developments that led to the military build-up implemented by President Kennedy in *Politics and Force Levels: the Strategic Missile Program of the Kennedy Administration*. In his analysis, Ball (1980) identifies the presidential election of November 1960 as the key event that led to the Kennedy military build-up.

3.2.5.1 Historical Account

In the fall 1960, defense and foreign policy was a central issue of the presidential campaign of Senator Kennedy—the Democratic nominee. At the time, Senator Kennedy had become "a major spokesman on matters relating to defense and foreign policy" (Ball 1980, p. 15) who persistently criticized President Eisenhower's defense policy.

In August 1958, Senator Kennedy claimed that, given the Soviet technological and scientific prowess, "In the years 1960-1964, the deterrent ratio will in all likelihood be weighted very heavily against [the United States]" (cited in Ball 1980, p. 16). Similarly, in November 1959, he stated, "[The United States] have fallen behind the

Soviet Union in the development and production of ballistic missiles—both intercontinental and those of intermediate range" (cited in Ball 1980, p. 16).

With regard to defense purchases, most of the public estimates of "what Kennedy would do" ranged from $2 to $4 billion a year according to Ball (1980). These estimates were based, among other things, on the specific requests he pledged to send to Congress, if elected, in a letter published in October 1960 by the magazine Missiles and Rockets. In this letter, Senator Kennedy stated among other things that he would act "in January" to accelerate "[the] Polaris, Minuteman and other strategic missile programs" (cited in Ball 1980, p. 19).

In his State of the Union message on January 30, 1961, President Kennedy announced his decision to double the number of Polaris submarines approved in the defense budget for FY 1961, which was to end on June 30, 1961. Then, he announced a series of decisions to strengthen both conventional and nuclear forces. Overall, Rearden (1984) notes, "Kennedy was compelled to seek increases in military spending that added $5 billion to the defense budget during his first year in office" (Rearden 1984, p. 18).

Defense Secretary McNamara claimed that, in roughly three years, the Kennedy administration was able to build up "the most powerful force in American history" (cited in Ball 1980, introduction, p. xix). However, the actual increase in defense spending during the Kennedy build-up was less than implied by their verbal explanations.

According to the figures from CSBA, actual defense outlays increased modestly from FY 1961 to FY 1963. They were $48.1 billion in FY 1960, $49.6 billion in FY 1961, and $53.4 billion in FY 1963. Similarly, real defense purchases increased moderately from $301.5 billion in 1960:4 to $333.5 billion in 1962:2. However, they declined slightly in the following quarters, and were $324.5 billion in 1963:1.

3.2.5.2 U.S. News and World Report

In the newsletter Tomorrow published on November 7, 1960, which preceded the presidential election, it is claimed that defense spending was about to increase whether Senator Kennedy or Vice President Nixon—the Republican nominee—won the election. It is stated, "More for Defense? Surely, No Matter Who Is Elected."

On November 14, after the electoral victory of Senator Kennedy, it is argued, "What you can be quite sure of, however, is this much: …Spending for defense will rise further." The same week, in an article entitled "What the Election Means to You", it is projected that, with the election of Senator Kennedy,

> "*More money—at least 1.5 billions a year—will be spent on the defense establishment*. Billions will be invested in years just ahead on defense against missile attack. Other billions will be put into antisubmarine defenses." (Italics mine).

In the newsletter Tomorrow published on November 21, 1960, it is stated, "Defense spending will be increased." The same week, it is argued in an article entitled "What Kennedy Would Do as President",

> "The Kennedy plan means the following: More for defense. *Mr. Kennedy wants—and a Democratic Congress also appears to want—a speed-up in the building of U.S. defenses. Congress will be asked to approve added spending of between 2.5 and 3 billion dollars.* Missile programs will be speeded and expanded. There will be more money to modernize the Army. Submarine programs will be speeded and enlarged." (Italics mine).

3.2.6 December 1963: The Johnson Retrenchment

Moise (1996) and LaFeber (1985) provide two studies of the U.S. defense policy during the 1960s in *Tonkin Gulf and the Escalation of the Vietnam War* and *The Rise and Fall of American Power: 1963-1975*, respectively. From their analyses, one exogenous shock to defense purchases is identified that took place in December 1963. It corresponds to the beginning of a retrenchment in defense purchases implemented when President Johnson came to the White House.

3.2.6.1 Historical Account

When President Kennedy was assassinated in November 1963, it was apparent that the military build-up that began in the early 1960s was coming to a conclusion. For instance, the budget under preparation for FY 1965 projected the addition of only 50 new Minuteman silos to the existing nuclear forces. However, the retrenchment in defense purchases that took place as soon as President Johnson came to the White House was unexpected.

As LaFeber (1985) argues, President Johnson "wanted to be the President who, through so-called Great Society programs, fulfilled the New Deal's promises to the minorities, poor, elderly, and ill in America" (LaFeber 1985, p. 218). Therefore, as early as in December 1963, President Johnson attempted, with some success, to cut defense spending. Moise (1996) notes that, in fact, President Johnson was far more successful in his efforts to cut defense spending "than most people now remember" (Moise 1996, p. 32).

Moise (1996) points out, "[President Johnson] managed to cut more than a billion dollars in defense spending for what remained of FY 1964" (Moise 1996, p. 31), which ended on June 30, 1964. Moreover, he cut $3.8 billion from the budget for FY 1965 that had been almost entirely drafted during the Kennedy presidency. Eventually, the decline in defense purchases achieved by the Johnson administration was more modest than the President had expected because cuts in military expenditures became increasingly difficult to implement as American involvement in Vietnam grew.

According to the figures from CSBA, actual defense outlays increased slightly in FY 1964. They were $54.8 billion, compared to $53.4 billion in FY 1963. However, actual defense outlays were reduced to $50.6 billion in FY 1965. Real defense purchases decreased continually, although moderately, from 1963:4 to 1965:1. They were $319.6 billion in 1963:4 and $296.3 billion in 1965:1.

3.2.6.2 U.S. News and World Report

On November 18, 1963, the week preceding President Kennedy's assassination, U.S. News and World Report published an article entitled "Coming Cuts in Defense Spending: How Big?" in which it is stated,

> "Defense spending, which has been rising steadily year after year, may soon begin to dip.
>
> Pentagon officials claim the U.S. is now well prepared, should be able to save as much as 5 billions a year…
>
> Spending on defense—scheduled at 50 billion dollars for the year ending next June 30—will rise slightly in the following year, then start downward.
>
> *A cut of 5 billion dollars, to a level of 45 billion, is projected for the five years ahead*. This is based on the assumption that there will be no major change in the world situation." (Italics mine).

However, in the same articles it is emphasized that no drastic cut in defense purchases would occur. The following statement from Roswell Gilpatric, Deputy Secretary of Defense, is reported,

> "An area of low defense costs can hardly be said to lie ahead with military spending remaining on a level about 25 percent above that of the last Eisenhower year…As wee see things now, spending for defense will level off and then, perhaps, go down after a year or two."

In an article entitled "Where Johnson Stands on Financial Issues" published on December 9, 1962, it is argued, "President Johnson is a believer in a strong defense…The President's attitude suggests that spending [in defense] will continue to be large." Yet, in the Newsletter Tomorrow published on December 23, 1963, it is stated, "Cost of defense gradually will be somewhat trimmed." The same week, in an article entitled "Johnson's First Budget—To Break All Records", it is argued,

> "[President Johnson] has ordered all Government agencies and departments to make a last-minute examination of their own budgets and try to trim them. The Defense Department announced plans to close or reduce activities at 33 military installations."

Finally, in the newsletter Tomorrow published on December 30, 1963, it is claimed that a retrenchment in defense purchase s had already began. It is stated, "The session of Congress that just ended did much more than many think. Appropriations were cut about 6 billions below requests. Defense, space bore the brunt of the appropriation cuts made."

3.2.7 July 1965: The Vietnam War Build-up

Ramey and Shapiro (1997) argue that attacks against U.S. barracks by Communists at Pleiku in February 1965 represent the key event that led to the exogenous shock to defense purchases that marked the beginning of the Vietnam War military build-up. Neither the foreign and defense literature nor the evidence from U.S. News and World Report supports the date they select.

It appears that the decision to deploy a large number of ground combat forces in South Vietnam, which was taken in July 1965, should be considered as the key event that led to the Vietnam War military build-up. It did not only fundamentally changed the nature of the U.S. involvement in Vietnam but also dramatically raised its cost.

Gibbons (1995) and Berman (1982) provide two detailed analyses of the escalation of the Vietnam War in *The U.S. Government and the Vietnam War, Part IV: July 1965-January 1968* and *Planning a Tragedy: the Americanization of the War in Vietnam*, respectively. In both analyses, the decision to deploy a large number of ground combat forces in South Vietnam is identified as the key event that led to the Vietnam War military build-up.

3.2.7.1 Historical Account

As was mentioned before, the decline in military spending envisioned by the Johnson became increasingly difficult to implement as American involvement in Vietnam grew. Finally, a significant and sustained increase in defense purchases became inevitable in July 1965, when President Johnson announced his decision to send a large number of U.S. combat ground troops in South Vietnam.

In the spring 1965, it became evident that the South Vietnamese army could not stop a Communist victory in Vietnam. Therefore, in June 1965, General Westmoreland, Commander of the U.S. Forces in South Vietnam, requested the deployment of a large number of U.S. combat ground troops. As Gibbons (1995) relates,

> "[General Westmoreland] concluding that there was imminent danger of a Communist victory, requested large-scale deployment of U.S. combat forces- the '44 battalion' request-'to take the war to the enemy.' He recommended that U.S. ground forces be increased to 175,000 by the end of 1965 and to 275,000 in 1966, and be deployed on the coast as well as inland and used both offensively and defensively…
>
> In the following weeks, Westmoreland request was discussed by the President and his advisors. Papers were prepared summarizing major points of view, and a report was filed by McNamara after a trip which he and others made to Vietnam in mid-July… Between July 21 and 28, 1965, a numbers of meeting were held by the President to discuss McNamara report prior to a decision on Westmoreland's request" (Gibbons 1995 p. 15).

During a meeting on July 22, President Johnson himself emphasized that the deployment of a large number of U.S. troops would represent a true "change of policy." He explained, "[The United States] have relied on the South to carry the brunt. Now [they] would be responsible for satisfactory military outcome" (cited in Berman 1982, p. 115). The cost of a large-scale deployment of U.S. combat forces in Vietnam was also debated, and it was generally agreed that it would be high. President Johnson was presented the plan under consideration, and asked, "Do you have any ideas of what it will cost?" The answer from Defense Secretary McNamara was, "yes, sir, twelve billion dollars in 1966" (cited in Berman 1982, p. 114), almost a fourth of the actual defense outlays in FY 1965.

There is some historical evidence that President Johnson had decided to commit a large number of ground forces in South Vietnam by mid-July 1965 (Gibbons 1995, p. 15). In any case, he did not announce his decision until July 28, 1965. During a televised news conference, he stated that he was sending 50,000 more troops in South Vietnam, and that more troops would be needed and would be sent "as requested."

Berman (1982) points out that the press generally recognized the political significance of the decision announced by President Johnson and its implications for future defense purchases (see Berman 1982, preface, p. xi-xiv). An immediate and substantial increase in defense purchases took place. In August 1965, an emergency request was presented to Congress that added $12 billion to the defense budget for FY 1966.

According to the figures from CSBA, in the year following the decision to deploy a large number of U.S. troops in Vietnam, which corresponds to FY 1966, actual defense outlays increased from $50.6 billion to $58.1 billion. Real defense purchases increased sharply and continually for more than two years beginning in 1965:3. They were $300.7 billion in 1965:2, they reached $397.3 billion in 1967:3, and more than $400 billion in 1968:1.

Two alternative dates were also considered for the onset of the Vietnam War military build-up. The first date corresponds to the attacks against U.S. destroyers in the Gulf of Tonkin, which took place in August 1964, and led to the Gulf of Tonkin

resolution. The second date corresponds to the attacks against U.S. barracks at Pleiku, which led to a campaign of systematic bombing in North Vietnam. Those dates are important because they coincide with the beginnings of new stages in the escalation of the conflict in Vietnam; however, they do not coincide with dramatic changes in U.S. policy and defense purchases (see Moise 1996, p. 254; LaFeber 1985, p. 218; Palmer 1985, p.106).

3.2.7.2 U.S. News and World Report

Ramey and Shapiro (1997) claim that Business Week began forecasting the Vietnam War build-up in March and April 1965 following the attacks at Pleiku. During this period, neither the escalation of the Vietnam War nor a future military build-up was mentioned as a certainty in U.S. News and World Report. It is stated in the newsletter Tomorrow published on February 22, 1965,

> "It's well to face facts about Vietnam: *What's going on there could blow up into big war. The odds now seems against it, but it could happen…* Officially, however, the belief is this: Nobody on either side wants big war; everybody will go to lengths to prevent it." (Italics mine).

In an article entitled "New Look at Defense—Why Congress Worries" published the following week President Johnson's plan to cut defense expenditures in FY 1966, which was to begin in July 1, 1965 is discussed. It is argued,

> "With foreign problems looming larger, a showdown is taking shape between Congress and the White House over U.S. defenses. Ordered or on the way: troop reductions, more bomber cuts, slowdown in new weapons… Congress has before it the lowest defense budget in five years, calling for the scrapping of more nuclear bombers, a decrease in manpower, a slowdown in development of new weapons, other reductions in military strength...*At this time, Mr. Johnson is firmly on the side of reducing defense costs.* His aim is to pump military savings into domestic projects that will give meaning to his 'Great Society.'" (Italics mine).

In the newsletter Tomorrow published on June 21, 1965, an escalation of the war is still described as uncertain even though the position of the South Vietnamese army had recently weakened. It is stated,

> "A note of doubt and uncertainty is influencing attitudes just now. War in Vietnam, expanding, raises question, creates uncertainty… Limited bombing in Vietnam is proving indecisive… War on the ground as now waged with U.S. in a limited role, is not making progress but is actually being lost. Large-scale action involving many U.S. troops may readily being forced by events."

Finally, U.S. News and World Report repeatedly announced the upcoming escalation of the Vietnam War and future increases in military expenditures in July 1965. In the newsletter Tomorrow published on July 5, 1965, it is stated, "War in Vietnam is to grow more costly in both lives and dollars."

The following week, it is argued, "War in Vietnam will go on, grow bigger. U.S. troop involvement will be expanded to 100, 000 and maybe a good deal beyond… Arms spending will rise as war costs go up." In an article entitled "At Home: Growing Pressure to 'Get Ready for Big War'" published on July 26, 1965, the following outlook for the future is given,

> "President Johnson announced only July 13 he would make a new assessment of U.S. needs after the completion of the fact-finding tour to Vietnam by Defense Secretary Robert S. McNamara and Ambassador-designate Henry Cabot Lodge. Mr. Johnson warned that 'new and serious steps' may soon be necessary. *The president's words were taken as the forerunner of a sizable request for more defense money and for a call-up of some reserves*. Congress was ready to move into action swiftly." (Italics added).

In the newsletter Tomorrow published on August 9, 1965, a substantial increase in defense expenditures is projected, "Defense spending in months ahead will be raised about 4 billions… Later spending, if war goes on, will be increased sharply." In an article entitled "In the Year Ahead: 143 Billions of Federal Spending" published on August 30, 1965 it is anticipated that defense expenditures were to increase, at the least, by $7 billion in the following two years. It is claimed,

> "*In these two years—mid-1965 to mid-1967—cash spending on defense is expected to increase about 7.6 billions, to a total of 53.8 billions for fiscal 1967*. These figures on defense expenditures are conservative estimates made by the Economic Unit of 'U.S. News and World Report.'
>
> Actually, defense outlays may go up much more sharply than this, as key members of Congress freely predict." (Italics mine)

3.2.8 July 1969: The Nixon Retrenchment

LaFeber (1985) provides an analysis of U.S. defense policy during the later stages of the Vietnam War in *The Rise and Fall of American Power: 1963-1975*. Schurmann (1987) and Bundy (1998) provide two studies of the U.S. defense policy during the Nixon Presidency in *The Foreign Politics of Richard Nixon: The Grand Design* and *A Tangled Web: the Making of Foreign Policy in the Nixon Presidency*, respectively. According to LaFeber (1985), Schurmann (1987), and Bundy (1998), the announcement of the "Nixon doctrine" in July 1969 represents the key event that led to the retrenchment in defense purchases taking place in the early 1970s.

3.2.8.1 Historical Account

When President Nixon came to the White House in January 1969, Thorton (1989) argues, "The deterioration of the strategic, geopolitical, and economic positions brought about primarily by involvement in Vietnam combined to produce a crisis of strategy for the United States (Thorton 1989, p. 3). Similarly, Williams (1987) notes, "With the increasing unpopularity of the war [in Vietnam]…it became obvious that another reappraisal of American foreign and defense policy was called for" (Williams 1987, p. 35).

As Congress debated the defense budget for FY 1970, it pressured the Nixon administration not only to withdraw U.S. troops from Vietnam but also to drastically cut defense expenditures (see U.S. Defense Policy 1983, p. 7). In the first months of his administration, President Nixon refused to give in to popular and congressional pressures. He opposed a quick withdrawal from Vietnam because it would have undermined the credibility of the American commitment abroad (see LaFeber 1985, p. 281; Bundy 1998, p. 82). Furthermore, he opposed drastic cuts in defense expenditures that would have prevented the United States from maintaining a strong and credible military posture (see Nixon 1971, p. 162).

However, in March 1969, President Nixon announced a two-prong policy known as the "Vietnamization" to finally end the presence of U.S. ground forces in Vietnam. It led to a first withdrawal of 25, 000 troops in June 1969.Then, he announced what was to be known as the "Nixon doctrine" in July 1969 during an informal press conference in Guam. Bundy (1998) reports,

> "[President Nixon] defined future American policy under three headings: The United States would keep all his treaty commitments (but by implication be chary of new ones); it would 'provide a shield' if a nuclear power threatened the freedom of an allied nation or of a nation whose survival was vital to American security or that of the 'region a s a whole'; and it would furnish military and economic assistance against aggression but would expect the nation directly threatened to assume the primary responsibility of providing manpower for its own defense" (Bundy 1998, p. 68).

At first, as Schurmann (1987) reports, President Nixon's statement "appeared to be little more than a rationalization for pulling American troops out of Vietnam (to reduce casualties and costs)" (Schurmann 1987, pp. 36-37). However, in the weeks following the press conference in Guam, it became evident that the "Nixon doctrine" represented a dramatic turn in new U.S. foreign and defense policy, which implied a significant reduction in defense spending.

According to the figures from CSBA, actual defense outlays decreased from \$82.5 billion to \$81.7 billion in the first year after the announcement of the Nixon doctrine, which corresponds to FY 1970. Then, they decreased modestly until FY 1973, when they were \$76.7 billion. Real defense purchases also decreased steadily for more than two years after the announcement of the "Nixon doctrine." They were \$303.2 billion in 1971:4, compared to \$383.3 in 1969:2.

3.2.8.2 U.S. News and World Report

In the newsletter Tomorrow published on January 27, 1969, no sudden cuts in government and defense expenditures are anticipated. It is stated, "Even if the war is slowed drastically, cost of Government will keep rising. Arms rebuilding in year ahead under present plans will go up 4 billions, more than offsetting a scheduled drop of 3.5 billions in Vietnam spending."

In the newsletter Tomorrow published on July 7, 1969 modest cuts in defense expenditures are projected; however, it is emphasized that substantial cuts appeared unlikely. It is argued,

> "*Continuing war means Congress will have trouble cutting military spending…* Research, 7 billions, a favorite target, probably will be cut somewhat. Chief battleground, procurements at 22.5 billions, may provide future savings—but not much in 1970 because the money goes for Vietnam equipment.
> On the budget, as with everything else, Congress and Mr. Nixon cannot make big savings until the war ends." (Italics mine).

The issue of U.S. News and World Report published on July 21, 1969 reports that, as the first American troops had pulled out of Vietnam, pressures from Congress to reduce U.S. defense expenditures were increasing. In the newsletter Tomorrow, it is stated,

"War in Vietnam is definitely in the downswing. Americans finally can foresee an end to major involvement. Official attention is turning to postwar…
A start, long expected, is being made on cutting U.S. commitments and the numbers of Americans overseas. This pullback will expand."

The cover of the magazine published the same week features an article entitled "The New Pressure to Trim U.S. Defense" in which it is argued,

"At the time when President Nixon is about to embark on a mission to shore up U.S. relations abroad, Congress appears more determined than at any time since the end of World War II to cut back America's global commitment, and trim its defense as well."

In the newsletter Tomorrow published on August 18, 1965, after President Nixon returned from his trip abroad, it is argued, "Defense spending will take a big slash." The following week, drastic cuts in procurements are announced,

"*It's open season on defense*. Take the purchases of new military hardware: Lyndon Johnson left behind a 23.1-billion-dollar procurement request. Mr. Nixon cut that to 21.9 before it got to Congress. Now the Senate has whittled the figure to below20 billion—and lawmakers are not finished.
Main casualties so far: Navy shipbuilding, the Army's new helicopter, Air Force's man-in-space program, the FB-111 bomber, several missile projects." (Italics mine).

In the newsletter Tomorrow published on September 1, 1969, further cuts in defense expenditures are anticipated. It is claimed, "Slash of another 3 billions in Pentagon spending plans for this fiscal year, revealed August 21, probably isn't the end. President's opponents in Congress will take aim at research and new procurement plans."

3.2.9 December 1979: The Carter-Reagan Build-up

Ramey and Shapiro (1997) content that the invasion of Afghanistan by Soviet troops in December 27, 1979 represents the key event that led to the beginning of the Carter-Reagan build-up. Since this invasion took place very late in the month, they date the beginning of the Carter-Reagan build-up in the first quarter of 1980.

U.S. Defense Policy (1983) edited by Wormser provides a very detailed account of the events and developments that led to the Carter-Reagan build-up. It implies that the Iranian crisis that began in November 1979 was the key event that led to a sudden increase in defense spending. At the beginning of December 1979, the decisions to implement a significant and sustained build-up were taken and announced. Therefore, it is argued that the Carter-Reagan build-up should be dated as beginning in the last quarter of 1979.

3.2.9.1 Historical Account

At the turn of 1979, President Carter insisted that the Senate hearings on the second stage of the Strategic Arms Limitation Talk (SALT II), which were scheduled for the spring 1979, should focus on the impact of SALT II on the U.S.-Soviet military balance. In fact, they "became a forum for reviewing the U.S.-Soviet military balance and assessing the adequacy of Carter's defense policies" (U.S. Defense Policy 1983, p. 22).

It was reported that a "window of vulnerability" had opened up and that U.S. land based strategic missiles were vulnerable to Soviet aggressions. Then, reports that Soviet troops were stationed in Cuba emerged in August 1979. Finally, in November 1979, Iranian militants seized the U.S. embassy in Teheran. As U.S. Defense Policy (1983)

points out, “in the wake of these events, the American public backed a more assertive U.S. international posture” (U.S. Defense Policy 1983, p. 24).

At the same time, a “congressional consensus favoring a ‘tougher’ defense stand” developed as “it was apparent that congressional alarm over the U.S.-Soviet balance of power had reach a new level of intensity” (U.S. Defense Policy 1983, p. 24). At the beginning of December 1979, the Senate approved a plan to increase defense expenditures by 5 percent a year beyond inflation in the next two years. On December 12, 1979, President Carter announced a ten percent increase in defense spending for FY 1980, which was to end in July 1980, and a plan to build up conventional and nuclear forces in the long run. As U.S. Defense Policy (1983) summarizes,

> “Carter and Congress had agreed on a fiscal 1980 defense budget of approximately $142.6 billion—an increase of almost $15 billion over the previous year. And Carter was forced to pledge that he would seek future and real increases for defense of 5 percent annually. The Senate had already approved a build-up at that rate.” (U.S. Defense Policy 1983, p. 21)

According to U.S. Defense Policy (1983), the invasion of Afghanistan by Soviet troops on December 27, 1979, did not lead “to a sudden change in the U.S. policy” as Ramey and Shapiro (1997) claim. It merely ended the remaining hope, if any existed, that SALT II would be approved (see U.S. Defense Policy 1983, pp. 58-61).

According to the figures from CSBA, actual defense outlays increased from $116.3 billion in FY 1979 to $134.0 billion in FY 1980. Then, they continually rise until FY 1983, when they reached $209.9 billion. Real defense purchases increased moderately in 1980, from $273.1 billion in 1979:4 to $280.8 billion in 1980:4. Then, they rise more steadily, and reached $327.5 billion in 1982:4.

By the end of 1982, congressional support for the military build-up was eroding; however, the Reagan administration was able to revitalize the American military effort after the announcement of the Strategic Defense Initiative (SDI) in March 1983. According to the figures from CSBA, actual defense outlays continually increased from FY 1983 to FY 1986, and reached $273.4 billion in FY 1986. Real defense purchases increased moderately in 1983, and then they rose sharply for more than three years. In 1986:3, they reached more than $400 billion for the first time in U.S. history.

3.2.9.2 U.S. News and World Report

Following the recent crises with Cuba and the Soviet Union, it is stated in the newsletter Tomorrow published on October 1, 1979,

> “More Americans are waking up to the possibility that the U.S. may be letting its military power slip too far behind the Soviets’.
>
> *A new mood of toughness is developing. You see it in the Senate vote September 18 for annual hikes of 5 percent after inflation in the 1981 and ’82 arms budgets…*
>
> President Carter is committed to a 3 percent increase beyond inflation in the 1980 arms budget. But that will do little more than replace used-up munitions and fund the stockpiling of arms and ammunition in Western Europe.
>
> So, the White House has opened the door for a bigger increase in 1981.
>
> Top Army commanders will meet late this month to decide which new, major weapons to push. Near the top: A new tank and a new antiaircraft missile.
>
> What about the direct threat of Soviet rockets aimed at the U.S. mainland?

Washington's answer will be the MX-mobile-missile system and the airborne cruise missile. Now, it's a full green light for both." (Italics mine).

Before the Iranian Crisis, in the newsletter Tomorrow published on November 5, 1979, a significant increase in defense expenditures is already anticipated. It is argued, "Carter is about to commit himself to big new defense outlays: At least 143 billion in 1981, up 16 billion from 1980."

On December 10, 1979, a sustained military build-up is again anticipated,

"What will Carter do? For one thing, he will jump Pentagon spending no matter the effects on the economy. People are demanding a stronger America.

Best bet: An increase above inflation of about 5 percent in each of the next five years, making 1981 military outlays about 145 billion dollars."

After President Carter announced the establishment of a RDF and the deployment of Pershing II missiles in Western Europe, the newsletter Tomorrow published on December 24, 1979 announced, "It's a turning point: America is going to strengthen its military forces to defend the country's interest at trouble spots overseas." It also warned, "Rebuilding Yankee military might will be expensive and take time. It will need the backing of Congress and of the voters."

3.2.10 November 1989: The Bush-Clinton Retrenchment

American Defense Annual (1988-1989) edited by Knuzel provides an analysis of U.S. defense policy during the second term of President Reagan. The Brookings Institution, the Center for Defense Information (CDI) and RAND, provide further studies of U.S. defense policy since the end of the Cold War. They imply that although, defense purchases had been frozen since November 1987, a significant and sustained retrenchment in defense expenditures was not implemented until the Soviet Empire began collapsing in the fall 1989.

3.2.10.1 Historical Account

Korb and Daggett (1988), who wrote their study at the end of the second Reagan presidency, argued that the Reagan administration was facing a growing opposition to the military build-up that began at the end of the previous decade. They noted, "In November 1987, the administration finally bowed to the inevitable and reached an agreement with Congress that virtually freeze military spending for the remainder of the president's second term." (Korb and Daggett 1988, p. 43). However, they did not anticipate any significant cut in defense spending in the near future.

With respect to the upcoming presidential election of November 1988, Korb and Daggett (1988) state, "… It remains unlikely that the public will endorse a candidate who would drastically cut today's level of military spending" (Korb and Daggett 1988, p. 60). Like most experts, they did not anticipate the reversal in defense purchases that began with the collapse of the Soviet Empire in the Fall 1989.

The collapse of the Soviet Empire occurred quickly and unexpectedly. The Berlin Wall fell in November 1989. Two weeks later, the Velvet Revolution took place in Czechoslovakia. A month later, Nikolae Ceausescu was executed in Romania. By the end of 1990, no communist government remained in Europe. At this time, MacLaury, President of the Brookings Institution, already emphasized the impact of the collapse of the Soviet Empire on U.S. defense purchases. He stated,

"The administration has reversed its position on spending for national defense. Only eight months ago, President Bush proposed a plan calling for an average

> annual increase (after inflation) of 1.7 percent between fiscal years 1990 to 1994. Now in December 1989, Secretary of Defense Cheney is considering reductions that could amount to as much as $195 billion between fiscal 1991 and 1995" (MacLaury, in preface of Kaufmann 1990, p. vii).

Despite the end of the Cold War, the Bush administration implemented a relatively limited retrenchment in defense purchases because of the possibility of a resurgent Russia and the need to deal with regional contingencies. Then, the Clinton administration continued to pursue a cautious retrenchment (see The Defense Monitor 1997, pp. 1-4; Kugler 1994).

According to the figures of CSBA, actual defense outlays decreased very slightly in the first years after the end of the Cold War. They declined from $303.6 billion in FY 1989 to $297.9 billion in FY 1990, and $296.7 billion in FY 1991. Then, they declined more steadily; however, they never fell below $265 billion a year. Real defense purchases remained stable during the first two years after the collapse of the Soviet Empire. They were $407.4 billion in 1989:3 and $405 billion in 1991:2. Then, they declined steadily. They were $376.8 billion when President Bush left the White House in 1992:4, and $335.1 billion in 1994:1. Finally, they fell below $300 billion in 1998:1.

3.2.10.2 U.S. News and World Report

In the mid-1980s, the format of the newsletter Tomorrow published in U.S. News and World Report changed entirely. At the time of the Collapse of the Soviet Empire, it mostly focused on domestic issues and no longer provided economic and political forecasts. Therefore, only evidence from articles published in U.S. News and World Report are presented in this sub-section.

On December 11, 1989, the cover of U.S. News and World Report featured an article entitled "After the Cold War? Do We Need an Army?" in which significant cuts in defense expenditures are predicted,

> "The tantalizing promise of an end to the cold war is already generating political pressure to bring American boys home from Europe and to slash the nation's $300 billion defense budget…
>
> *Secretary of Defense Richard Cheney has ordered the services to plan for $150 billion in cuts from projected spending for the next five years*. The Army is considering eliminating at least 135, 000 troops, reducing its active-duty divisions by one sixth; the navy has proposed to abandon its long cherished goal of a 600-ship fleet, eliminating three aircraft carriers and about 60 other vessels." (Italics mine).

However, in an article entitled "Bush Looks Ahead to the 1990s" published in December 25, 1989, it is reported that, while President Bush will support gradual reductions, he will oppose drastic cuts in defense expenditures. The following statement from President Bush is cited,

> "There has been such a euphoric feeling in Capitol Hill about this change that they think they can just cut the heart out of the defense program. And that I will resist. I don't want to encourage the thought that we always have to operate at these substantial levels. But on the other hand, I don't want to encourage reckless cuts."

3.2.11 Discussion of the Shocks Identified

Five exogenous positive shocks to defense purchases were identified in the previous section of this chapter. They are referred to as the March Crisis, the Korean War, the Kennedy, the Vietnam War, and the Carter-Reagan episodes. Four exogenous negative shocks were also identified. They are referred to as the Eisenhower, the Johnson, the Nixon, and the Bush-Clinton episodes.

The Korean War build-up is dated as beginning in the third quarter of 1950, which is also the date selected by Ramey and Shapiro (1997). The Vietnam War build-up is dated as beginning in the third quarter of 1965, two quarters after the date selected by Ramey and Shapiro (1997). The Carter-Reagan build-up is dated as beginning in the last quarter of 1979, one quarter before the date selected by Ramey and Shapiro (1997). Furthermore, the March Crisis and the Kennedy episodes are dated as beginning in 1948:2 and 1960:4, respectively. The Eisenhower, the Johnson, the Nixon, and the Bush-Clinton episodes are dated as beginning in 1952:4, 1963:4, 1969:3, and 1989:4, respectively.

The first panel of Figure 3.1 presents the evolution of real defense purchases over the period 1947:1 to 1999:2. The vertical lines mark the onsets of the four exogenous increases and the retrenchments in defense purchases identified in the previous section. As was mentioned in the first chapter of the dissertation, the evolution of defense purchases in the post-World War II era is characterized by the existence of the three major cycles in defense purchases that began at the onsets of the Ramey-Shapiro episodes. They are hereafter referred as the Korean War, the Vietnam War and the Carter-Bush cycles. In comparison to these major cycles, the cycle that began at the onset the Kennedy episode, which is hereafter referred as the Kennedy-Johnson cycle, appears very modest and brief. The rise in defense purchases that followed the March Crisis of 1948 appears even more modest and brief.

Defense purchases began to slowly increase two years before the date selected for the Carter-Reagan episode and more than a year before the date selected for the Nixon episode. It is believed that the lags between the dates when defense purchases began to change and the dates selected for these episodes reflect the uncertainty about the future of defense spending, which was predominant in the late 1960s and late 1970s. As was mentioned before, the key issue in identifying exogenous shocks to defense purchases using a narrative approach is to find the dates at which the decisions to implement sustained changes in defense purchases were taken and announced, which do not necessarily correspond to the dates at which defense purchases actually began to change.

Furthermore, as Perotti (2000) points out, when a narrative approach is used to estimate the macroeconomic effects of fiscal policy, it is usually assumed that they have identical effects on the economy. Since the changes in defense purchases after the March Crisis, the Kennedy, and the Johnson episodes were very small and brief, it may be difficult to argue that they had the same effects, or even similar effects on the economy, as the other episodes identified in the previous section.

Therefore, it may be problematic to construct a dummy variable that includes the March Crisis, the Kennedy, and Johnson episodes along with the other shocks to defense purchases identified earlier. Accordingly, the study of the implications of the more comprehensive narrative approach presented in the next sections of this chapter focuses

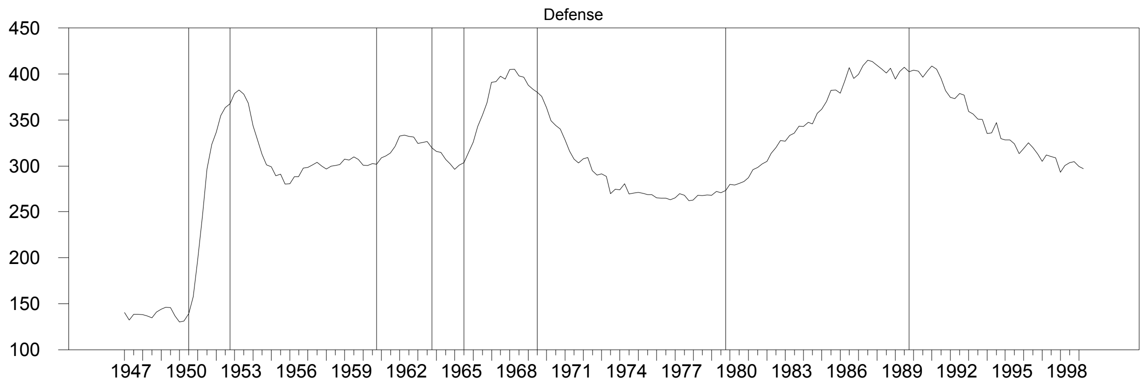

Figure 3.1: Real Defense Purchases in the Post-World War II Era
Sample period: 1947:1-1999:2

on the effects of shocks to a dummy variable that includes the six episodes associated with the three major defense purchases cycles identified earlier.

A major advantage of the narrative approach presented in the previous section over the narrative approach of Ramey and Shapiro (1997) is that, since it includes military retrenchment as well as military build-ups, twice as many exogenous shocks to defense purchases are identified. Ramey and Shapiro (1997) do not include retrenchments in defense purchases in their study because they argue that they are much more gradual than the build-ups. In fact, the three major retrenchments identified in the post-World War II era do not appear much more gradual than the preceding military build-ups.

The maximum decreases in defense purchases within eight quarters after the onsets of the Eisenhower, the Nixon, and the Bush-Clinton episodes are \$66 billion, \$72 billion, and \$21 billion, respectively. The maximum increases in defense purchases within eight quarters after the onset of the Korean War, the Vietnam War, and the Carter-Reagan episodes are \$232, \$56 and \$29 billion, respectively.

Although the decline in defense purchases during the Eisenhower retrenchment is modest in comparison to the increase in defense purchases during the preceding build-up, it is larger than the increase in defense purchases during the Vietnam War and Carter-Reagan build-ups. The decline in defense purchases during the Vietnam War retrenchment is slightly larger than the increase during the preceding build-up. The Carter-Reagan build-up and the Cold War retrenchment are similar in magnitude.

3.3 Alternative Dates for Korean War and Vietnam War Episodes

Edelberg, Eichenbaum, and Fisher (1999) examine the sensitivity of the results they report for real GDP, residential investment, non-residential investment, after-tax manufacturing wages, consumption of non-durables and services, and government purchases to small perturbations in the dates selected for the Ramey-Shapiro episodes. For each Ramey-Shapiro episode, they carry out the same exercise.

First, they construct a modified Ramey-Shapiro dummy variable that has the value one the quarter before the one selected by Ramey and Shapiro (1997) for the episode under examination and the quarters selected by Ramey and Shapiro (1997) for the other episodes. Then, they estimate their benchmark model and extended models in which the modified Ramey-Shapiro dummy variable is included as an exogenous variable.

Finally, they compute IRFs that present the effects of a unit shock to the modified Ramey-Shapiro dummy variable on the variables listed above and plot them against the corresponding confidence intervals reported for a unit shock to the Ramey-Shapiro dummy variable. They repeat the same procedure when the episode under examination is assumed to have occurred two and three quarters before, and one, two, and three quarters after the date selected by Ramey and Shapiro (1997).

Edelberg, Eichenbaum, and Fisher (1999) only present the IRFs computed when the date of the Korean War episode is altered. Since these IRFs are generally similar to the ones reported for their benchmark model, they argue that the results they report are robust to small perturbations in the dates of Korean War episode. Furthermore, they claim that their results are "extremely robust" to small perturbations in the dates of the Vietnam War and Carter-Reagan episodes (see Edelberg, Eichenbaum, and Fisher 1999, p. 15).

The dates selected earlier in this chapter for the onsets of the Vietnam War and Carter-Reagan episodes are slightly different from ones selected by Ramey and Shapiro (1997). Therefore, they can be used to re-examine the sensitivity of the results reported for a shock to the Ramey-Shapiro dummy variable to small perturbations in the dates of the Ramey-Shapiro episodes.

This section investigates the sensitivity of the results reported in the previous chapter of the dissertation for the benchmark and alternative models to using the dates selected earlier in this chapter for the onsets of the Vietnam War and Carter-Reagan episodes. The benchmark model is a VAR system that includes a constant and four lagged values of real defense purchases, real GDP, the net three month interest rate on Treasury bills (RTB), and the GDP deflator that are included as endogenous variables. In addition, the contemporaneous value and four lagged values of the Ramey-Shapiro dummy are entered as exogenous variables. The logarithmic values of the variables are used except for interest rates.[1]

The alternative model includes the same variables as the benchmark model; however, six lagged values of the variables are used and a "Perron-type" time trend is added to each equation in the system. The benchmark and alternative models are estimated over the sample periods from 1948:1 to 1999:2 and from 1948:3 to 1999:2, respectively.

To examine the sensitivity of the results reported for the benchmark model to using the alternative date selected earlier in this chapter for the Vietnam War episode, a modified Ramey-Shapiro dummy variable is constructed in which the Vietnam War episode is dated as beginning two quarters after the date selected by Ramey and Shapiro (1997). It has the value one in 1950:3, 1965:3, 1980:1 and zero otherwise.

Then, the benchmark model is estimated using the modified Ramey-Shapiro dummy variable. Finally, the IRFs for defense purchases, real GDP, RTB, and the GDP deflator are computed for a unit shock to the modified Ramey-Shapiro dummy variable following the same methodology as the one presented in the previous chapter of the dissertation. If the results reported for the benchmark model are not sensitive to using the alternative date for the Vietnam War episode, the IRFs computed using the modified Ramey-Shapiro dummy variable ought to lie within the corresponding confidence intervals reported using the Ramey-Shapiro dummy variable.

The same procedure is implemented to examine the sensitivity of the results reported for the benchmark model to using the alternative date selected earlier in this chapter for the Carter-Reagan episode. In this case, the Carter-Reagan episode is dated as beginning a quarter before the date selected by Ramey and Shapiro (1997).

In the first and second columns of Figure 3.2, the solid lines display the point estimates of the IRFs computed for the benchmark model when the alternative dates for the Vietnam War and Carter-Reagan episodes selected earlier in this chapter are used, in turn, to construct the modified Ramey-Shapiro dummy variable. The dashed lines display

[1] The benchmark model as well as the alternative model is discussed in detail in the previous chapter of the dissertation.

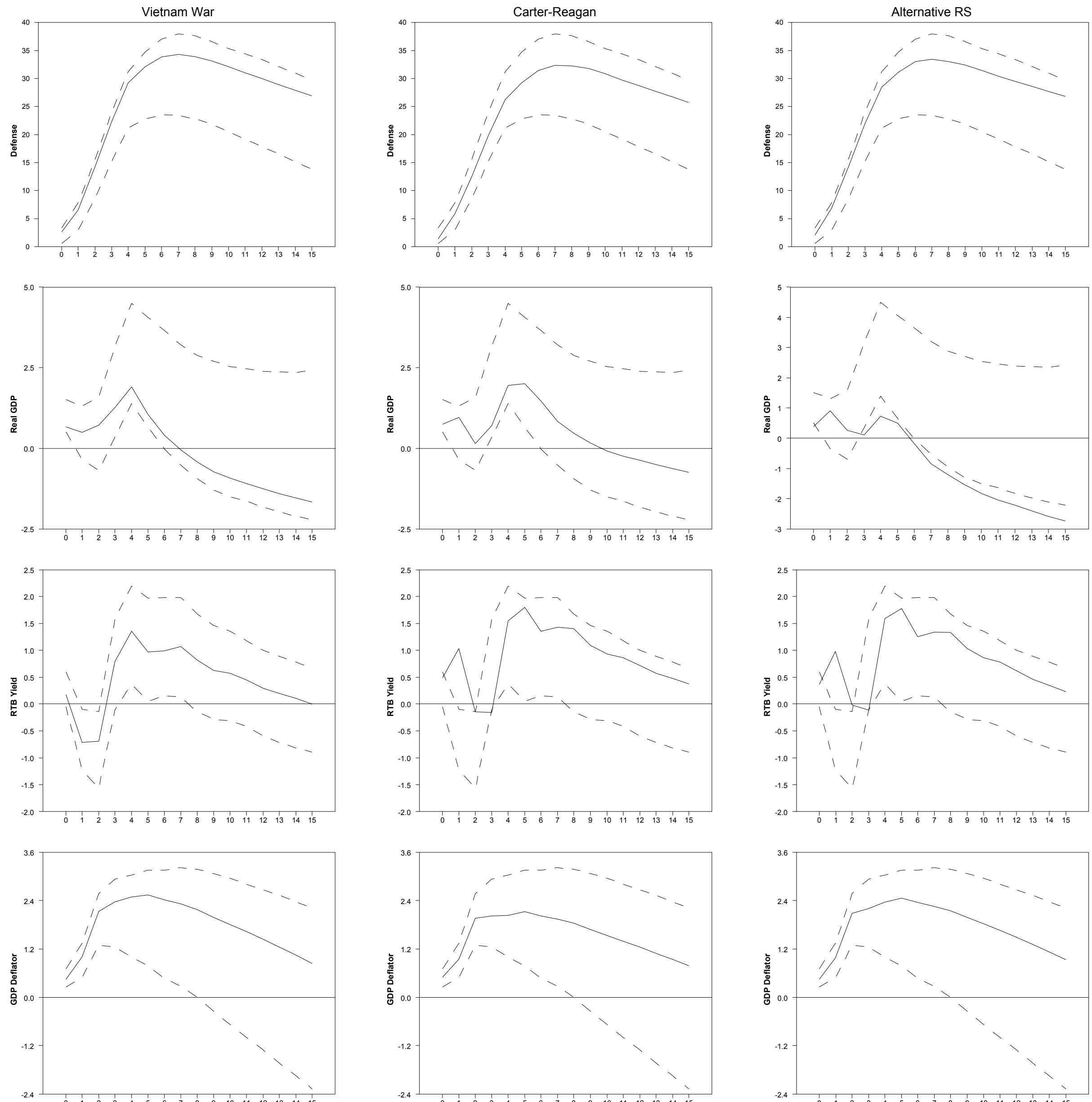

Figure 3.2: Point Estimates from Models With Alternative Dates for the Ramey-Shapiro Episodes
Confidence Intervals from the Benchmark Model

the lower and upper bounds of the sixty-eight percent confidence intervals computed for a unit shock to the Ramey-Shapiro dummy variable, which were reported in the previous chapter of the dissertation.

When the alternative date is used for the Vietnam War episode, all the IRFs reported lie within the corresponding confidence intervals reported for a shock to the Ramey-Shapiro dummy variable at all horizons. However, the patterns of the IRF for real GDP is different from the one reported using the Ramey-Shapiro dummy variable at long horizons. A year after a Ramey-Shapiro episode, it begins to decline steadily and persistently.

When the alternative date is used for the Carter-Reagan episode, the IRFs computed for defense purchases, real GDP, and the GDP deflator lie within the corresponding confidence intervals reported for a shock to the Ramey-Shapiro dummy variable at all horizons. The IRF computed for RTB lies above the upper bound of the confidence interval reported for a shock to the Ramey-Shapiro dummy variable for two quarters, and then it lies within the confidence interval. Furthermore, the pattern of the IRF for RTB is initially very different from the one reported for a shock to the Ramey-Shapiro dummy variable.

To further investigate the sensitivity of the results reported for the benchmark model to small perturbations in the dates of the Ramey-Shapiro episodes, an alternative Ramey-Shapiro dummy variable is constructed using the alternative dates selected earlier in this chapter for both the Vietnam War and Carter-Reagan episodes. It has the value one in 1950:3, 1965:3, 1979:4, and zero otherwise.

In the last column of 3.2, the solid lines display the point estimates of the IRFs for defense purchases, real GDP, RTB, and the GDP deflator computed for a unit shock to the alternative Ramey-Shapiro dummy variable when the benchmark model is estimated. The dashed lines display the lower and upper bounds of the sixty-eight percent confidence intervals computed for a shock to the Ramey-Shapiro dummy variable.

The IRFs computed for defense purchases and the GDP deflator lie within the corresponding confidence intervals reported for a shock to the Ramey-Shapiro dummy variable at all horizons. Furthermore, their patterns are similar to the ones reported for a shock to the Ramey-Shapiro dummy variable.

The IRF for real GDP lies within the confidence interval reported for a shock to the Ramey-Shapiro dummy variable for three quarters, and then it lies slightly below the lower bound of the confidence interval. The IRF for RTB lies above the upper bound of the confidence interval reported for a shock to the Ramey-Shapiro dummy variable for two quarters, and then it lies within the confidence interval. Furthermore, the pattern of the IRF for real GDP is different from the one reported for a shock to the Ramey-Shapiro dummy variable at long horizons, and the pattern of the IRF for RTB is initially very different from the one reported for a shock to the Ramey-Shapiro dummy variable.

To investigate the sensitivity of the results reported for the alternative model to small perturbations in the dates of the Ramey-Shapiro episodes, the exercises presented above for the benchmark model are reproduced for the alternative model. In the first and second columns of Figure 3.3, the solid lines display the point estimates of the IRFs for defense purchases, real GDP, RTB, and the GDP deflator computed for the alternative model when the alternative dates selected earlier in this chapter for the Vietnam War and

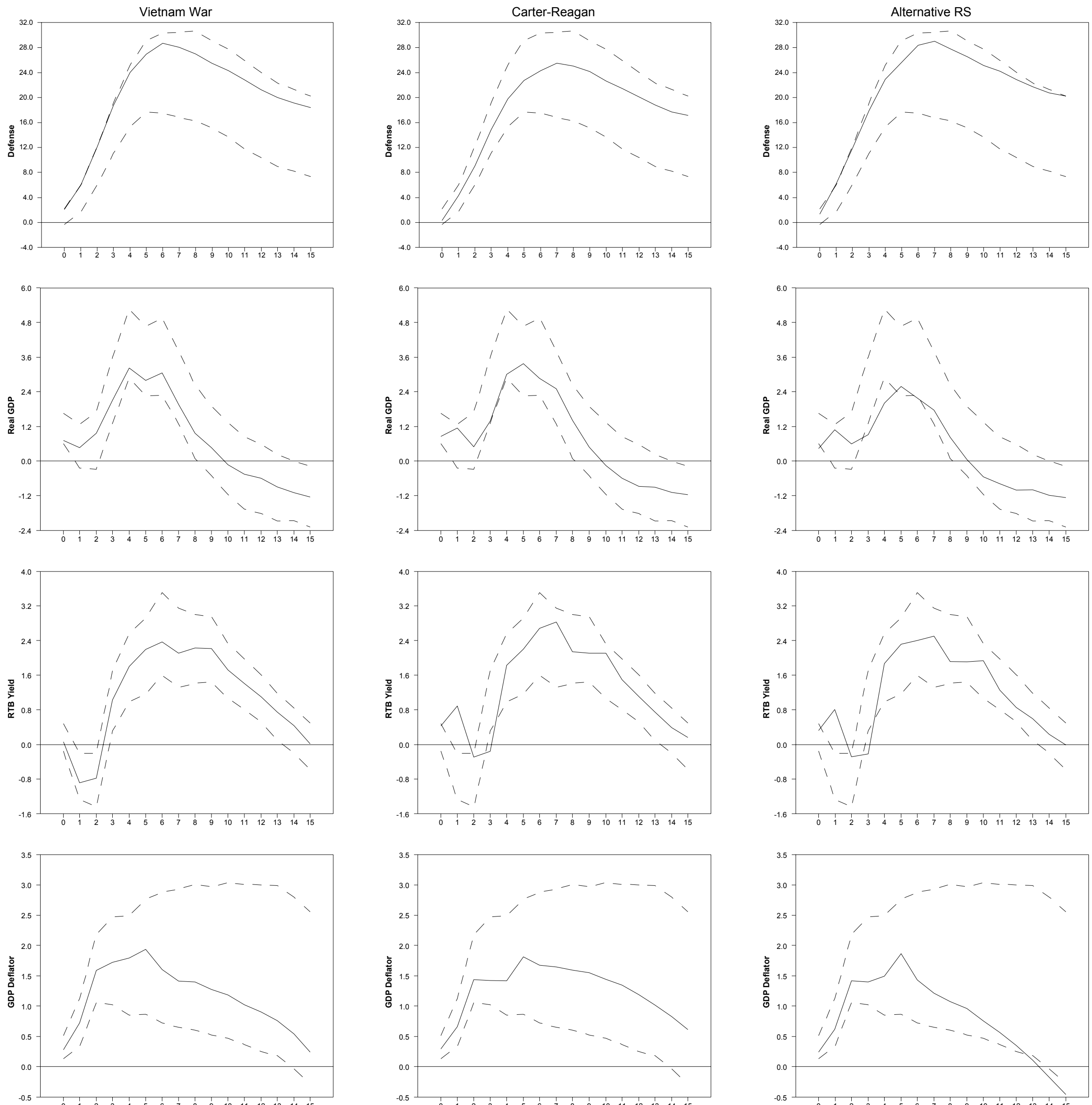

Figure 3.3: Point Estimates from Models With Alternative Dates for the Ramey-Shapiro Episodes
Confidence Intervals from the Alternative Model

Carter-Reagan episodes are used, in turn, to construct the modified Ramey-Shapiro dummy variable. The dashed lines display the lower and upper bounds of the sixty-eight percent confidence intervals computed for a shock to the Ramey-Shapiro dummy variable, which are reported in the previous chapter of the dissertation.

When the alternative dates are used for the Vietnam War or the Carter-Reagan episodes, the IRFs computed for defense purchases, real GDP, and the GDP deflator lie within the corresponding confidence intervals reported for a shock to the Ramey-Shapiro dummy variable at all horizons. Furthermore, their patterns are similar to the ones reported using the Ramey-Shapiro dummy variable. When the alternative date is used for the Vietnam War episode, the IRF for RTB also lies within the confidence interval reported for a shock to the Ramey-Shapiro dummy variable at all horizons.

However, when the alternative date is used for the Carter-Reagan episode, the IRF computed for RTB lies above the upper bound of the confidence interval reported for a shock to the Ramey-Shapiro dummy variable for two quarters, and then it lies within the confidence interval. Furthermore, its pattern is initially very different from the one reported using the Ramey-Shapiro dummy variable.

In the last column of Figure 3.3, the solid lines display the point estimates of the IRFs computed for the alternative model for a unit shock to the alternative Ramey-Shapiro dummy variable. The dashed lines display the lower and upper bounds of the sixty-eight percent confidence intervals reported for a shock to the Ramey-Shapiro dummy variable.

The IRF for defense purchases computed for a shock to the alternative Ramey-Shapiro dummy variable lies within or on the confidence intervals reported for a shock to the Ramey-Shapiro dummy variable at all horizons. The IRF for real GDP lies within the confidence interval reported for a shock to the Ramey-Shapiro dummy variable for two quarters, and then it lies slightly below the lower bound of the confidence interval for two quarters.

The IRF for RTB lies above the upper bound of the confidence interval reported for a shock to the Ramey-Shapiro dummy variable for two quarters, and then it lies within the confidence interval. The IRF for the GDP deflator lies within the confidence interval reported for a shock to the Ramey-Shapiro dummy variable for more than three years, and then it lies very slightly below the lower bound of the confidence interval. Furthermore, the pattern of the IRF for RTB is very different initially from the one reported for a shock to the Ramey-Shapiro dummy variable, and the pattern of the IRF for the GDP deflator is different at long horizons.

In conclusion, Edelberg, Eichenbaum, and Fisher (1999) argue that the results they report are robust to small perturbations in the dates of the Ramey-Shapiro episodes. However, the IRFs reported in this section indicate that the results presented in the previous chapter of the dissertation for the benchmark and alternative models are sensitive to small perturbations in the date of the Carter-Reagan episode, and to a lesser extent the date of the Vietnam War episode.

In particular, when an alternative Ramey-Shapiro dummy variable is constructed using the dates selected earlier in this chapter for the Vietnam War and the Carter-Reagan episodes, the IRFs for real GDP and RTB computed for the benchmark and alternative models are significantly affected by small perturbations in the dates of Ramey-Shapiro episodes.

3.4 Military Build-ups and Retrenchments

As was mentioned before, it is of interest to investigate the implications of using a more comprehensive narrative approach than the one presented by Ramey and Shapiro (1997) to estimate the macroeconomic effects of exogenous shocks to government purchases. This section presents the effects of shocks to government purchases computed when the six major shocks to defense purchases identified earlier in this chapter are included in a measure of shocks to government purchases.

First, a dummy variable is constructed that has the value one at the dates of the onsets of the Korean War, the Vietnam War, and the Carter-Reagan shocks, minus one at the dates of the Eisenhower, the Johnson, and the Bush-Clinton episodes, and zero otherwise. It is hereafter referred to as the defense purchases (DP) dummy variable. It differs from the Ramey-Shapiro dummy variable by including military retrenchment as well as military build-ups. Furthermore, the dates used for the onsets of the Vietnam War and Carter-Reagan episodes are slightly different from the dates selected by Ramey and Shapiro (1997).

Second, a system identical to the benchmark model introduced in the second chapter of the dissertation, except that the DP dummy variable is substituted for the Ramey-Shapiro dummy variable, is estimated. Finally, the IRFs that present the effects of a unit shock to the DP dummy variable on defense purchases, real GDP, RTB, and the GDP deflator are computed following the methodology presented in the second chapter of the dissertation.

In the first column of Figure 3.4, the solid lines display the point estimates of the IRFs for defense purchases, real GDP, RTB, and the GDP deflator computed for a unit shock to the DP dummy variable. The dashed lines display the lower and upper bounds of sixty-eight percent confidence intervals, which are computed following the methodology presented in the second chapter of the dissertation.

The IRFs for defense purchases and the GDP deflator computed for a shock to the DP dummy variable exhibit patterns similar to the ones reported for a shock to the alternative Ramey-Shapiro dummy variable, which includes the same dates for the onsets of the Ramey-Shapiro episodes as the DP dummy variable. However, they are smaller than the IRFs reported for a shock to the alternative Ramey-Shapiro dummy variable. The maximum effects of a shock to the DP dummy variable on defense purchases and the GDP deflator are only two-thirds and half the size of the ones reported for a shock to the alternative Ramey-Shapiro dummy variable, respectively.

The pattern of the IRF for RTB computed for a shock to the DP dummy variable is generally similar to the one reported for a shock to the alternative Ramey-Shapiro dummy variable. However, the initial rise in RTB reported for a shock to the DP dummy variable is relatively small and not significantly different from zero. The pattern of the IRF for real GDP is very different from the one reported for a shock to the alternative Ramey-Shapiro dummy variable. The IRF for real GDP exhibits a hump-shaped pattern, and after a delay of almost a year, it increases significantly for three quarters.

Overall, the IRFs computed for a shock to the DP dummy variable are consistent with the theoretical two-sector neoclassical models presented by Ramey and Shapiro

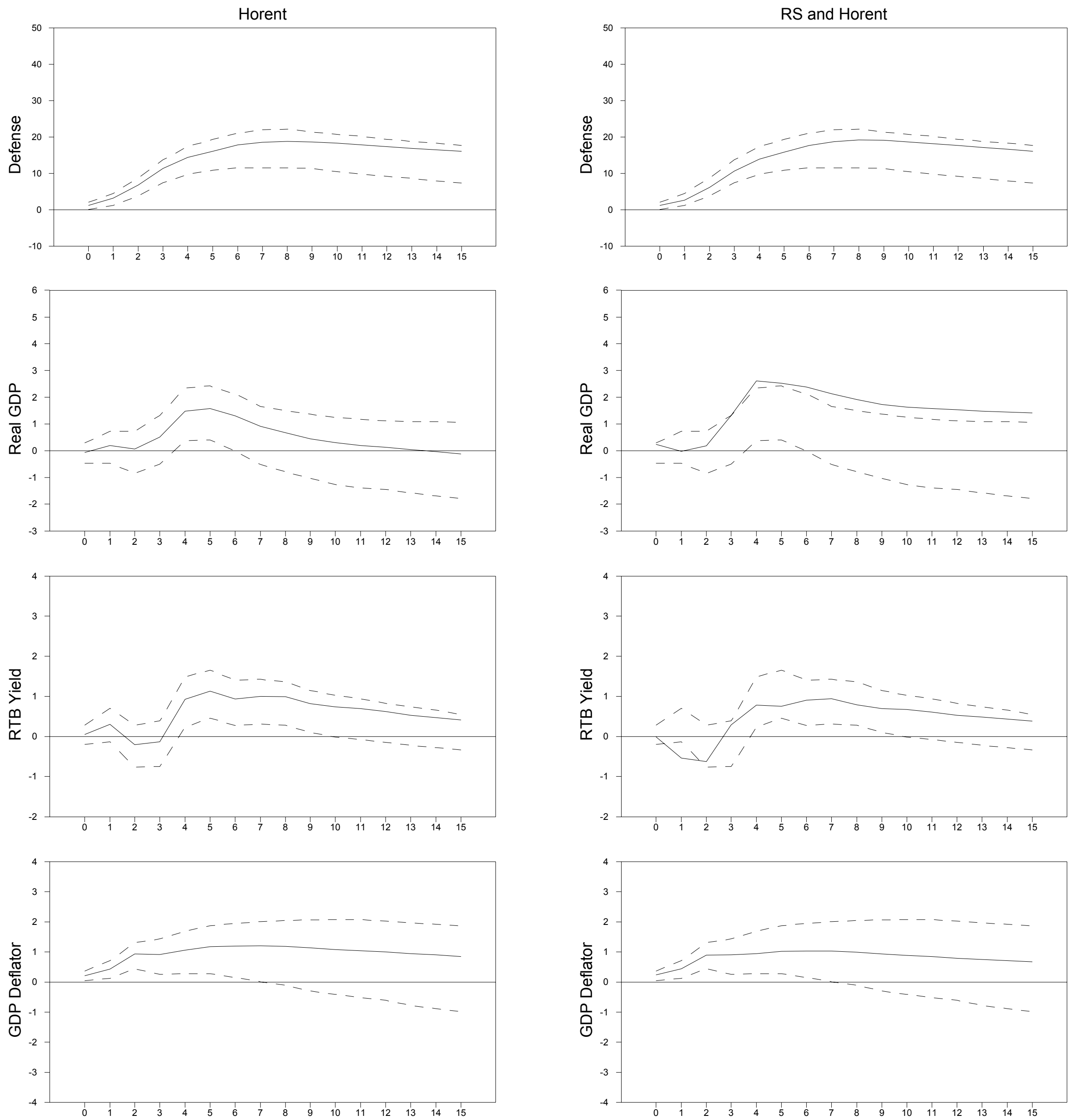

Figure 3.4: Point Estimates from Benchmark Model with DP Dummy. Dates Selected by Horent or Ramey-Shapiro and Horent
Confidence Intervals from the Model with the Dates Selected by Horent

(1997) and Edelberg, Eichenbaum, and Fisher (1999) as well as the more traditional IS-LM and one-sector neoclassical models.[2] They imply that defense purchases increase very persistently in response to a shock to the DP dummy variable, output rises temporarily, interest rate and the price level rise persistently.

The main difference between the results reported for a shock to the DP dummy variable and the results presented by Ramey and Shapiro (1997) and Edelberg, Eichenbaum, and Fisher (1999) is the initial response of RT. This difference may be explained by the discrepancies between the dates selected earlier in this chapter for the Carter-Reagan and Vietnam War episodes and the dates selected by Ramey and Shapiro (1997). Therefore, an alternative DP dummy variable is constructed that has the value one at the dates selected by Ramey and Shapiro (1997) for the positive shocks to defense purchases, minus one at the dates identified earlier in this chapter for the negative shocks, and zero otherwise.

Then, the benchmark model is estimated using the alternative DP dummy variable. Finally, the IRFs for defense purchases, real GDP, RTB, and the GDP deflator are computed for a unit shock to the alternative DP dummy variable. If the results computed for the benchmark model are not sensitive to using alternative dates for the Vietnam War and Carter-Reagan episodes, the IRFs computed for a shock to the alternative DP dummy variable ought to lie within the corresponding confidence intervals reported for a shock to the DP dummy variable.

In the second column of Figure 3.4, the solid lines display the point estimates of the IRFs computed for a shock to the alternative DP dummy variable. The dashed lines display the lower and upper bounds of the sixty-eight percent confidence intervals computed for a shock to the DP dummy variable. The IRFs for defense purchases and the GDP deflator computed for a shock to the alternative DP dummy variable lie within the corresponding confidence intervals from the model with the DP dummy variable at all horizons.

After a delay of almost a year, the IRF for real GDP computed for a shock to the alternative DP dummy variable lies slightly above the upper bound of the confidence interval from the model with the DP dummy variable at all horizons. The IRF for RTB lies below the lower bound of the confidence interval from the model with the DP dummy variable for two quarters, and then it lies within the confidence interval.

Overall, the IRFs presented for a shock to the alternative DP dummy variable are consistent with the evidence reported earlier on the sensitivity of the IRFs computed for the benchmark model to small perturbations in the dates of the Ramey-Shapiro episodes. In particular, the IRFs for real GDP and RTB computed for a shock to the alternative DP dummy variable appear significantly different from the ones reported for the DP dummy variable.

As was mentioned before, the Kennedy and the Johnson episodes are not included in the DP dummy variable because they are much smaller and shorter in duration than the episodes included. However, it is of interest to examine the sensitivity

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[2] It is noted that interest rates increase immediately in response to a shock to government purchases within the traditional IS-LM model; however, the IRF for RTB reported in Figure 4 rises after a delay of several periods.

of the results reported for the benchmark model to adding the Kennedy and Johnson episodes to the DP dummy variable.

First, an extended DP dummy variable is constructed that includes the Kennedy and Johnson episodes along with the six major episodes included in the DP dummy variable. The dates used for the onsets of the episodes are the ones selected earlier in this chapter. Then, the benchmark model is estimated using the extended DP dummy variable, and the IRFs for defense purchases, real GDP, RTB, and the GDP deflator are computed for a unit shock to the extended DP dummy variable.

If the results computed for the benchmark model are not sensitive to adding the Kennedy and Johnson episodes to the DP dummy variable, the IRFs computed for a shock to the extended DP dummy variable ought to lie within the corresponding confidence intervals reported for a shock to the DP dummy variable. In the first column of Figure 3.5, the solid lines display the point estimates of the IRFs computed for a shock to the extended DP dummy variable. The dashed lines display the lower and upper bounds of sixty-eight percent confidence intervals reported for a shock to the DP dummy variable.

All the IRFs computed for a shock to the extended DP dummy variable lie within the corresponding confidence intervals from the model with the DP dummy variable. Furthermore, their patterns are very similar to the ones reported for a shock to the DP dummy variable. Therefore, it is concluded that the IRFs reported for the benchmark model are not sensitive to adding the Kennedy and Johnson episodes to the DP dummy variable.

The second column of Figure 3.5 presents the IRFs computed when the dates selected by Ramey and Shapiro (1997) for the onsets of the Vietnam War and Carter-Reagan episodes are used to construct an alternative extended DP dummy variable. The solid lines display the point estimates of the IRFs for defense purchases, real GDP, RTB, and the GDP deflator computed for a unit shock to this alternative extended DP dummy variable. The dashed lines display the lower and upper bounds of the sixty-eight percent confidence intervals reported for a shock to the alternative DP dummy variable.

All the IRFs computed for a shock to the extended alternative DP dummy variable lie within the corresponding confidence intervals from the model with the alternative DP dummy variable. Furthermore, their patterns are similar to the ones reported for a shock to the alternative DP dummy variable. Therefore, it is concluded that the IRFs reported for the benchmark model are not sensitive to adding the Kennedy and Johnson episodes to the alternative DP dummy variable.

In conclusion, when the benchmark model is estimated, the IRFs computed for a shock to the DP dummy variable are generally similar to the ones reported for a shock to the alternative Ramey-Shapiro dummy variable, which includes the same dates for the onsets of the Ramey-Shapiro episodes as the DP dummy variable. They imply that defense purchases increase very persistently in response to a shock to the DP dummy variable, output rises temporarily, interest rates and the price level rise persistently.

Furthermore, when the dates selected by Ramey and Shapiro (1997) for the onsets of the Vietnam War and Carter-Reagan episodes are used to construct the DP dummy variable, the IRFs computed for real GDP and RTB imply that the results reported for the benchmark model are sensitive to small perturbations in the dates of the Ramey-Shapiro episodes. However, when an extended DP dummy variable that includes the Kennedy and

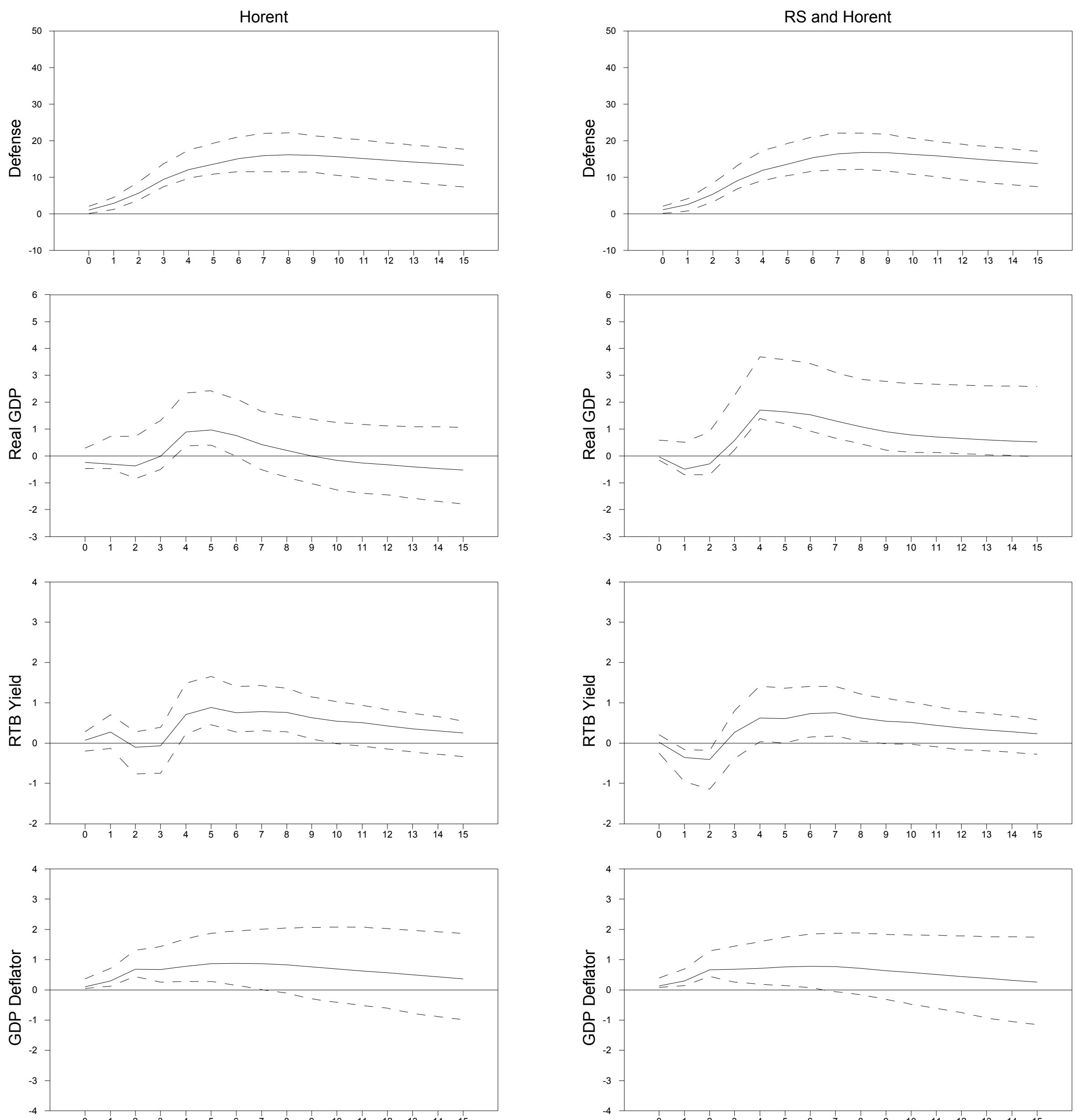

Figure 3.5: Point Estimates from the Model with Extended DP Dummy. Dates Selected by Horent or Ramey-Shapiro and Horent
Confidence Intervals from the Model with the Dates Selected by Horent

Johnson episodes is constructed, the IRFs computed imply that they are not sensitive to adding the Kennedy and Johnson episodes to the DP dummy variable.

3.5 Alternative Time Trends and Lag Lengths

As was mentioned before, although the DP dummy variable includes twice as many shocks to defense purchases as the Ramey-Shapiro dummy variable, the number of shocks included remains modest. Therefore, the robustness of the results computed for a shock to the DP dummy variable is an important issue to address.

This section presents statistical evidence on the selection of an appropriate time trend and an adequate lag length for the variables included in the VAR system under study. It also investigates the sensitivity of the results reported for the benchmark model to adding a time trend and changing the lag length used. The methodology followed is exactly identical to the one presented for the Ramey-Shapiro dummy variable in the previous chapter of the dissertation.

3.5.1 Time Trend

To select an appropriate time trend for the VAR system under study, models in which different types of time trend are added, in turn, to each equation of the benchmark model are estimated, and the corresponding AIC and Schwartz Bayesian Criterion (SBC) values are computed. Systems with no time trend, a linear trend only, linear and quadratic trends, and a "Perron-type" time trend are considered.[3] The preferred specification is the one that minimizes the AIC and SBC values.

A series of likelihood ratio test statistics is also computed. First, the null hypothesis of no time trend is tested against the alternatives of a linear trend only, linear and quadratic trends, and a "Perron-type" trend. Second, the null hypothesis of a linear trend only is tested against the alternatives of linear and quadratic trends and a "Perron-type" trend.

Table 3.1 reports the AIC and SBC values computed when the benchmark model is estimated under the alternative assumptions for the time trend. The AIC criterion implies that it is better to include a "Perron type" time trend in the VAR system under study. The SBC criterion implies that it is better not to include a time trend; however, it is noted that the SBC values computed for the models with no time trend and the model with a "Perron-type" trend are almost identical.

Table 3.1: AIC and SBC Values for Time Trend
Benchmark Model (1948:1-1999:2)

Type of time trend	Aikaike's Information Criterion	Schwarz's Criterion
No trend	-5852.76	-5559.91
Linear trend only	-5864.02	-5557.85
"Perron-type"	-5878.76	-5559.28
Linear and quadratic trend	-5871.86	-5552.39

Table 3.2 reports the results of the likelihood ratio tests carried out. In each case, the null hypothesis is rejected. Thus, it is concluded that including any type of time trend

[3] The "Perron-type" time trend as well as the other time trends included in this chapter are discussed in details in the previous chapter of the dissertation.

is better than including no time trend. Furthermore, it is concluded that including linear and quadratic trends or a “Perron-type” trend is better than including a linear trend only.

While the statistical evidence reported above implies that it may be better to include linear and quadratic trends or a “Perron-type” trend to the benchmark model, the addition of time trends may not significantly affect the IRFs reported. If the results reported for the benchmark model are not sensitive to the addition of time trends, the IRFs computed for the models with time trends ought to lie within the corresponding confidence intervals reported for the benchmark model.

Table 3.2: Likelihood Ratio Tests for Time Trend

Benchmark Model (1948:1-1999:2)

Null hypothesis	Alternative	Test value	P-value
No time trend	Linear trend only	17.10*	0.0018
No time trend	Linear and Quadratic trend	31.01**	0.0001
No time trend	“Perron-type” trend	37.10**	0.0000
Linear trend only	Linear and Quadratic trend	14.00*	0.0073
Linear trend only	“Perron-type” trend	20.09*	0.0010

* 4 restrictions are imposed. The critical value at a 5% significance level for a chi-square distribution with 4 degrees of freedom is 9.49.

** 8 restrictions are imposed. The critical value at a 5% significance level for a chi-square distribution with 8 degrees of freedom is 15.51.

In Figure 3.6, the solid lines display the point estimates of the IRFs for defense purchases, real GDP, RTB, and the GDP deflator computed when linear and quadratic trends and a “Perron-type” trend are added, in turn, to the benchmark model. The dashed lines display the confidence intervals computed for the benchmark model.

When linear and quadratic trends are added to each equation of the benchmark model, the IRFs for defense purchases, real GDP, and the GDP deflator computed lie within or on the corresponding confidence intervals from the benchmark model at all horizons. The IRF for RTB lies within the corresponding confidence interval from the benchmark model for more than two years, and then it lies slightly below the lower bound of the confidence interval.

When a “Perron-type” trend is added to each equation of the benchmark model, all the IRFs computed lie within the corresponding confidence intervals reported for the benchmark model at all horizons. Overall, although adding linear and quadratic trends to the benchmark model moderately affects the results reported for RTB at long horizons, it is concluded that the results reported for the benchmark model are not sensitive to adding time trends.

3.5.2 Lag Length

To select an adequate lag length for the variables included in the VAR system under study, models identical to the benchmark model except for the lag length used are estimated. Then, the corresponding AIC and SBC values are computed. Systems with one to eight lags of the endogenous variables and the DP dummy variable are considered.[4]

[4] As for the study of the Ramey-Shapiro dummy variables, only models for which the lag length used for the endogenous variables and the DP dummy variable are identical are considered.

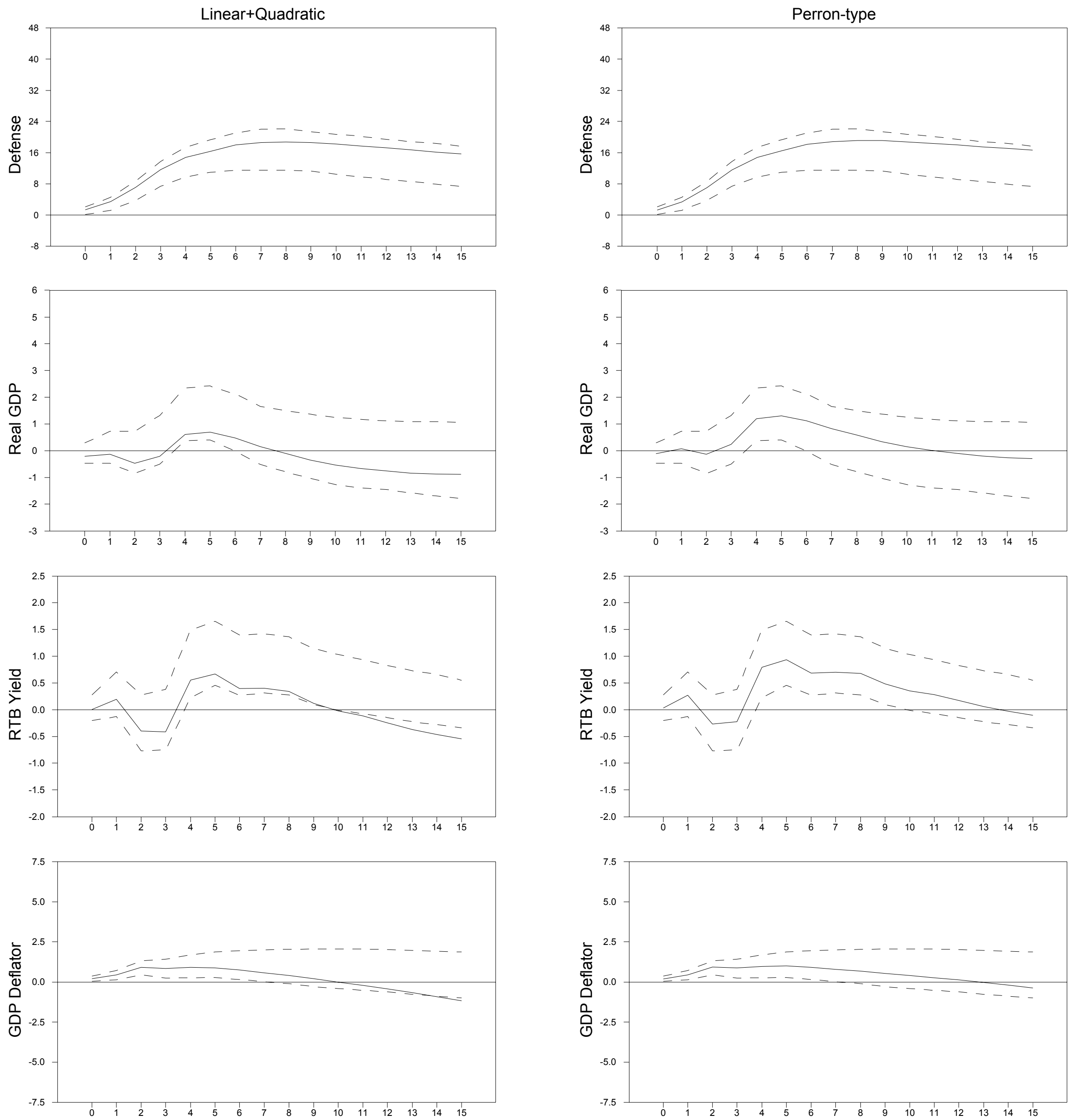

Figure 3.6: Point Estimates from Models with Alternative Time Trends
Confidence Intervals from Benchmark Model

The preferred lag length is the one that minimizes the AIC or SBC values. A sequence of likelihood ratio tests is also computed. The null hypothesis of seven lags versus the alternative of eight lags, then the null hypothesis of six lags versus the alternative seven lags, and so on, are tested.

Table 3.3 reports the AIC and SBC values computed for the VAR systems in which one to eight lagged values of the variables are included.[5] Table 3.4 reports the results of the likelihood ratio tests carried out. The AIC and SBC values and the likelihood ratio tests reported for the models with the DP dummy variable yield the same conclusions as the ones presented for model with the Ramey-Shapiro dummy variable in the previous chapter of the dissertation.

According to the AIC criterion, it is better to include six lagged values of the variables. In contrast, the SBC values reported imply that it is better to include two lagged values of the variables. The likelihood ratio tests indicate that the null hypotheses of seven and six lags cannot be rejected; however, the null hypothesis of five lags can be rejected. Therefore, according to the likelihood ratio tests, it is better to include six lagged values of the variables.[6]

Table 3.3: AIC and SBC Values for Lag Length
Benchmark Model (1949:1-1999:2)

Number of lags	Aikaike's Information Criterion	Schwarz's Criterion
1	-5492.73	-5400.10
2	-5710.44	-5551.64
3	-5732.84	-5507.88
4	-5752.45	-5461.32
5	-5756.73	-5399.44
6	-5811.78	-5388.32
7	-5798.02	-5308.40
8	-5792.02	-5236.23

Table 3.4: Likelihood Ratio Tests for Lag Length
Benchmark Model (1949:1-1999:2)

Null hypothesis	Alternative	Test value*	P-value
Lag length = 7	Lag length =8	26.29	0.1372
Lag length = 6	Lag length = 7	24.81	0.2087
Lag length = 5	Lag length = 6	79.69	0.0000

* For every test we impose 20 restrictions. The critical value at a 5% significance level for a chi-square distribution with 20 degrees of freedom is 31.41.

[5] For comparison's sake, the AIC and SBC values and the likelihood ratio statistic are computed when the corresponding systems are estimated over the period from 1949:1 to 1999:2.

[6] In some circumstances, using a criterion such as the AIC, the SBC, or likelihood ratio tests to select the lag length may yield a model in which serial correlation of the residuals may be problematic. However, the q-statistic computed when the benchmark model is estimated with two, four, and six lags of the endogenous and dummy variables suggest that the residuals are serially uncorrelated for all lag lengths.

While the statistical evidence reported above implies that it is better to include either two or six lagged values of the variables in the VAR system under study, altering the lag length used to estimate the system may not affect the results reported for the benchmark model. If the results reported for the benchmark model are not sensitive to the lag length used, the IRFs computed for the models with two and six lags ought to lie within the corresponding confidence intervals from the benchmark model.

In Figure 3.7, the solid lines display the point estimates of the IRFs for defense purchases, real GDP, RTB, and the GDP deflator computed for the models with two and six lagged values of the variables. The dashed lines display the confidence intervals computed for the benchmark model. Several of the IRFs computed for the models with two and six lags differ significantly from the ones reported for the benchmark model.

The IRF for real GDP computed for the model with two lags lies slightly below the lower bound of the corresponding confidence interval from the benchmark model for several quarters in the second year after a shock. Furthermore, it exhibits a pattern very different from the one reported for the benchmark model. It is very small and flat. A year after a shock to defense purchases, the IRF for RTB computed for the model with two lags lies below the lower bound of the confidence interval from the benchmark model for two and a half years. Furthermore, it also exhibits a pattern very different from the one reported for the benchmark model. Two quarters after a shock, it is negative.

Less than a year after a shock to the DP dummy variable, the IRF for defense purchases computed for the model with six lags lies below the lower bound of the corresponding confidence interval from the benchmark model at all horizons. Three quarters after a shock, the IRFs for real GDP and RTB lie below the lower bound of the corresponding confidence intervals for more than one and half years and two years, respectively. They also exhibit patterns very different from the ones reported for the benchmark model. Two quarters after a shock, they are negative.

In conclusion, the statistical evidence reported in this section imply that it may be more appropriate to estimate a VAR system in which each equation includes a "Perron-type" time trend or linear and quadratic time trends rather than the benchmark model. However, the IRFs presented when these time trends are added to the benchmark model are not significantly different from the ones reported for the benchmark model.

With regard to the best lag length to use for the VAR system under study, the SBC criterion implies that it is better to include only two lagged values of the variables. However, the AIC criterion and the likelihood ratio tests carried out imply that it is better to include six lagged values of the variables. Altering the lag length used to estimate the VAR system under study significantly affects the results reported for real GDP and RTB, and to a lesser extent, defense purchases.

Furthermore, when two or six lagged values of the variables are used to estimate the VAR system under study, the patterns of the IRFs for real GDP and RTB are inconsistent with the theoretical two-sector neoclassical models presented by Ramey and Shapiro (1997) and Edelberg, Eichenbaum, and Fisher (1999) as well as the more traditional IS-LM and one-sector neoclassical models.

3.6 Alternative Model

Following Edelberg, Eichenbaum, and Fisher (1999), the benchmark model includes four lagged values of the variables and no time trend. However, it may not be the best specification for the VAR system under study. Therefore, AIC values are

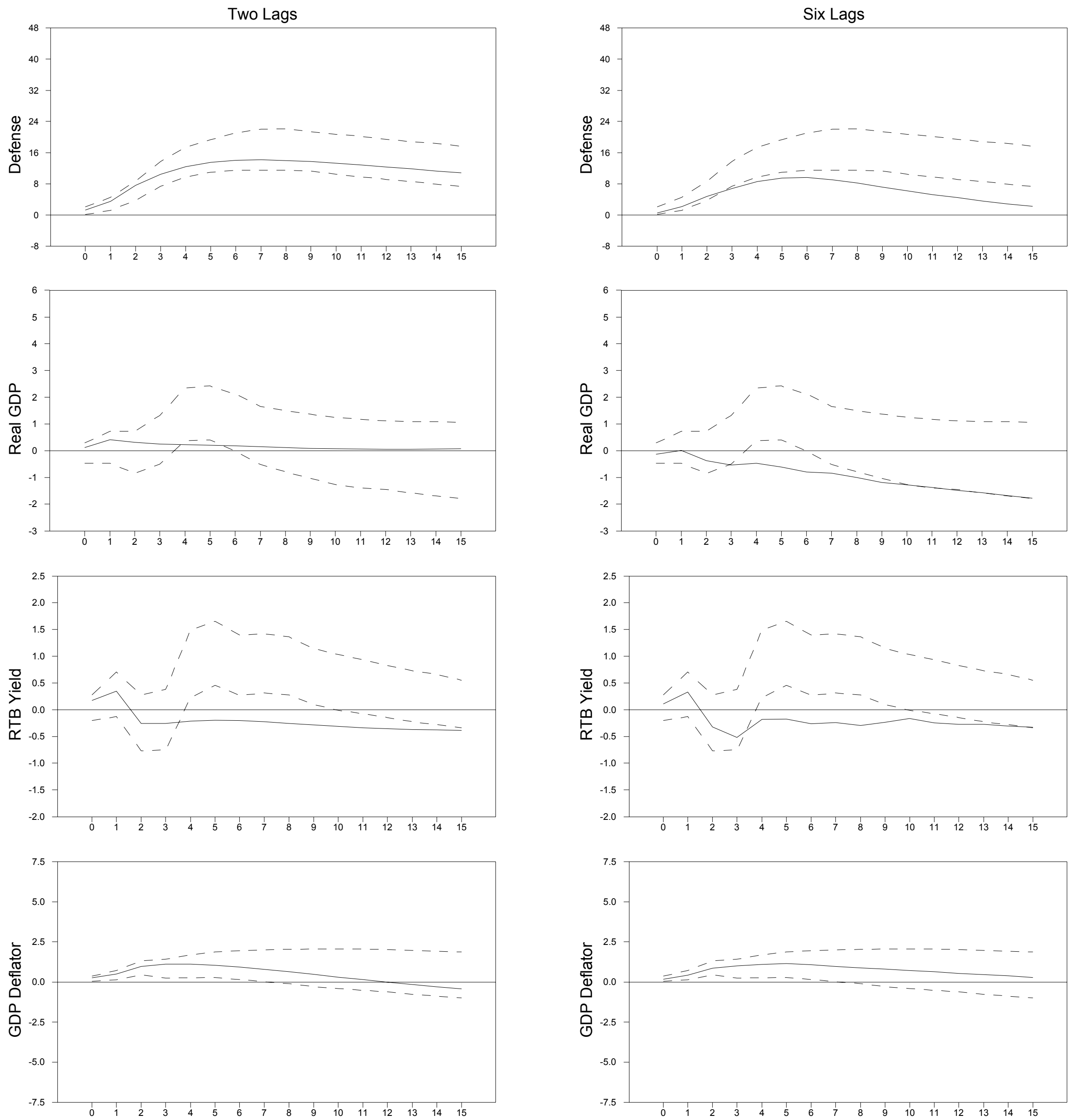

Figure 3.7: Point Estimates from Models with Alternative Lag Lengths
Confidence Intervals from Benchmark Model

computed when twelve models that include defense purchases, real GDP, RTB, and the GDP deflator are estimated using with different lag lengths and time trends.

Models with two, four, six and eight lagged values of the variables are considered as well as with no time trend, linear and quadratic trends, and a "Perron-type" trend. The model that yields the lowest AIC value is selected as the alternative model. The AIC values computed for the different models are reported in Table 3.5. As for VAR system with the Ramey-Shapiro dummy variable, they indicate that the model with six lags and a "Perron-type" time trend represents the best specification for the system with the DP dummy variable.

Table 3.5: AIC values for Various Time Trends and Lag Lengths
Benchmark Model (1949:1-1999:2)

Number of lags	No Time Trend	Linear and Quadratic Trend	"Perron-type" Trend
2	-5710.44	-5735.17	-5739.34
4	-5752.45	-5773.26	-5782.18
6	-5811.78	-5832.93	-5837.54
8	-5792.02	-5810.80	-5814.09

In the first column of Figure 3.8, the solid lines display the point estimates of the IRFs for defense purchases, real GDP, RTB, and the GDP deflator computed for a unit shock to the DP dummy variable when the alternative model is estimated. The dashed lines display the lower and upper bounds of sixty-eight percent confidence intervals. The patterns of the IRFs computed for the alternative model differ moderately from the ones reported for the benchmark model.

The IRF for defense purchases appears slightly flatter at long horizons than the one reported for the benchmark model. The IRF for real GDP appears similar but more persistent than the one reported for the benchmark model. The delayed increase in RTB reported for the alternative model is almost twice as large as for the benchmark model. Moreover, it is significant for more two and a half years, compared to one and a half years for the benchmark model. Finally, the IRF for the GDP deflator is similar to the one reported for the benchmark model for more than a year, but then it returns to its original value more rapidly than the one reported for the benchmark model.

To further compare the results reported for the benchmark and alternative models, the IRFs for defense purchases, real GDP, RTB, and the GDP deflator computed for the benchmark model are plotted against the corresponding confidence intervals from the alternative model, which is the preferred model. If the IRFs computed for the benchmark model are not significantly different from the IRFs reported for the alternative model, they ought to lie within the corresponding confidence intervals from the alternative model.

In the second column of Figure 3.8, the solid lines display the point estimates of the IRFs for defense purchases, real GDP, RTB, and the GDP deflator computed for the benchmark model. The dashed lines display the corresponding confidence intervals computed for the alternative model. The IRFs for defense purchases, real GDP, and the

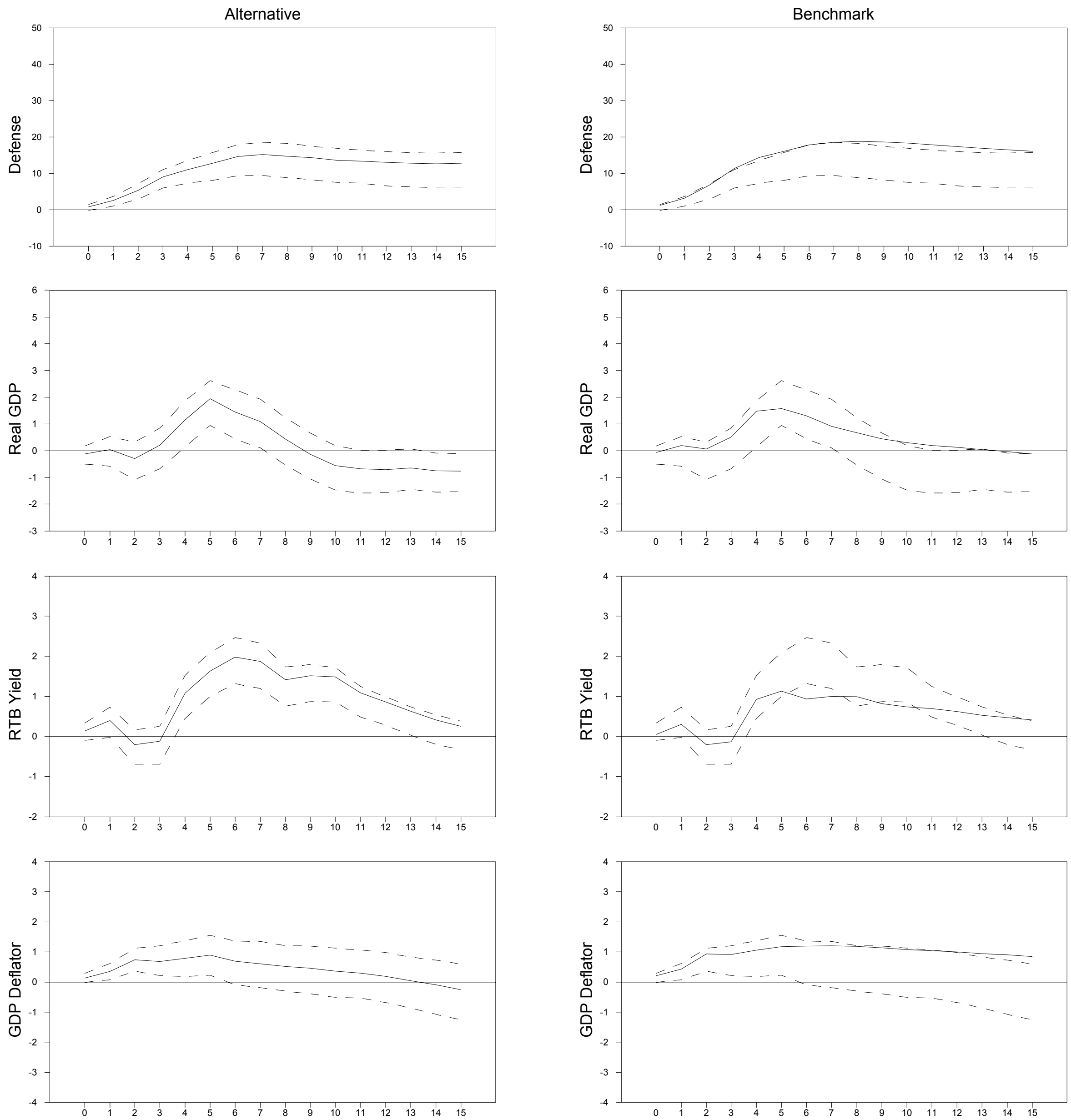

Figure 3.8: Point Estimates from Alternative Model and Benchmark Model
Confidence Interval from Alternative Model

GDP deflator computed for the benchmark model are not very different from the ones reported for the alternative model. The IRF for RTB appears significantly different from the one reported for the alternative model.

Two years after a shock to the DP dummy variable, the IRF for defense purchases computed for the benchmark model lies very slightly above the upper bound of the confidence interval from the alternative model. In the second and third year after a shock, the IRF for real GDP lies very slightly above the upper bound of the confidence interval from the alternative model for several periods.

A year after a shock to the DP dummy variable, the IRF for RTB lies below the lower bound of the confidence interval from the alternative model for more than a year. The IRF for the GDP deflator computed for the benchmark model is not significantly different from the one reported for the alternative model for three years. Then, it lies very slightly above the upper bound of the confidence interval from the alternative model.

In conclusion, based on the AIC criterion, it is better to estimate an alternative model with a "Perron-type" trend as well as six lagged values of the variables rather than the benchmark model. The patterns of the IRFs computed for the alternative model are fairly similar to the ones reported for the benchmark model. However, the magnitudes of the effects computed for the alternative model differ moderately from the ones reported for the benchmark model.

3.7 Extended Models

This section investigates the sensitivity of the results reported for defense purchases, real GDP, RTB, and the GDP deflator to adding an endogenous variable or an exogenous dummy variable to the alternative model. Seventeen variables are considered; they are the ones introduced in the previous chapter for the investigation of the model with the Ramey-Shapiro dummy variable.

First, the effects of the shocks to the DP dummy variable in models that alternatively include fiscal variables are examined. Then, the effects of the shocks in models that alternatively include consumption, investment, and labor market variables are investigated. Finally, the effects of the shocks in models that alternatively include the Romers' monetary policy dummy variable, the monetary base, Hamilton's oil price dummy variable, the PPI for crude fuel, and a measure of long-term interest rates are presented.

For each variable under consideration, the same exercise as the one introduced in the previous chapter for the model with Ramey-Shapiro dummy variable is presented. First, an extended version of the alternative model is estimated that includes the DP dummy variable, defense purchases, real GDP, RTB, the GDP deflator, and the variable under consideration. Six lagged values of the variable under consideration are included if it is endogenous. The contemporaneous and six lagged values are included if it is an exogenous dummy variable.

Then, the IRFs for defense purchases, real GDP, RTB, and the GDP deflator are computed for a unit shock to the DP dummy variable. Finally, the point estimates of the IRFs computed for the extended model are plotted against the corresponding confidence intervals reported for the alternative model. If the results reported for the alternative model are not sensitive to perturbations in the list of variables used, the IRFs computed for the extended model ought to lie within the corresponding confidence intervals from the alternative model.

3.7.1 Additional Fiscal Variables

This sub-section presents evidence on the effects of shocks to the DP dummy variable in models that alternatively include non-defense purchases, real federal government receipts, and the real federal government deficit. The logarithmic values of the fiscal variables are used except for the deficit, which takes negative values. To construct the measures of real federal government receipts and the real federal government deficit, the current values of these variables in billions of dollars are deflated by the CPI. Non-defense purchases are in billions of chained (1992) dollars.[7]

In Figure 3.9, the point estimates of the IRFs for defense purchases, real GDP, RTB, and the GDP deflator computed when the fiscal variables listed above are added, in turn, to the alternative model are plotted against the corresponding confidence intervals from the alternative model. The solid lines display the point estimates of the IRFs. The dashed lines display the confidence intervals, which were presented in the previous section.

All the IRFs computed for the models with non-defense purchases and real federal government receipts lie within or on the confidence intervals from the alternative model at all horizons. The IRFs for defense purchases, real GDP, and the GDP deflator computed for the models with the real federal government deficit also lie within or on the confidence intervals from the alternative model at all horizons. The IRF for RTB computed for the model with the real federal government deficit lies within the confidence interval from the alternative model for three years, and then it lies very slightly below the lower bound of the confidence interval.

Overall, eleven out of twelve IRFs computed when the fiscal variables are added, in turn, to the alternative model are not significantly different from the corresponding IRFs reported for the alternative model at any horizon. Furthermore, the IRF for RTB computed for the model with the real federal government deficit is only marginally different at long horizons from the IRF reported for the alternative model. Therefore, it is concluded that the results reported for the alternative model are not sensitive to the addition of fiscal variables.

3.7.2 Additional Sectoral Variables

This sub-section presents evidence on the effects of shocks to the DP dummy variable on defense purchases, real GDP, RTB, and the GDP deflator in models that alternatively include components of consumption and investment. Following Edelberg, Eichenbaum, and Fisher (1999), consumption and investment are broken down into three components: consumption of non-durables and services, residential investment plus consumption of durables, and non-residential investment.

This sub-section also presents evidence on the effects of shocks to the DP dummy variable on defense purchases, real GDP, RTB, and the GDP deflator in models that alternatively include measures of employment, real wages, and real compensation. First, employment in the private sector, employment in the non-durables manufacturing sector, and employment in the durables manufacturing sector are examined. Then, real wages in

[7] The different extended models estimated in this section and the variables included in these extended models are identical to the ones presented in the study of the Ramey-Shapiro dummy variables. They are more thoroughly discussed in the first chapter of the dissertation.

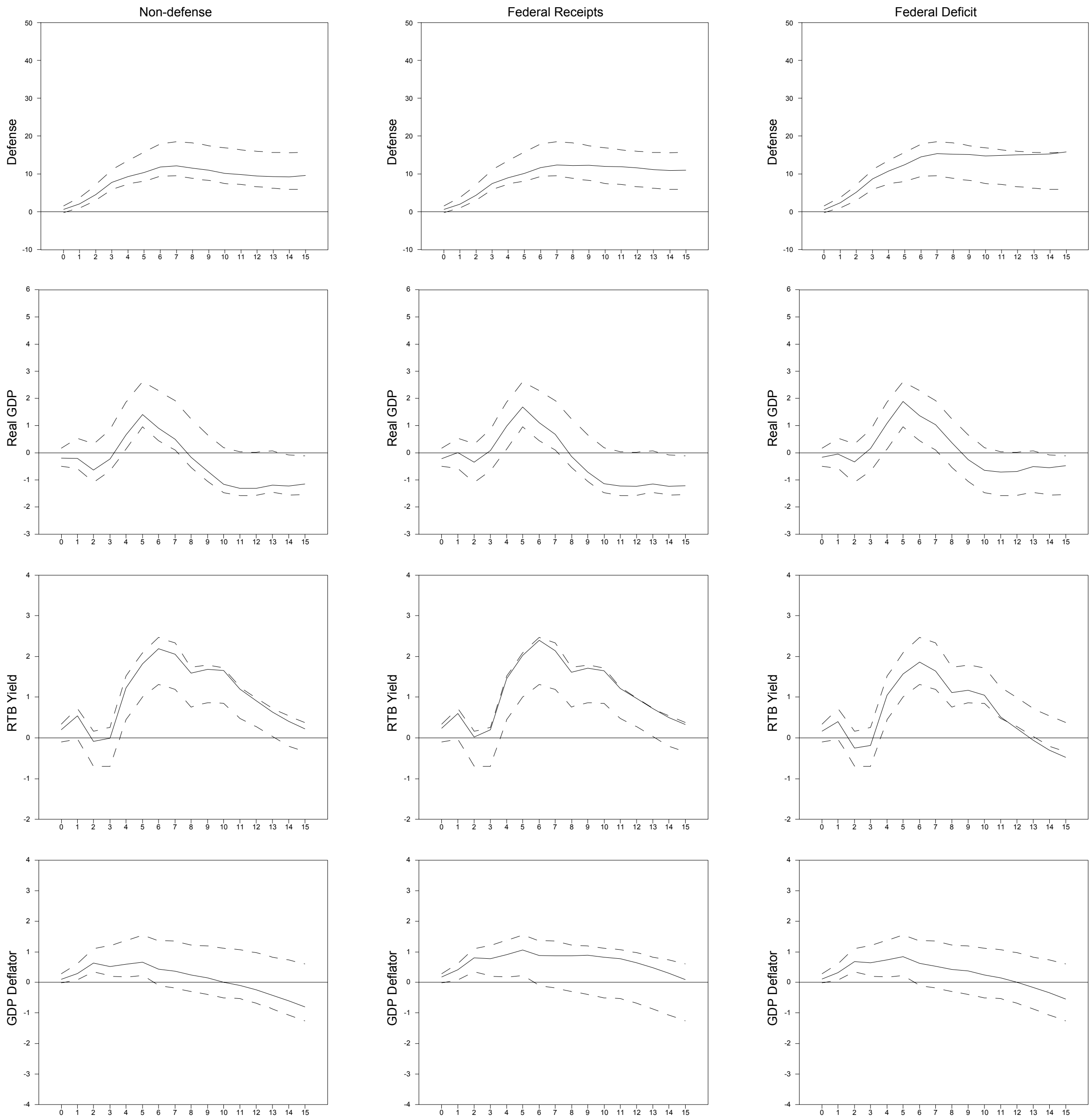

Figure 3.9: Point Estimates from Models with a Fiscal Variable
Confidence Intervals from Alternative Model

private industry, real compensation in the manufacturing sector, and real compensation in the business sector are considered.

The logarithmic values of the consumption and investment variables, as well as the other sectoral variables examined hereafter, are included in the models estimated. To construct the measures of real compensation and real wages, the nominal values of these variables are deflated by the CPI. The other additional sectoral variables examined hereafter are in billions of chained (1992) dollars.

In Figure 3.10, the point estimates of the IRFs for defense purchases, real GDP, RTB, and the GDP deflator computed when the consumption and investment variables listed above are added, in turn, to the alternative model are plotted against the corresponding confidence intervals from the alternative model. The solid lines display the point estimates of the IRFs and the dashed lines display the confidence intervals. All the IRFs reported for the models with a component of consumption and investment lie within or on the corresponding confidence intervals from the alternative model at all horizons.

In Figure 3.11, the point estimates of the IRFs for defense purchases, real GDP, RTB, and the GDP deflator computed when employment in private industry, employment in the non-durables manufacturing sector, and employment in the durables manufacturing sector are added, in turn, to the alternative model are plotted against the corresponding confidence intervals from the alternative model. The solid lines display the point estimates of the IRFs and the dashed lines display the confidence intervals.

Except for the IRF for defense purchases computed for the model with employment in the durables manufacturing sector, the IRFs reported for the models with a measure of employment lie within or on the corresponding confidence intervals from the alternative model at all horizons. The IRF for defense purchases reported for the model with employment in the durables manufacturing sector lies within the corresponding confidence interval from the alternative model for two years, and then it lies slightly above the upper bound of the confidence interval.

In Figure 3.12, the point estimates of the IRFs computed when real wages in private industry, real compensation in the manufacturing sector, and real compensation in the business sector are added, in turn, to the alternative model are plotted against the corresponding confidence intervals from the alternative model. The solid lines display the point estimates of the IRFs and the dashed lines display the confidence intervals. Since the series for compensation in the manufacturing sector is not available before 1949:1, the model with this variable is estimated from 1950:3 to 1999:2, and the IRFs computed for this model are plotted against confidence intervals computed for the alternative model over the same sub-sample period.

Except for the IRF for RTB computed for the model with real compensation in the manufacturing sector, the IRFs reported for the models with a measure of real wages or real compensation lie within the corresponding confidence intervals from the alternative model at all horizons. The IRF for RTB computed for the model with real compensation in the manufacturing sector lies within the corresponding confidence interval from the alternative model for three and a half years, and then it lies very slightly above the upper bound of the confidence interval.

Overall, thirty-four out of thirty-six IRFs computed when consumption, investment, employment, real wages, and real compensation variables are added, in turn,

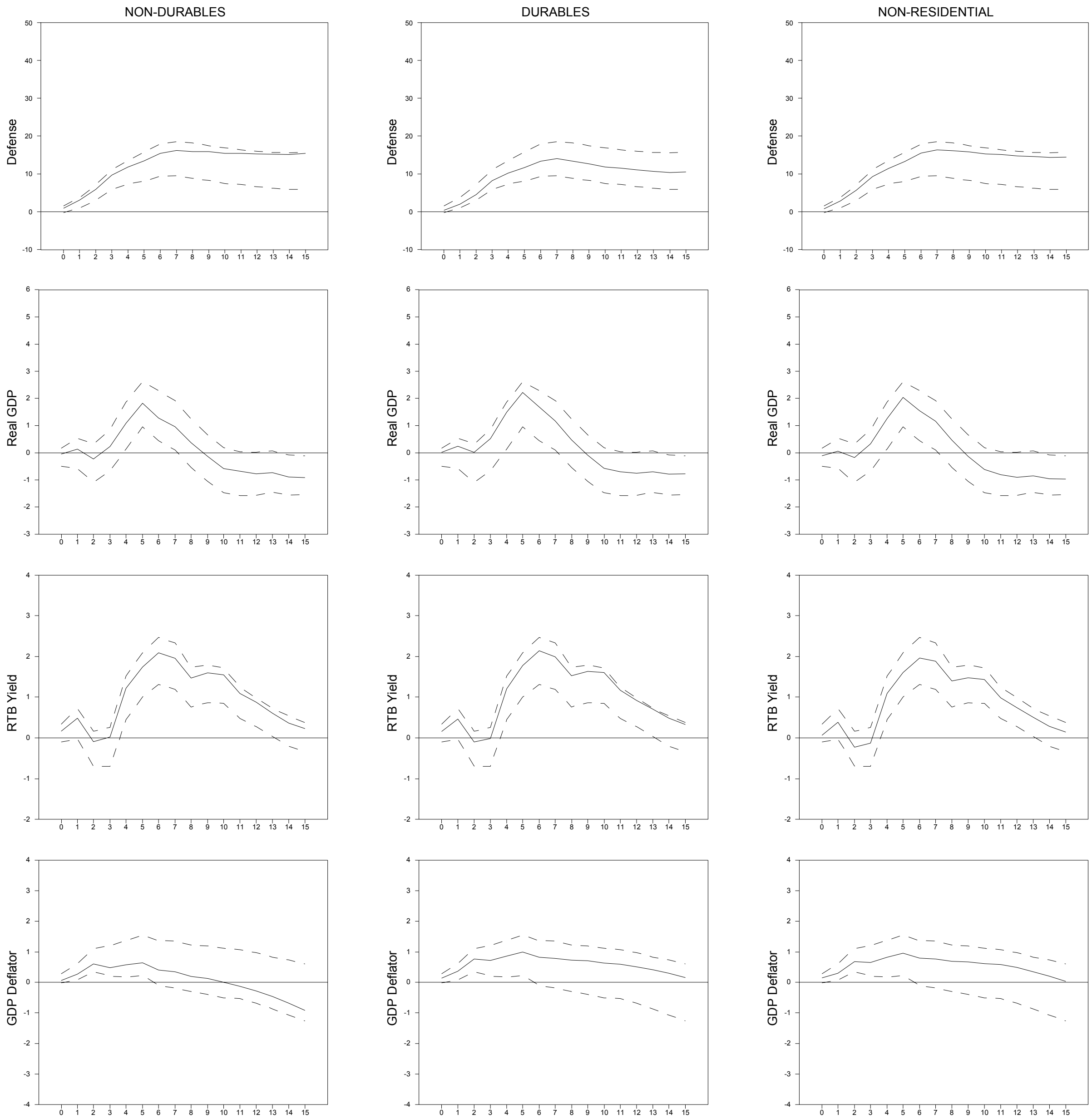

Figure 3.10: Point Estimates from Models with a Consumption or Investment Variable

Confidence Intervals from Alternative Model

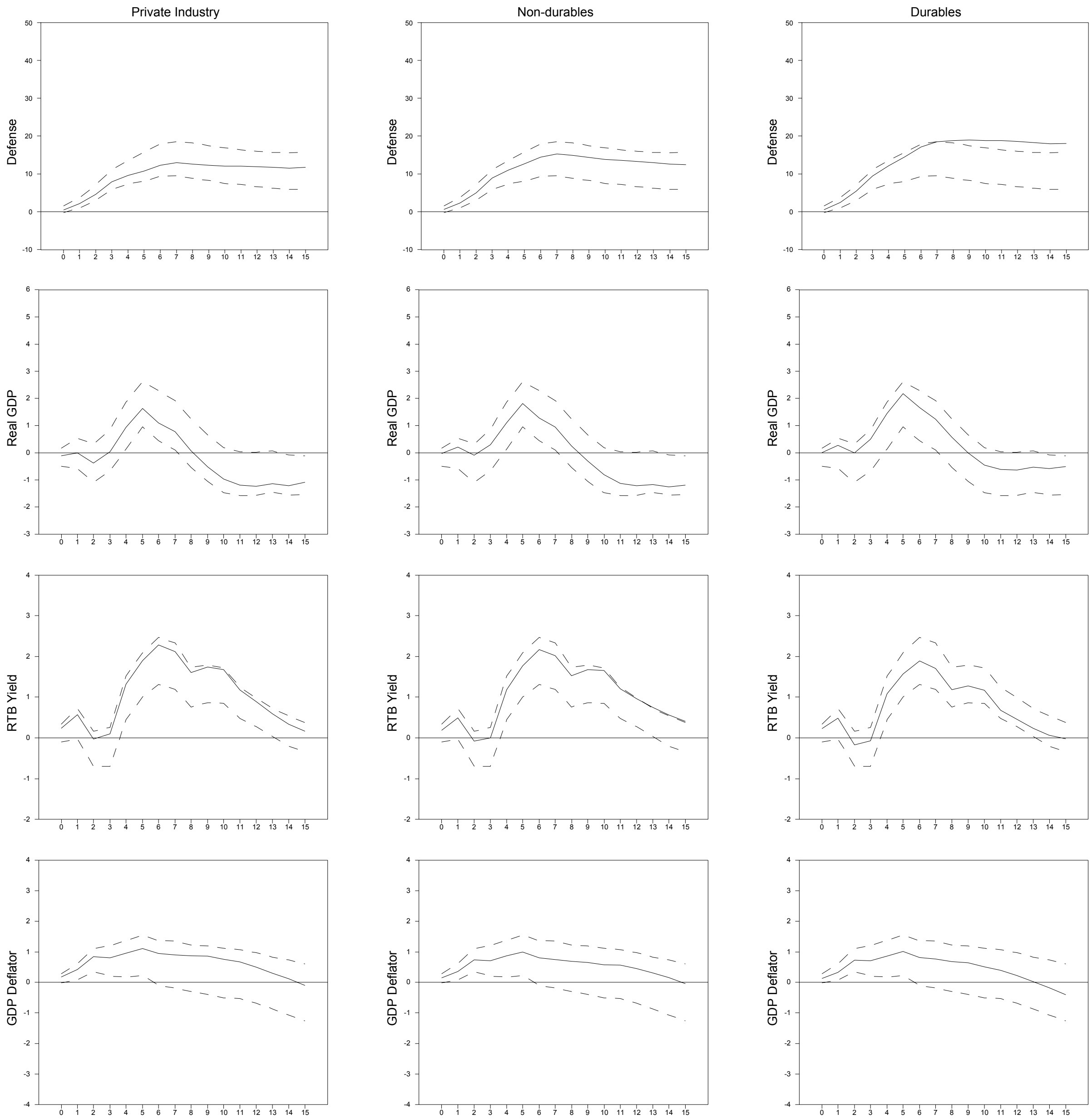

Figure 3.11: Point Estimates from Models with an Employment Variable
Confidence Intervals from Alternative Model

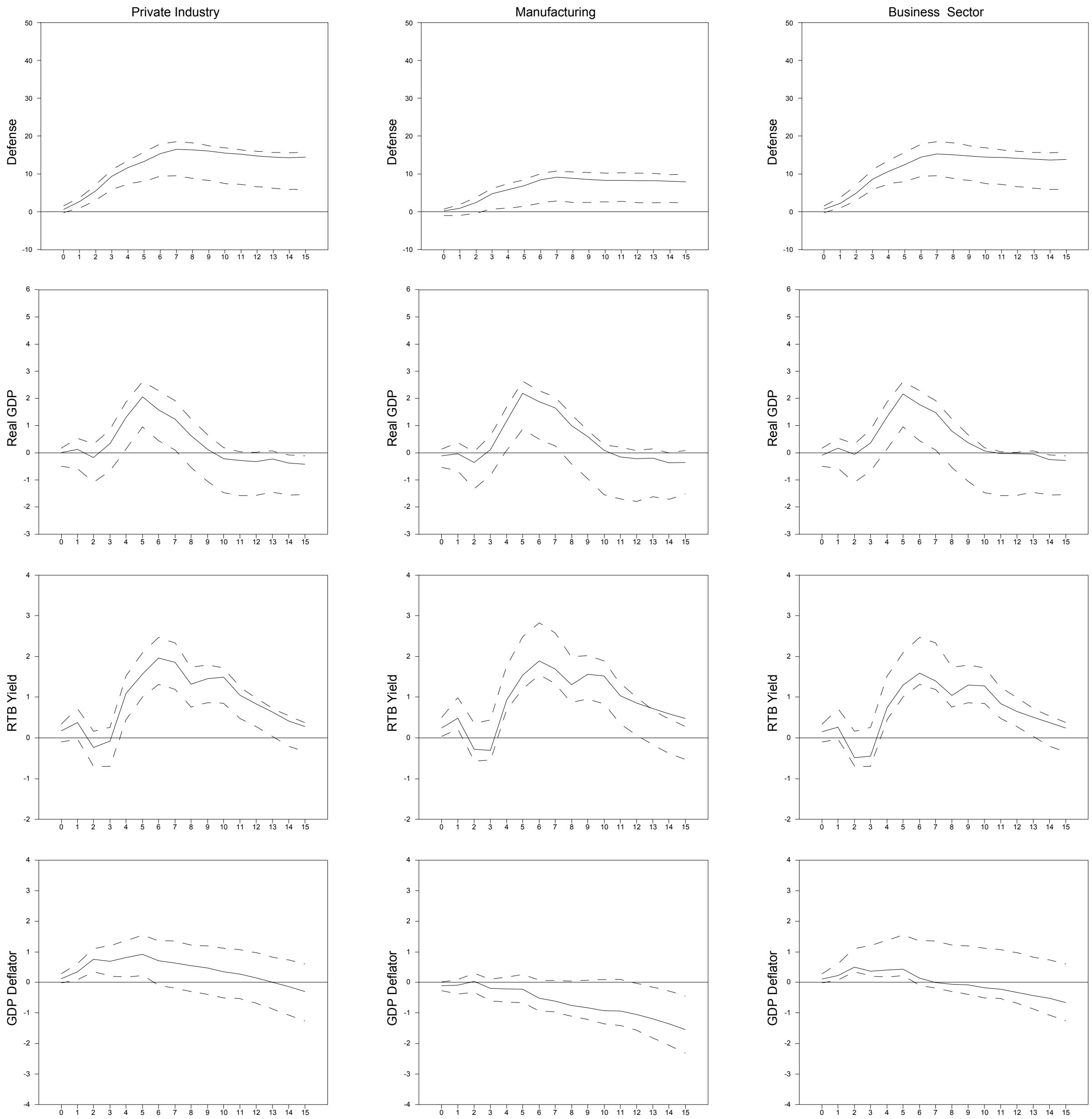

Figure 3.12: Point Estimates from Models with a Measure of Real Wages or Real Compensation
Confidence Intervals from Alternative Model

to the alternative are not significantly different from the corresponding IRFs reported for the alternative model at any horizon. The IRF for RTB computed for the model with real compensation in the manufacturing sector is briefly and marginally different from the IRF reported for the alternative model.

However, the IRF for defense purchases computed for the model with employment in the durables manufacturing sector is persistently different from the IRF reported for the alternative model. Therefore, it is concluded that the results reported for the alternative model are not sensitive to the addition of sectoral variables, except maybe for employment in the durables manufacturing sector.

3.7.3 Additional Macroeconomic Variables

First, this sub-section presents evidence on the effects of shocks to the DP dummy variable in models that alternatively include the Romers' monetary policy dummy variable and the monetary base. The Romers' monetary policy dummy variable is considered since it provides a crude way to control for the effects of monetary policy shocks, specifically monetary contractions, on the economy. The monetary base is considered because it responds quickly to monetary policy actions; however, it should not be interpreted as a measure of monetary policy.

Second, this sub-section presents evidence on the effects of shocks to the DP dummy variable in models that alternatively include Hamilton's oil price dummy variable and the PPI for crude fuel. These variables provide a crude way to control for the effects of exogenous supply shocks. Finally, since the interest rate channel is an important channel of transmission of fiscal policy, this sub-section presents evidence on the effects of shocks in a model that includes the constant maturity ten-year Treasury bond yield (LTR) in addition to RTB.

In the first and second columns of Figure 3.13, the point estimates of the IRFs for defense purchases, real GDP, RTB, and the GDP deflator computed when the monetary variables listed above are added, in turn, to the alternative model are plotted against the corresponding confidence intervals from the alternative model. The solid lines display the point estimates of the IRFs and the dashed lines display the confidence intervals.

All the IRFs computed for the model with the Romers' monetary policy dummy variable lie within the confidence intervals from the alternative model at all horizons. Except for defense purchases, the IRFs reported for the model with the monetary base also lie within the confidence intervals from the alternative model at all horizons.

The IRF for defense purchases computed for the model with the monetary base lies within the confidence interval from the alternative model for more than two years after a shock to the DP dummy variable, and then it lies very slightly above the upper bound of the confidence interval. Furthermore, after a delay of two and a half years, the IRF for real GDP lies on the upper bound of the corresponding confidence interval from the alternative model.

In the third and fourth column of Figure 3.13, the point estimates of the IRFs for defense purchases, real GDP, RTB, and the GDP deflator computed when Hamilton's oil price dummy variable and the PPI for crude fuel are added, in turn, to the alternative model are plotted against the corresponding confidence intervals from the alternative model. The solid lines display the point estimates of the IRFs and the dashed lines display the confidence intervals. All the IRFs computed for the models with Hamilton's oil price

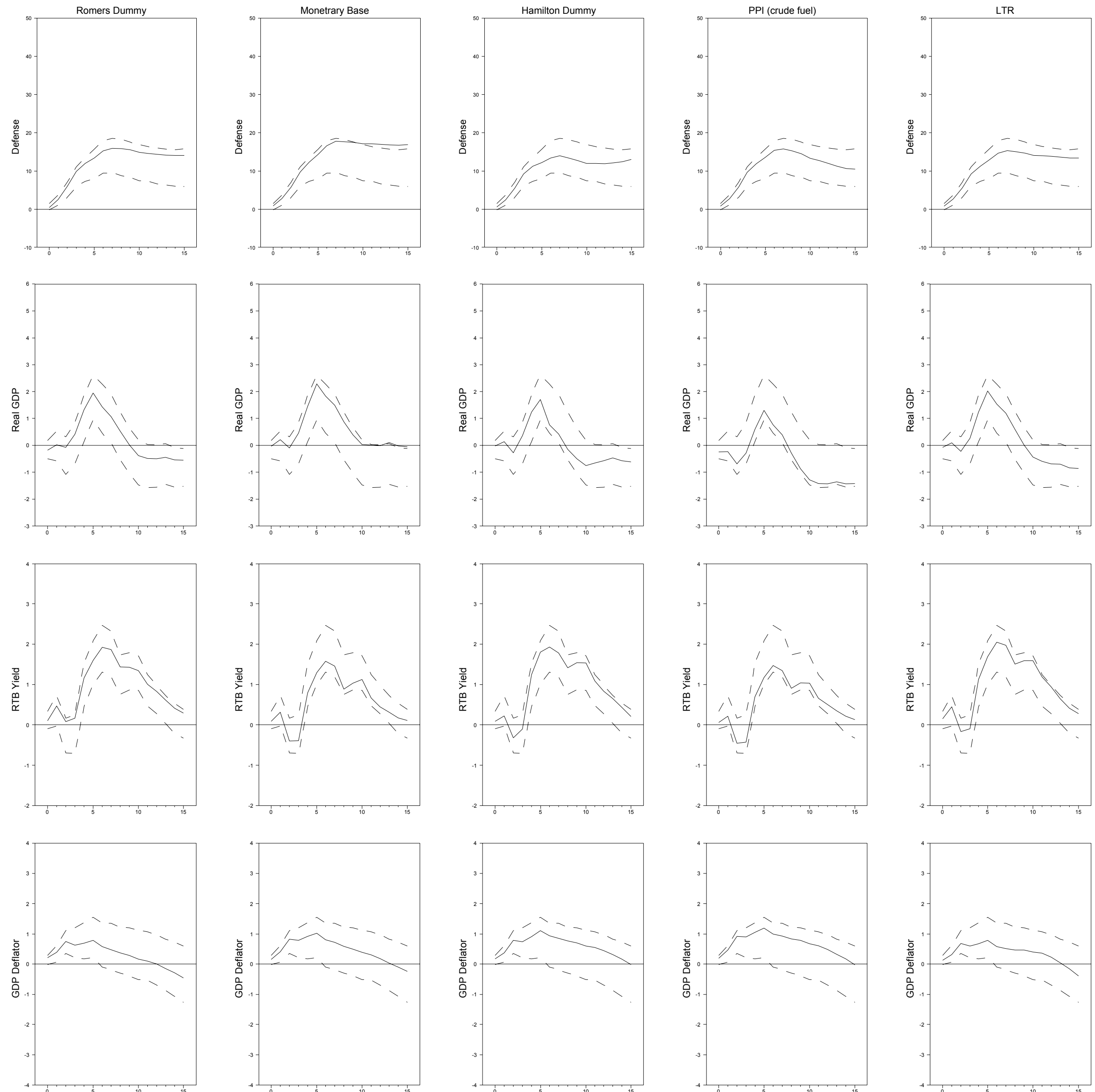

Figure 3.13: Point Estimates from Models with an Additional Macroeconomic Variable
Confidence Intervals from Alternative Model

dummy variable and the PPI for crude fuel lie within the corresponding confidence intervals from the alternative model at all horizons.

In the last column of Figure 3.13, the point estimates of the IRFs for defense purchases, real GDP, RTB, and the GDP deflator computed when LTR is added to the alternative model are plotted against the corresponding confidence intervals from the alternative model. The solid lines display the point estimates of the IRFs and the dashed lines display the confidence intervals. All the IRFs reported for the model with LTR lie within the corresponding confidence intervals from the alternative model at all horizons.

Overall, nineteen out of twenty IRFs computed when the Romers' monetary policy dummy variable, the monetary base, Hamilton's oil price dummy variable, the PPI for crude fuel, and LTR are added, in turn, to the alternative model are not significantly different from the corresponding IRFs reported for the alternative model at any horizon.

Furthermore, the IRF for defense purchases computed for the model with the monetary base differs only marginally from the one presented for the alternative model at long horizons. Therefore, it is concluded that the results reported for the alternative model are not sensitive to the addition of the macroeconomic variables examined in this sub-section.

3.7.4 Responses of Fiscal and Monetary Variables

As for the Ramey-Shapiro dummy variable, it is of interest to determine whether the shocks included in the DP dummy variable coincide not only with increases in defense purchases but also changes in other dimensions of fiscal policy or changes in monetary policy. Therefore, this sub-section presents the effects of a shock to the DP dummy variable on non-defense purchases, real federal government receipts, the real federal government deficit, and the monetary base.

In Figure 3.14, the solid lines display the point estimates of the IRFs computed for the additional fiscal variables and the monetary base when the extended models that include these variables are estimated. The dashed lines display the lower and upper bounds of sixty-eight percent confidence intervals. The IRF reported for the monetary base, and to a lesser extent the IRF for non-defense purchases, are different from the ones presented for a shock to the Ramey-Shapiro dummy variable in the last chapter.

The IRF for non-defense purchases is negative for more than a year after a shock to the DP dummy variable. However, it is significant for less a year, and then it is not significantly different from zero. The IRF for real federal government receipts exhibits a hump-shaped pattern. It increases sharply for one and a half years after a shock to the DP dummy variable, and then it quickly returns to its original value. Overall, the increase in real federal government receipts is significant for more than a year. It is consistent with the IRFs reported for real GDP and the GDP deflator.

The IRF computed for the real federal government deficit is small and not significantly different from zero for almost two years after a shock to the DP dummy variable. Then, it deteriorates significantly and persistently. The pattern of the IRF computed for the real federal government deficit appears consistent with the IRFs reported for federal government purchases and receipts.

Following a shock to the DP dummy variable, non-defense purchases decline for more than a year and government receipts increase for more than two years, which allows the federal government to finance the military build-up without a significant deterioration of its deficit. In the third year after an episode, defense purchases remain very high, but

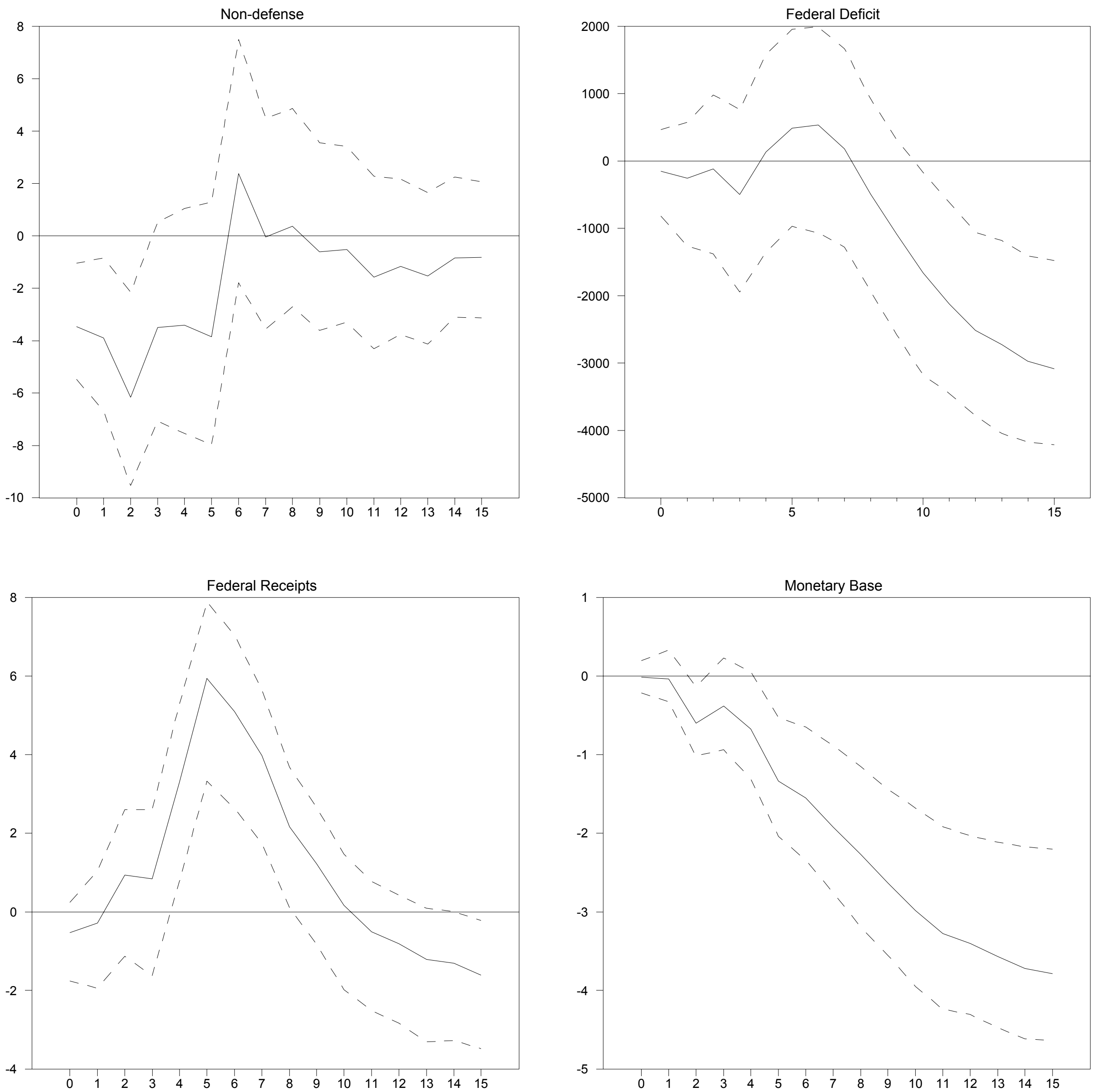

Figure 3.14: Point Estimates of the IRFs for Fiscal and Monetary variables
Sample Period: 1948:3-1999:2

non-defense purchases have returned to their initial level and the increase in federal government receipts comes to an end. Therefore, a portion of the military build-up is financed through government deficits at longer horizons.

The IRF for the monetary base is negative at all horizons. Less than a year after a shock to the DP dummy variable, it declines significantly and very persistently. This result implies that the shocks to defense purchases identified earlier in this chapter may have been associated with persistent changes in monetary policy, which is consistent with the evidence reported by Caplan (1999) for instance.

Overall, the IRFs for the fiscal and monetary variables presented in this sub-section indicate that the shocks to defense purchases included in the DP dummy variable coincide with significant and temporary declines in non-defense purchases as well as significant and very persistent decrease in the monetary base.

Furthermore, like the IRFs reported for the models with the Ramey-Shapiro dummy variable, the IRFs computed for a shock to the DP dummy variable imply that the federal government is initially able to finance military build-ups through increases in revenues. However, once the increases in revenues come to end, the government needs to finance the military build-ups through deficits.

3.8 Alternative Sample Periods

This section provides evidence on the sensitivity of the results reported for the alternative model to perturbations in the sample period used. First, the alternative model is estimated over the four sub-sample periods used in the study of the Ramey-Shapiro dummy variable. The early and late sub-sample periods span from 1948:1 to 1973:1 and 1960:1 to 1999:2, respectively. The next sub-sample periods selected span from 1950:1 to 1999:2 and from 1948:3 to 1989:4, which corresponds to the Cold War era.

For each sub-sample period, the point estimates of the IRFs for defense purchases, real GDP, RTB, and the GDP deflator computed for a unit shock to the DP dummy variable are plotted along with the corresponding confidence intervals for the whole sample period. If the results reported for the alternative model are not sensitive to perturbations in the sample period used, the IRFs computed for the different sub-sample periods ought to lie within the corresponding confidence intervals from the whole sample period.

In the first and second columns of Figure 3.15, the solid lines display the point estimates of the IRFs for defense purchases, real GDP, RTB, and the GDP deflator computed when the alternative model is estimated over the early and late sub-sample periods. The dashed lines display the confidence intervals reported for the whole sample period.

The IRFs for real GDP and the GDP deflator computed for the early sub-sample period are marginally different from the ones reported for the whole sample period. The IRF for real GDP lies very slightly above the upper bound of the confidence interval from the whole sample period for several periods in the first and third year after a shock to the DP dummy variable. The IRF for the GDP deflator lies very slightly above the upper bound of the confidence interval from the whole sample period at the end of the fourth year after a shock

The IRFs for defense purchases and RTB computed for the early sub-sample period are significantly and persistently different from the ones reported for the whole sample period. After a delay of a quarter, the IRF for defense purchases lies well above

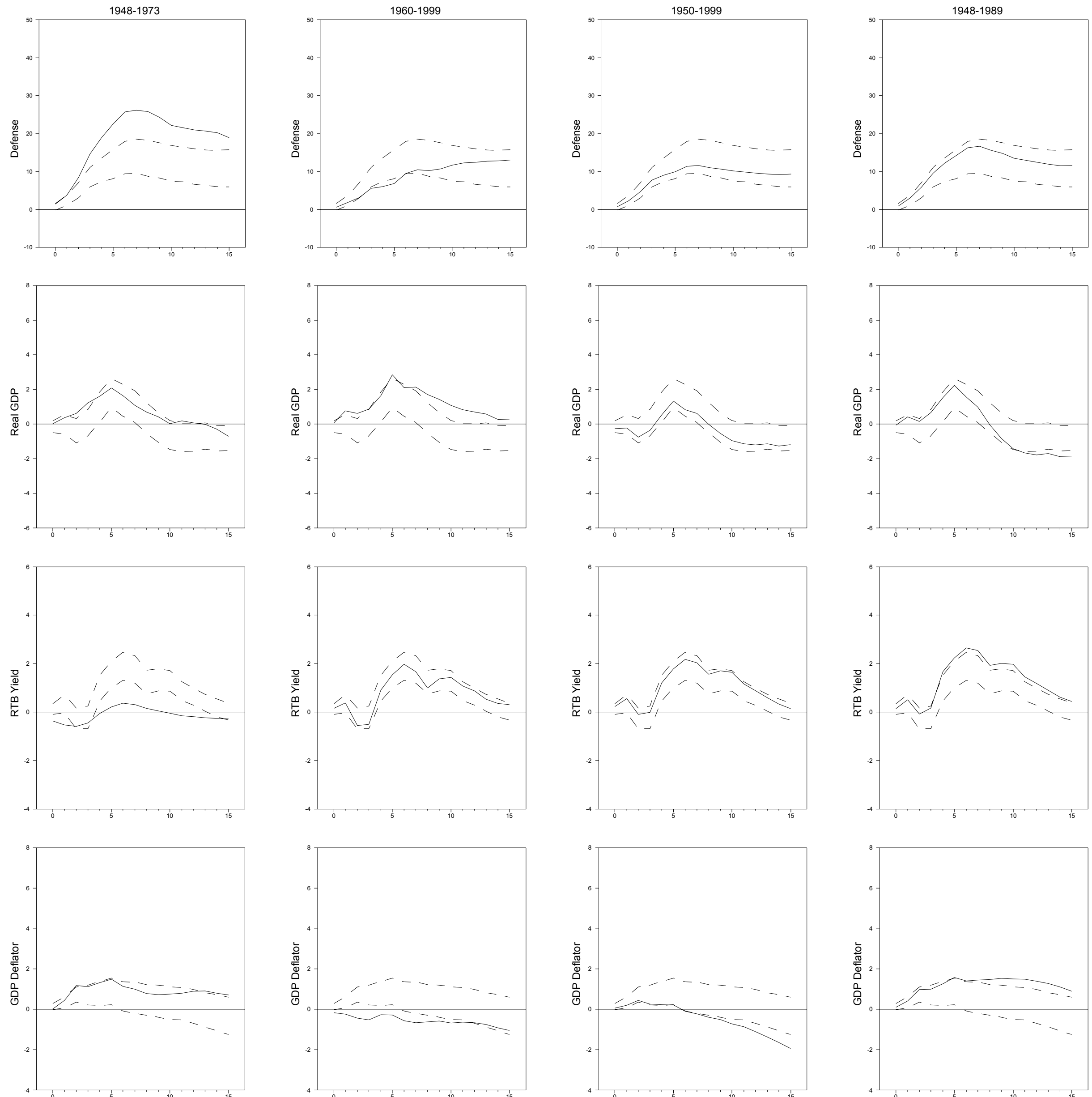

Figure 3.15: Point Estimates from Alternative Sample Periods
Confidence Intervals from the Whole Sample Period

the upper bound of the confidence interval from the whole sample period at all horizons. The IRF for RTB is initially negative and it is very small at all horizons. Except for a quarter, it lies below the lower bound of the confidence interval from the whole sample period.

The IRF for defense purchases computed for the late sub-sample period is only marginally different from the one reported for the whole sample period. It lies on or close to the lower bound of the corresponding confidence interval from the whole sample period for one and a half years, and then it lies within the confidence interval. The IRF for RTB is not significantly different from the one reported for the whole sample period. It lies within the confidence interval from the whole sample period at all horizons.

The IRFs for real GDP and the GDP deflator computed for the late sub-sample period are significantly and persistently different from the ones reported for the whole sample period. The IRF for real GDP lies on the upper bound of the confidence interval from the whole sample period for one and a half years, and then it lies above the upper bound. The IRF for the GDP deflator lies below the lower bound of the confidence interval from the whole sample period for more than two and a half years.

In the third and fourth columns of Figure 3.15, the solid lines display the point estimates of the IRFs for defense purchases, real GDP, RTB, and the GDP deflator computed when the alternative model is estimated over the sub-sample period from 1950:1 to 1999:2 and the Cold War era. The dashed lines display the confidence intervals reported for the whole sample period.

The IRFs for defense purchases, real GDP, and RTB computed for the sub-sample period from 1950:1 to 1999:2 are not significantly different from the ones reported for the whole sample period. They lie within the corresponding confidence intervals from the whole sample period at all horizons. However, the IRF for the GDP deflator is significantly different from the one reported for the whole sample period. A year after a shock to the DP dummy variable, it lies below the lower bound of the confidence interval from the whole sample period.

The IRF for defense purchases computed for the Cold War era is not significantly different from the ones reported for the whole sample period. It lies within the confidence interval from the whole sample period at all horizons. However, the IRFs for real GDP, RTB, and the GDP deflator are significantly different from the ones reported for the whole sample period.

The IRF for real GDP computed for the Cold War era lies within the confidence interval from the whole sample period for two and a half years after a shock to the DP dummy variable. Then, it lies slightly below the lower bound of the confidence interval. After a delay of a year, the IRF for RTB lies slightly above the upper bound of the confidence interval from the whole sample period. The IRF for the GDP deflator lies within the confidence interval from the whole sample period for a year, and then it lies above the upper bound of the confidence interval.

To further examine the sensitivity of the results reported for the alternative model to perturbations in the sample period, Figure 3.16 presents the point estimates and confidence intervals of the IRFs for defense purchases, real GDP, RTB, and the GDP deflator computed for a unit shock to the DP dummy variable when the alternative model is estimated over the early and late sub-sample periods. The solid lines display the point

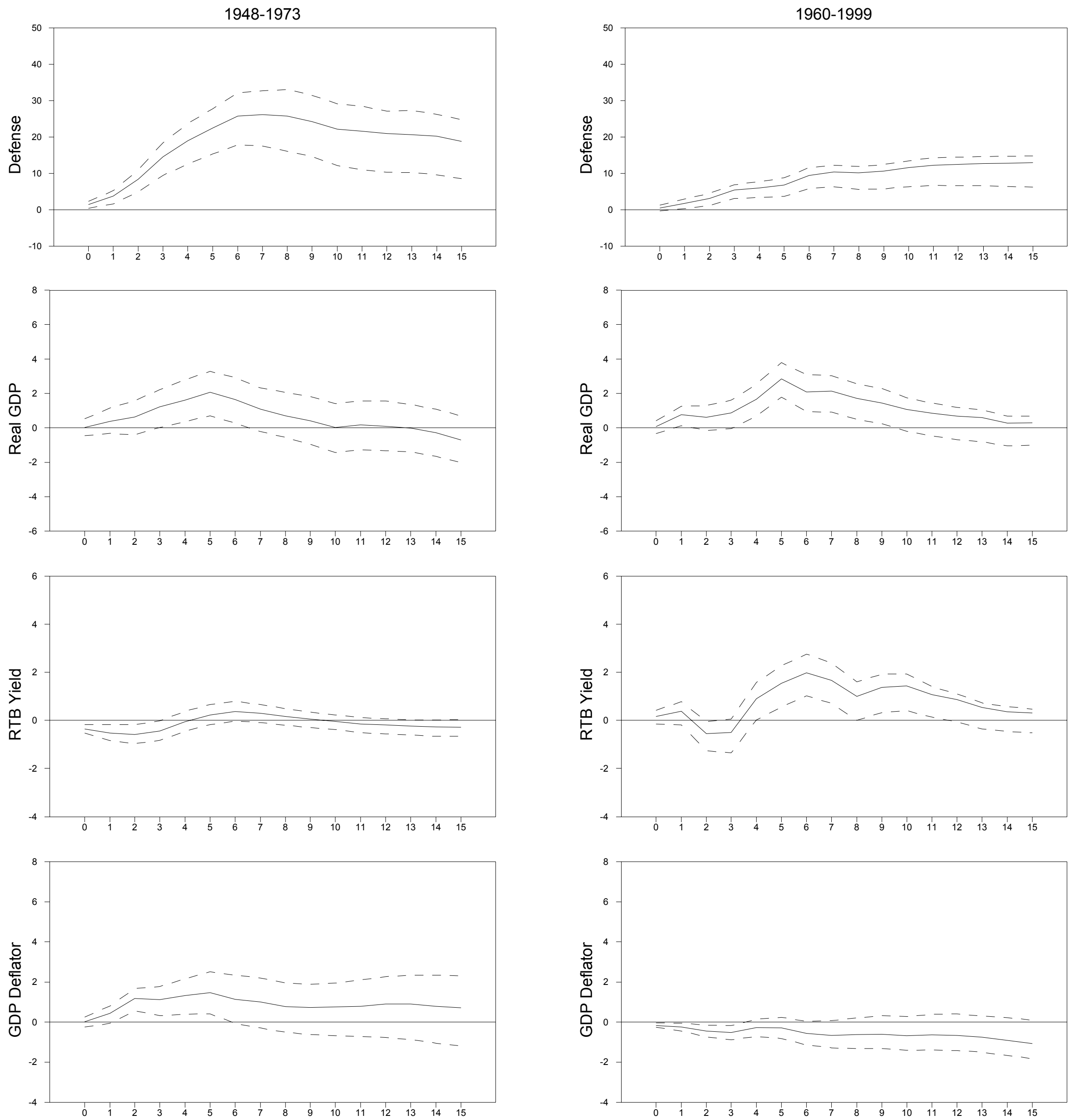

Figure 3.16: Point Estimates from Alternative Sample Periods
Confidence Intervals from Alternative Sample Periods

estimates of the IRFs and the dashed lines display the lower and upper bounds of sixty-eight percent confidence intervals.

The patterns of the IRFs for defense purchases, real GDP, and the GDP deflator computed for the early sub-sample period are similar to the ones reported for the whole sample period. However, the IRF for defense purchases is much smaller than to the one reported for the whole sample period. The IRF for RTB computed for the early sub-sample period exhibits a pattern very different from the one reported for the whole sample period. It declines significantly for three quarters after a shock to the DP dummy variable, and then it is not significantly different from zero.

The pattern of the IRF for defense purchases computed for the late sub-sample period is different from the one reported for the whole sample period. It increases more gradually than the IRF reported for the whole sample period and it is smaller. The patterns and sizes of the IRFs for real GDP and RTB are similar to the ones reported for the whole sample period. The pattern of the IRF for the GDP deflator is very different from the one reported for the whole sample period. It is negative at all horizons and significantly different from zero for almost a year after a shock to the DP dummy variable.

In conclusion, when the alternative model is estimated over the early and late sub-sample periods, the results reported for the alternative model appear sensitive to perturbations in the sample period used. The IRFs computed for over the early and late sub-sample periods are very different from the ones reported for the whole sample period. Furthermore, when the alternative model is estimated over the Cold War era, the results reported for the alternative model also appear sensitive to perturbations in the sample period used.

Except for the GDP deflator, the results computed when the alternative model is estimated over the sub-sample period from 1950:1 to 1999:2 are similar to the ones reported for the whole sample period. As was mentioned in the previous chapter, the sensitivity of the IRF for the GDP deflator to the subtraction of a small number of data at the beginning of the whole sample period may be explained by the unusual behavior of the GDP deflator during the period from 1948:3 to 1949:4.

Like the results presented for the Ramey-Shapiro dummy variable in the previous chapter, the IRFs reported above imply that the results computed for the alternative model are sensitive to the exclusion of shocks from the DP dummy variable. This may be expected since the DP dummy variable includes a modest number of shocks to defense purchases.

3.9 Accounting for the Differences Among the Shocks Identified

As was mentioned before, the changes in defense purchases and government purchases that followed the shocks to defense purchases included in the DP dummy variable differ greatly in size and shape. As for the Ramey-Shapiro dummy variable, the Korean War episode is much larger than the other episodes included in the DP dummy variable.

Therefore, it is of interest to examine the results reported for the alternative model when the values of the shocks included in the DP dummy variable differ according to the sizes of the military build-ups or retrenchments that follow them. This is done following the same methodology as the one presented in the previous chapter for the Ramey-Shapiro dummy variable.

An alternative DP dummy variable is constructed that has the value one at the date of the Korean War episode. The values of the other shocks are assigned according to the maximum change in defense purchases within six quarters after the onsets of these shocks relative to the maximum change after the onset of the Korean War episode. The Vietnam War and Carter-Reagan episodes have the values 0.44 and 0.12, respectively. The Eisenhower, the Nixon, and the Bush-Clinton episodes have the values -0.17, -0.27, and -0.05, respectively.

Then, a system identical to the alternative model, except that it includes the modified DP dummy variable, is estimated. Finally, the IRFs for defense purchases, real GDP, RTB, and the GDP deflator are computed for a unit shock to the modified DP dummy variable. In Figure 3.17, the solid lines display the point estimates of these IRFs and the dashed lines display the lower and upper bounds of sixty-eight percent confidence intervals.

The patterns of the IRFs for defense purchases and real GDP computed using the modified DP dummy variable are similar to the ones reported using the DP dummy variable; however, their magnitudes are very different. The maximum effects reported for defense purchases and real GDP using the modified DP dummy variable are twice as large as the ones reported for the DP dummy variable.

The IRF for RTB computed for the modified DP dummy variable is initially very different from the one reported for the DP dummy variable. It is negative for a year after a shock to defense purchases, and significant for several periods. Then, it is similar to the IRF reported for the DP dummy variable. The IRF for the GDP deflator computed for the modified DP dummy variable is more persistent and larger than the one reported for the DP dummy variable.

Overall, since the changes in defense purchases and government purchases that follow the shocks included in the DP dummy variable differ in size, it could be argued that it is better to estimate a VAR system in which the assumption that the shocks to defense purchases are of equal intensity is abandoned. Therefore, the modified DP dummy variable is constructed.

Except for RTB, the patterns of the IRFs computed for a shock to the modified DP dummy variable are fairly similar to the ones reported for a shock to the DP dummy variable; however, their magnitudes differ. Unlike the IRF for RTB reported for a shock to the DP dummy variable, the one computed for a shock to the modified DP dummy variable declines significantly in the first year after a shock. This last result may reflect the importance of the Korean War episode in generating the IRFs reported for a shock to the modified DP dummy variable.

3.10 The Exogeneity of the Shocks Identified

In the previous chapter, the exogeneity of the Ramey-Shapiro episodes was investigated following the methodology used by Leeper (1997) to study the exogeneity of the Romers' monetary policy dummy variable. First, logit equations that included macroeconomic variables were estimated for the Ramey-Shapiro dummy variable.

Then, the probability that the logit equations have the value one at the dates selected by Ramey and Shapiro (1997) was computed. The logit equations were very imprecisely estimated, and the results reported for the Korean War were problematic. Therefore, it was concluded that estimating logit equations did not provide meaningful evidence on the exogeneity of the Ramey-Shapiro episodes.

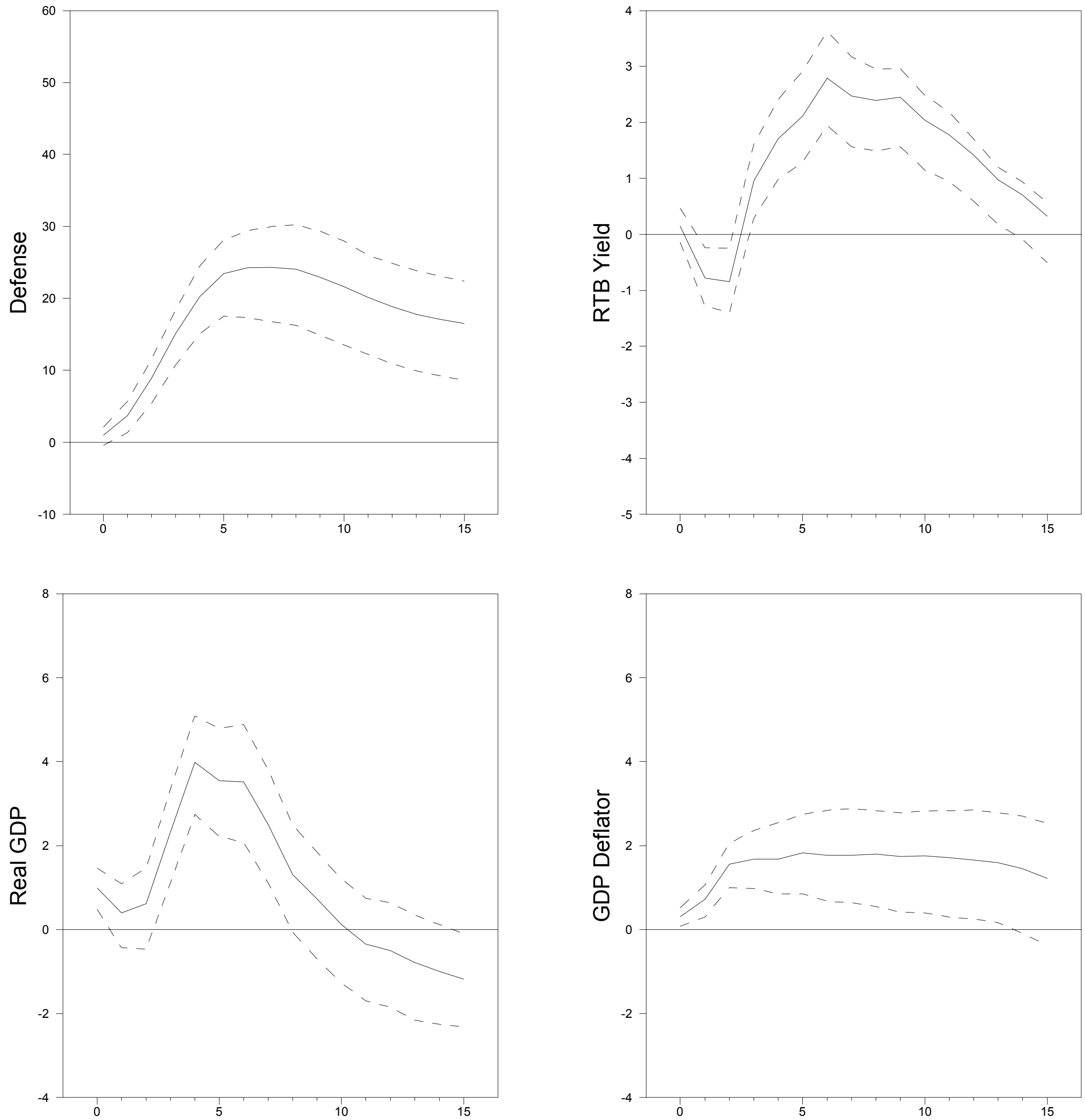

Figure 3.17: Point Estimates from the Model with Modified DP Dummy Variable

Similarly, several logit equations that included macroeconomic variables were estimated for the DP dummy variable.[8] Like the logit equations presented for the Ramey-Shapiro dummy variable, they were very imprecisely estimated, and the results reported for the Korean War were problematic. Therefore, it was concluded that estimating logit equations for the DP dummy variable did not provide meaningful evidence on the exogeneity of the shocks included the DP dummy variable, and the results computed for these equations are not presented in this chapter.

Two VAR systems in which the Ramey-Shapiro dummy variable was entered as an endogenous variable were also estimated in the previous chapter to examine the exogeneity of the Ramey-Shapiro episodes. Similarly, two VAR systems in which the DP dummy variable is entered as an endogenous variable are estimated to examine the exogeneity of the shocks included in the DP dummy variable.

The so-called linear systems include the DP dummy variable along with defense purchases, real GDP, RTB, and the GDP deflator. Like the other equations in the linear systems, the equation for the DP dummy variable includes six lagged values of itself, defense purchases, real GDP, RTB, and the GDP deflator, plus a constant and a "Perron-type" time trend. The linear systems are estimated using OLS, and the IRFs for defense purchases, real GDP, RTB, and the GDP deflator that present the effects of a unit shock to the DP dummy variable are computed.

The Choleski decomposition is used to identify the shocks to the DP dummy variable within the linear systems. For the first linear system, the DP dummy variable is ordered first, defense purchases are ordered second, real GDP is ordered third, RTB is ordered fourth, and the GDP deflator is ordered last. For the second linear system, real GDP is ordered first, RTB is ordered second, the GDP deflator is ordered third, the DP dummy variable is ordered fourth, and defense purchases are ordered last.[9]

If the shocks included in the DP dummy variable are truly exogenous, the IRFs computed for the linear systems and the alternative model should be similar. Furthermore, if the shocks are truly exogenous, the IRFs computed for the linear systems should not be sensitive to the ordering of the residuals in the Choleski decomposition used to identify shocks to the dummy variable.

In Figure 3.18, the short dashed lines display the IRFs for defense purchases, real GDP, RTB, and the GDP deflator computed for a unit shock to the DP dummy variable when the first linear system is estimated. The long dashed lines display the IRFs computed when the second linear system is estimated. The solid lines display the confidence intervals reported for the alternative model. If the shocks included in the DP dummy variable are truly exogenous, the IRFs computed for the linear systems ought to lie within corresponding confidence interval reported for the alternative model.

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[8] Like for the Ramey-Shapiro dummy variable, a logit equation estimated for the DP dummy variable included a constant, a "Perron-type" time trend, real GDP, RTB, and the GDP deflator. Four lagged values of the independent variables were used because the coefficients estimated did not converge when more than four lagged values were used. A second logit equation estimated included a constant, a "Perron-type" time trend, real GDP, RTB, the GDP deflator, and defense purchases. In this case, two lagged values of the independent variables were used. The equations were estimated from 1948:1 to 1999:2 using a non-linear maximum likelihood method.

[9] The assumptions underlying of ordering of the residuals in the Choleski decompositions used for the linear models are discussed in the first chapter of the dissertation.

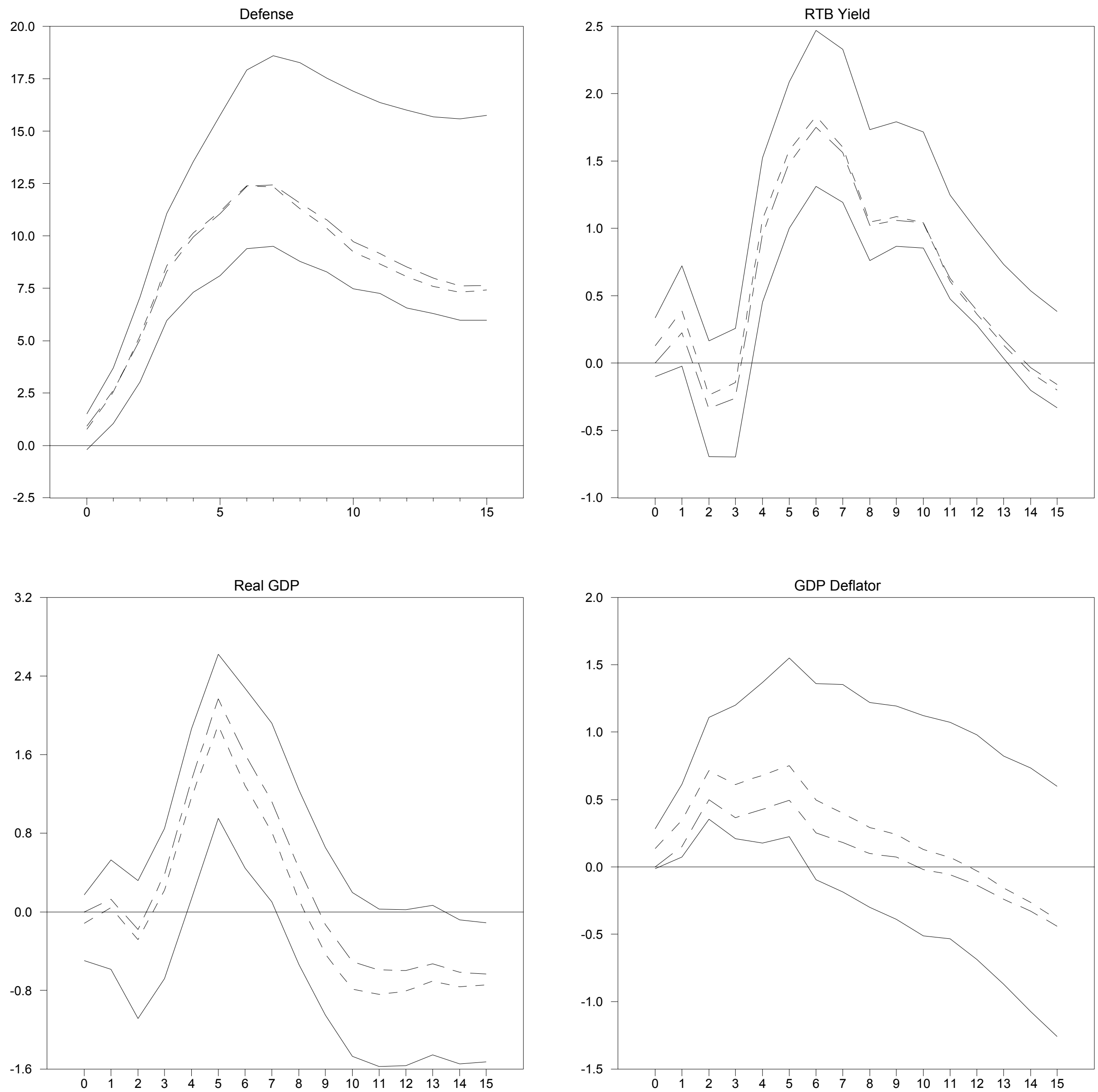

Figure 3.18: Point Estimates from Linear Systems
Confidence Intervals from Alternative Model

All the IRFs computed for the linear systems lie well within the corresponding confidence intervals from the alternative model at all horizons and they exhibit patterns very similar to the IRFs reported for the alternative model. Furthermore, the point estimates of the IRFs computed for the second linear system are close to the corresponding point estimates reported for first linear system.

Therefore, it is concluded that the IRFs reported for the linear systems are consistent with the shocks included in the DP dummy variable being exogenous. However, as was mentioned for the Ramey-Shapiro dummy variable, the IRFs reported for the linear systems do not represent definitive evidence on the exogeneity of the shocks under consideration.

3.11 Summary and Conclusions

This chapter introduces a more comprehensive narrative approach than the one of Ramey and Shapiro (1997) that tries to isolate exogenous reductions as well as exogenous increases in defense purchases. It also provides evidence on the implications of using the more comprehensive narrative approach for estimating the macroeconomic effects of exogenous shocks to government purchases.

Five exogenous increases in defense expenditures are identified in the post-World War II era using the more comprehensive narrative approach introduced in this chapter. They correspond to the March Crisis, the Korean War, the Kennedy, the Vietnam War, and the Carter-Reagan build-ups. Four exogenous retrenchments in defense expenditures are also identified that correspond to the Eisenhower, the Johnson, the Nixon, and the Bush-Clinton retrenchments.

The Korean War build-up is dated as beginning in the third quarter of 1950, which is also the date selected by Ramey and Shapiro (1997). The Vietnam War build-up is dated as beginning in the third quarter of 1965, two quarters after the date selected by Ramey and Shapiro (1997). The Carter-Reagan build-up is dated as beginning in the last quarter of 1979, one quarter before the date selected by Ramey and Shapiro (1997). Furthermore, the March Crisis and the Kennedy build-ups are dated as beginning in 1948:2 and 1960:4, respectively. The Eisenhower, the Johnson, the Nixon, and the Bush-Clinton retrenchments are dated as beginning in 1952:4, 1963:4, 1969:3, and 1989:4, respectively.

Since the dates selected in this chapter for the Vietnam War and Carter-Reagan shocks are slightly different from the ones presented by Ramey and Shapiro (1999), they are used to examine the sensitivity of the results computed in the previous chapter for the benchmark and alternative models to small perturbations in the dates of the Ramey-Shapiro episodes. Edelberg, Eichenbaum, and Fisher (1999) argue that the results they report using the Ramey-Shapiro dummy variable are robust to small perturbations in the dates of the Ramey-Shapiro episodes.

However, when the alternative dates selected in this chapter for the Vietnam War and Carter-Reagan episodes are used to construct modified Ramey-Shapiro dummy variables, some of the IRFs reported are significantly different from the ones computed when the dates selected by Ramey and Shapiro (1997) are used. Therefore, it is concluded that the results presented in the previous chapter of the dissertation for a shock to the Ramey-Shapiro dummy variable are sensitive to small perturbations in the dates of the Vietnam War and Carter-Reagan episodes.

To examine the implications of using the more comprehensive narrative approach for estimating the effects of fiscal policy, a dummy variable is constructed that has the value one at the dates of the onsets of the Korean War, the Vietnam War, and the Carter-Reagan episodes, minus one at the dates of the Eisenhower, the Johnson, and the Bush-Clinton episodes, and zero otherwise. It is referred to as the DP dummy variable.

As in the previous chapter of the dissertation, this chapter focuses on two VAR systems in the spirit of Edelberg, Eichenbaum and Fisher (1999). The benchmark model includes the contemporaneous and four lagged values of the DP dummy variable that are entered as exogenous variables as well as four lagged values of defense purchases, real GDP, RTB, and the GDP deflator that are entered as endogenous variables. The alternative model, which is selected according to the AIC criterion, includes six lagged values of the variables and a "Perron-type" time trend.

The IRFs that present the effects of a unit shock to the DP dummy variable on defense purchases, real GDP, RTB, and the GDP deflator are computed for the benchmark and alternative models. The IRFs reported for the benchmark model imply that defense purchases increase very persistently in response to a shock to the DP dummy variable, output rises temporarily, and interest rates and the price level rise persistently. The IRFs reported for the alternative model are similar in pattern to the ones reported for the benchmark model; however, they are slightly different quantitatively.

This chapter also presents evidence on the robustness of the results reported using the DP dummy variable, which is an important issue since the number of shocks included in this dummy variable is modest. First, the sensitivity of the results computed for the benchmark model is examined when an extended DP dummy variable is constructed that includes the Kennedy and Johnson episodes along with the shocks already in the DP dummy variable. The patterns of the IRFs computed for the extended DP dummy variable are similar to the ones reported for the DP dummy variable; however, they are generally smaller than the ones reported for the DP dummy variable.

Furthermore, the sensitivity of the results computed for the benchmark model is examined when the dates selected by Ramey and Shapiro (1997) for the onsets of the Vietnam War and Carter-Reagan episodes are used to construct the DP dummy variable or the extended DP dummy variable, the IRFs reported are consistent with the evidence presented on the sensitivity of the results computed for the benchmark and alternative models to small perturbations in the dates of the Ramey-Shapiro episodes.

Then, the sensitivity of the results computed for defense purchases, real GDP, RTB, and the GDP deflator to adding time trends and changing the lag length used in the benchmark model is examined. It is shown that the results reported for the benchmark model are not sensitive to adding time trends. However, the results reported for defense purchases, real GDP, and RTB appear sensitive to changing the lag length used.

Next, the sensitivity of the results computed for defense purchases, real GDP, RTB, and the GDP deflator to perturbations in the list of variables included in the alternative model is examined. Seventeen endogenous and exogenous variables are added, in turn, to the alternative model, and the IRFs computed for the extended models and the alternative model are compared.

It is concluded that, except maybe for employment in the durables manufacturing sector, the results reported for the alternative model are robust to perturbations in the list of variables used. In particular, unlike the results reported using the Ramey-Shapiro

dummy variable, the IRFs computed for a shock to the DP dummy variable are not altered by the addition of Hamilton's oil price dummy variable to the alternative model.

Furthermore, the IRFs reported when alternative fiscal variables and the monetary base are added, in turn, to the alternative model indicate that the shocks to the DP dummy variable ups coincide with significant and temporary changes in non-defense purchases as well as significant and very persistent changes in the monetary base. Therefore, it is concluded that the results reported using the DP appear may reflect, at least partially, the effects of systematic changes in other components of government purchases than defense purchases or monetary policy.

Finally, the sensitivity of the results computed for the alternative model to perturbations in the sample period used is examined. The results computed for sub-sample periods in which some shocks are excluded from the sub-sample used differ significantly from the results reported for the whole sample period. Except for the GDP deflator, the results computed for sub-sample periods 1950:1 to 1999:2 do not differ significantly from the results reported the whole sample period.

In addition to presenting evidence on the robustness of the results computed for the benchmark and alternative models, this chapter investigates the implications of abandoning the assumption that the DP episodes are of equal intensity. Furthermore, it investigates the exogeneity of the shocks included in the DP dummy variable.

To account for the differences in size among the shocks included in the DP dummy variable, a modified DP dummy variable whose values at the dates of the shocks to defense purchases vary according to the size of the changes in defense purchases that follows them is constructed. Then, the IRFs for defense purchases, real GDP, RTB, and the GDP deflator are computed for a unit shock to the modified DP dummy variable when the alternative model is estimated.

Except for RTB, the patterns of the IRFs computed for a shock to the modified DP dummy variable are fairly similar to the ones reported for a shock to the DP dummy variable; however, their magnitudes differ. The IRF for RTB reported for a shock to the modified DP dummy variable declines significantly in the first year after a shock, which may reflect the importance of the Korean War episode in generating the IRFs reported for a shock to the modified DP dummy variable.

To examine the exogeneity of the shocks included in the DP dummy variable, two linear systems are estimated in which the DP dummy variable is entered as an endogenous variable along with defense purchases, real GDP, RTB, and the GDP deflator. Then, the IRFs for defense purchases, real GDP, RTB, and the GDP deflator are computed for a unit shock to the DP dummy variable. They are similar to the IRFs reported for the alternative model; and therefore, it is concluded that the results reported for the linear systems are consistent with the Ramey-Shapiro episodes being exogenous.

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CHAPTER 4. THE CHOLESKI DECOMPOSITION

4.1 Introduction

Whereas the Choleski decomposition has been widely used to identify exogenous monetary policy shocks, it has been rarely used to identify exogenous fiscal policy shocks, in particular exogenous shocks to government purchases. Garcia-Mila (1989), Yuan and Li (1999), and Fatas and Mihov (2000) are among the small number of studies that have investigated the macroeconomic effects of government purchases using the Choleski decomposition.

As was mentioned in the introduction of the dissertation, the VAR systems estimated by Fatas and Mihov (2000) are similar in spirit to the ones presented by Edelberg, Eichenbaum, and Fisher (1999); however, the sample period used by Fatas and Mihov (2000) is different. Furthermore, the values of some of the government data used by Fatas and Mihov (2000) are incorrect. As a result, the evidence they report cannot actually be compared to the one presented by Edelberg, Eichenbaum, and Fisher (1999).

Moreover, the VAR systems estimated by Garcia-Mila (1989), and Yuan and Li (1999) are different in spirit from the models estimated by Edelberg, Eichenbaum, and Fisher (1999) and Fatas and Mihov (2000). Yuan and Li (1999) do not include a measure of the price level in their model and Garcia-Mila (1999) does not include measures of the price level and interest rates in her model. The sample periods used by Garcia-Mila (1989) and Yuan and Li (1999) are also different from the one presented by Edelberg, Eichenbaum, and Fisher (1999).

This chapter of the dissertation examines the implications of using the Choleski decomposition for estimating the effects of an exogenous shock to defense purchases. To compare the implications of using the Choleski decomposition and the narrative approaches presented in the previous chapters of the dissertation, it focuses on the same benchmark and alternative models as the ones examined in the previous chapters.

Ramey and Shapiro (1997) and Edelberg, Eichenbaum, and Fisher (1999), who use a narrative approach to identify exogenous shocks to defense purchases, argue against using the Choleski decomposition. They claim that several important problems may plague the evidence reported when the latter is used to identify exogenous shocks to defense purchases.

As was mentioned in the introduction of the dissertation, based on a handout for comments on a study by Rotemberg and Woodford (1990) provided by Christiano (1990), Edelberg, Eichenbaum, and Fisher (1999) argue that evidence reported using the Choleski decomposition appears "… Quite fragile to perturbations in the sample period used and the list of variables included in the VAR" (Edelberg, Eichenbaum, and Fisher 1999, p. 3).

The handout for comments by Christiano (1990) was prepared more than a decade ago, and it does not appear to have been published. Therefore, it is important to re-examine the robustness of the results computed when the Choleski decomposition is used to identify exogenous shocks to defense purchases, in particular with regard to perturbations in the list of variables and the sample period. In this chapter, the same methodology used in the previous chapters to investigate the robustness of earlier results is used to examine the robustness of the results reported when the Choleski decomposition is used to identify exogenous shocks to defense purchases.

In addition, Ramey and Shapiro (1997) argue that many of the shocks identified using the Choleski decomposition, "… Are due solely to timing effects on military contracts and do not represent unanticipated changes in military spending" (Ramey and Shapiro 1997, p. 40). More specifically, Edelberg, Eichenbaum and Fisher (1999) indicate that they do not reflect policy changes, but the effects of shocks in the private sector that cause defense contractors to rearrange their delivery schedules, such as strikes.

Finally, as the government and private agents may know of changes in defense purchases before they are recorded in the data, Edelberg, Eichenbaum and Fisher (1999) claim, "… Under these circumstances an econometrician will uncover, at best, a polluted measure of exogenous shocks to government purchases" (Edelberg, Eichenbaum, and Fisher 1999, p. 3).

In fact, it is likely that private agents and the government have additional systematic information beyond the past and current values of the variables included in a VAR model that includes defense purchases as the policy variable. For instance, Garnett argues, "… Money for defense is not 'free money', available to defense policymakers as they please. Most of it is already committed to a particular pattern of defense spending...Though [policymakers] are able to make change at the margin, existing programs reflecting unalterable commitments, sometimes for years ahead, severely restrict the defense planner's freedom to maneuver" (Garnett 1987, pp.10-11).

If a VAR model does not include systematic information about future defense purchases that private agents and the government have, the shocks to defense purchases identified using a Choleski decomposition will actually be mixtures of truly exogenous shocks to defense purchases and the systematic information about defense purchases excluded from the VAR model estimated.

This chapter also examines the implications of using new orders of defense products as a proxy for defense purchases for estimating the effects of a shock to defense purchases because the evidence reported when new orders of defense products are used as the policy variable is less likely to be subject to the criticisms presented by Ramey and Shapiro (1997) and Edelberg, Eichenbaum, and Fisher (1999).

First, new orders of defense products contain information about future flows of defense purchases. Second, since new orders of defense products are recorded before defense purchases, shocks to new orders of defense products are more likely to be unanticipated than shocks to defense purchases. Finally, since new orders of defense products are recorded before production begins, shocks to new orders of defense products do not reflect shocks to the private sector that lead to changes in delivery schedules such as strikes.

The plan of the remainder of this chapter is as follows. Section 4.2 of this chapter discusses the model estimated by Fatas and Mihov (2000). Section 4.3 presents the results computed for the benchmark model and for models in which alternative measures of the price level and interest rates are substituted for the GDP deflator and the net three month interest rate on Treasury bills (RTB), respectively. Section 4.4 examines the sensitivity of the benchmark model to adding time trends and altering the lag length used.

Section 4.5 presents the results computed for the alternative model. Section 4.6 and 4.7 discuss the sensitivity of the alternative model to perturbations in the list of variables and in the sample period used, respectively. Section 4.8 examines the results computed when new orders of defense products are used as a proxy for defense

purchases. Section 4.9 discusses the sensitivity of the model reported for the model with new orders of defense products to perturbations in the list of variables and the sample period. Section 4.10 provides a brief summary and conclusion.

4.2 Fatas and Mihov's Model

To compare the implications of using the Choleski decomposition and the narrative approach of Ramey and Shapiro (1997) for estimating the effects of shocks to government purchases, Fatas and Mihov (2000) estimate VAR systems in the spirit of Edelberg, Eichenbaum, and Fisher (1999).

The benchmark model estimated by Fatas and Mihov (2000) includes five endogenous variables: real government purchases, real private GDP, the GDP deflator, government receipts net of transfer, and real RTB.[1] Real government purchases are defined as defense and non-defense purchases by the federal government as well as local and state governments, real private GDP is defined as real total GDP minus real government purchases. The logarithmic values of the variables are used except for real RTB, and four lagged values of the variables are included in each equation of the system.

The benchmark model estimated by Fatas and Mihov (2000) includes one more endogenous variable, than the benchmark model estimated by Edelberg, Eichenbaum, and Fisher (1999): government receipts net of transfer. Furthermore, whereas Fatas and Mihov (2000) include the real values of RTB and private GDP in their system, Edelberg, Eichenbaum, and Fisher (1999) include the nominal value of RTB and total GDP. In addition, whereas Edelberg, Eichenbaum, and Fisher (1999) estimate their systems over the sample period 1948:1 to 1996:1, Fatas and Mihov (2000) estimate their systems over the sample period 1948:1 to 1996:4.

Fatas and Mihov (2000) compute impulse response functions (IRFs) that present the effects of a shock to government purchases on the variables included in their benchmark model as well as a series of aggregate variables. In the Choleski decomposition used to identify the exogenous shocks to government purchases within the benchmark model, the residuals of the variables are ordered as listed above.

It is assumed that shocks to defense purchases may have a contemporaneous effect on the other variables in the system; however, shocks to the other variables are constrained not to have a contemporaneous effect on defense purchases. Ordering defense purchases before the other variables in the system is consistent with the view that defense purchases are independent from contemporaneous macroeconomic fluctuations. This view is presented in many studies published in the foreign and defense policy literature (Garnett (1987), Rearden (1984), Shilling (1962)).

Fatas and Mihov (2000) downloaded the data for their analysis from the website of the NIPA visualization program of the University of Virginia.[2] Unfortunately, the values for government receipts and transfer payments posted on the website, as well as other data on this website from Table 3.1 of NIPA, are incorrect. Therefore, the benchmark model estimated by Fatas and Mihov (2000) is re-estimated hereafter using the correct values for government receipts and transfer payments. Two sample periods are considered. The first one spans 1960:1 to 1996:4, the one used by Fatas and Mihov

[1] Real RTB is defined as the net nominal three month Treasury bill yield minus inflation. See data appendix for details on the data used.

[2] The NIPA visualization program is located at the University of Virginia. The website address is www.lib.virginia.edu/socsci/nipa.

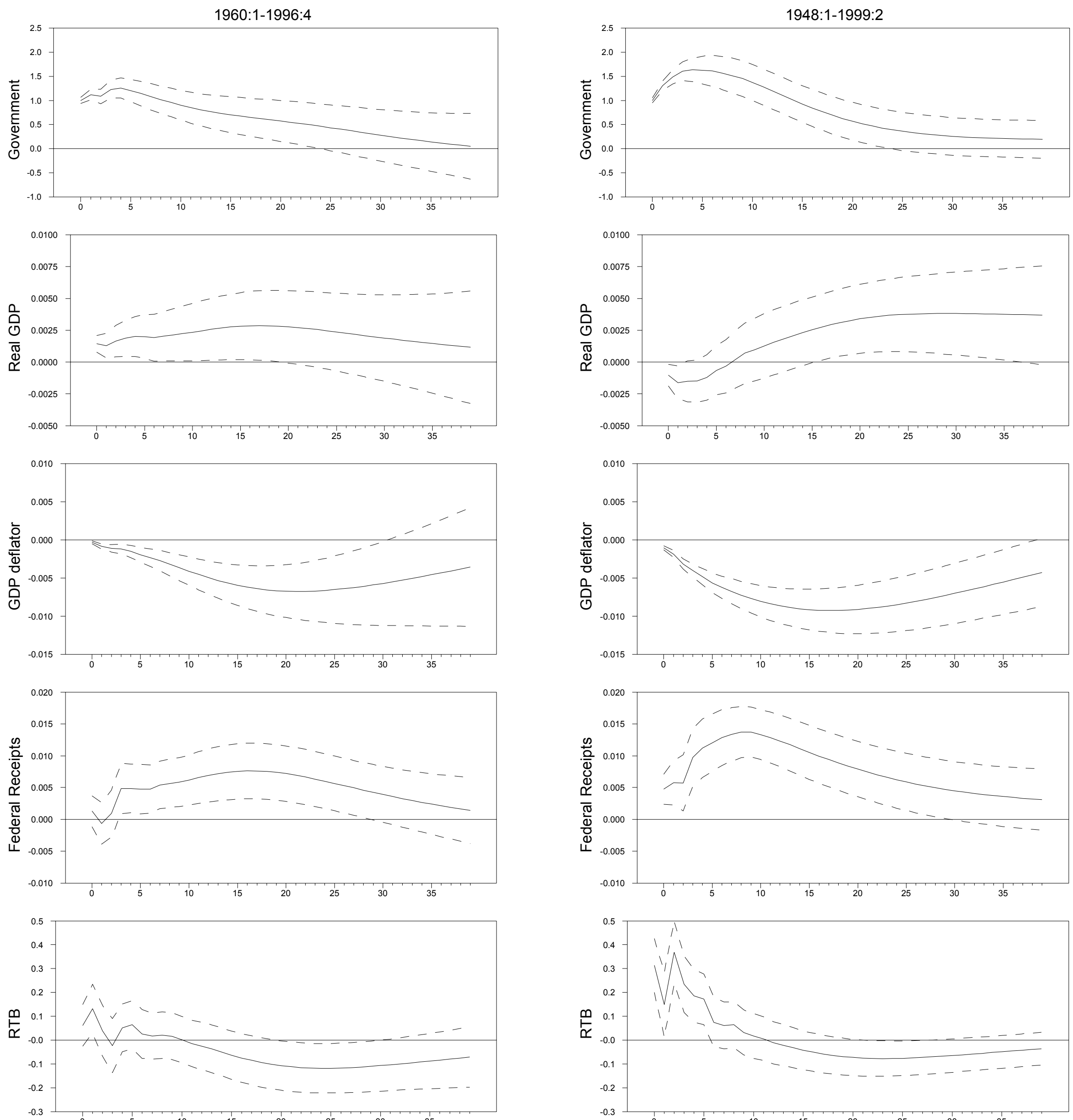

Figure 4.1: Point Estimates from Fatas and Mihov's Model

(2000). The second one spans 1948:1 to 1999:2, the one used in the previous chapters of the dissertation.

Following Fatas and Mihov (2000), IRFs that present the effects of a one standard deviation shock to government purchases are computed for the endogenous variables included in the benchmark model over a horizon of forty quarters. In Figure 4.1, the solid lines display the point estimates of the IRFs. The dashed lines display the lower and upper bounds of one-standard deviation confidence intervals computed using a Monte Carlo integration procedure.

For the sample period 1960:1 to 1996:4, the patterns of the IRFs for government purchases, real GDP, and real RTB computed using the correct data are similar to the ones reported by Fatas and Mihov (2000). However, the patterns of the IRFs computed for the GDP deflator and government receipts are substantially different from the ones reported by Fatas and Mihov (2000). Furthermore, the confidence intervals reported using the correct data are generally different from the ones presented by Fatas and Mihov (2000).

The IRF for the GDP deflator presented by Fatas and Mihov (2000) is slightly negative for more than six years after a shock to government purchases, and is marginally significant for two years. Then, it is slightly positive and not significantly different from zero. The IRF reported in Figure 4.1 is not positive at any horizon, and declines significantly for almost eight years after a shock to government purchases. Whereas the IRF for government receipts presented by Fatas and Mihov (2000) increases significantly in the period of a shock to government purchases, the one reported in Figure 4.1 increases significantly after a delay of several quarters.

Furthermore, the IRF for government purchases and real GDP presented by Fatas and Mihov (2000) increase significantly for ten years after a shock to government purchases. However, the IRF for government purchases reported in Figure 4.1 is significant for six years only. Similarly, the IRF for private GDP reported in Figure 4.1 is marginally significant for five years only.

Finally, the IRF for real RTB presented by Fatas and Mihov (2000) increases significantly for a couple of periods following a shock to government purchases, and then it declines gradually but is not significantly different from zero. However, the initial increase in real RTB reported in Figure 4.1 is very marginally significant and the ensuing decline is marginally significant for two years.

For the sample period 1948:1 to 1999:2, the IRFs for government purchases and the GDP deflator computed using the correct data are generally similar to the ones reported for the sample period 1960:1 to 1996:4. However, the IRFs for real private GDP, federal receipts, and RTB are different from the ones reported for the sample period 1960:1 to 1996:4.

The IRF for real private GDP reported for the sample period 1948:1 to 1999:2 is negative for more than six quarters after a shock to government purchases, and is very marginally significant for several quarters. Then, it increases slowly and is significant four years after a shock. The IRF for government receipts increases significantly in the period of a shock to government purchases. The IRF for RTB increases significantly for one and a half years after a shock to defense purchases. Then, it gradually declines and it is close to being significant at long horizons.

Overall, when the benchmark model presented by Fatas and Mihov (2000) is estimated using the correct values for government receipts and transfer payments, the results computed are troublesome. The IRFs for RTB and the GDP deflator reported for the sample periods 1960:1 to 1999:2 and 1948:1 to 1999:2 are inconsistent with the theoretical two-sector neoclassical models presented by Ramey and Shapiro (1997) and Edelberg, Eichenbaum, and Fisher (1999) as well as the more traditional IS-LM and one-sector neoclassical models. The IRF for real GDP reported for the sample period 1948:1 to 1999:2 is also inconsistent with most theoretical models of the effects of a shock to government purchases.

4.3 Benchmark Model

For comparison's sake, the benchmark model estimated in this section includes the same endogenous variables as the benchmark models estimated in the precedent chapters of the dissertation. They are defense purchases, real GDP, RTB, and the GDP deflator. However, it is not exactly identical to the benchmark models from the precedent chapters since it does not include a dummy variable for exogenous shocks to defense purchases.[3]

A constant and four lagged values of the endogenous variables are included in each equation of the benchmark model. The logarithmic values of the variables are used except for RTB. The system is estimated from 1948:1 to 1999:2 and data from 1947:1 to 1947:4 are used as pre-sample data. To identify the exogenous shocks to defense purchases, a Choleski decomposition is used.

As is done by Fatas and Mihov (2000), defense purchases are ordered first in the Choleski decomposition used to identify the exogenous shocks to defense purchases. Real total GDP is ordered second, RTB is ordered third, and the GDP deflator is ordered last.[4] It is assumed that shocks to defense purchases may have a contemporaneous effect on the other variables in the system; however, shocks to the other variables are constrained not have a contemporaneous effect on defense purchases.

Figure 4.2 presents the shocks to defense purchases identified using the Choleski decomposition when the benchmark model is estimated for the sample period 1948:1 to 1999:2. The shocks identified during the Korean War military build-up appear larger than the shocks identified in other periods. Otherwise, the shocks identified do not exhibit any particular pattern.

To present the effects of a unit shock to defense purchases, the IRFs for defense purchases, real total GDP, RTB, and the GDP deflator are computed when the benchmark model is estimated. In Figure 4.3, the solid lines display the point estimates of the IRFs. The dashed lines display the lower and upper bounds of one standard error confidence intervals computed using a Monte Carlo integration procedure.

The IRF for defense purchases computed for the benchmark model exhibits a hump-shaped pattern and is very persistent. It remains highly significant four years after a shock. The IRF for real GDP is small and the confidence interval reported is wide,

[3] The results computed when the Ramey-Shapiro dummy variable is added to the benchmark model are not significantly different from the ones reported from the benchmark model, except for RTB. See sub-section 4.6.3.

[4] In the ordering selected by Fatas and Mihov (2000) to identify exogenous shocks government purchases, the GDP deflator is ordered before real RTB. If the GDP deflator is ordered before RTB in the Choleski decomposition used to identify exogenous shocks to defense purchases in the benchmark model, the IRFs computed are essentially identical to the ones reported hereafter.

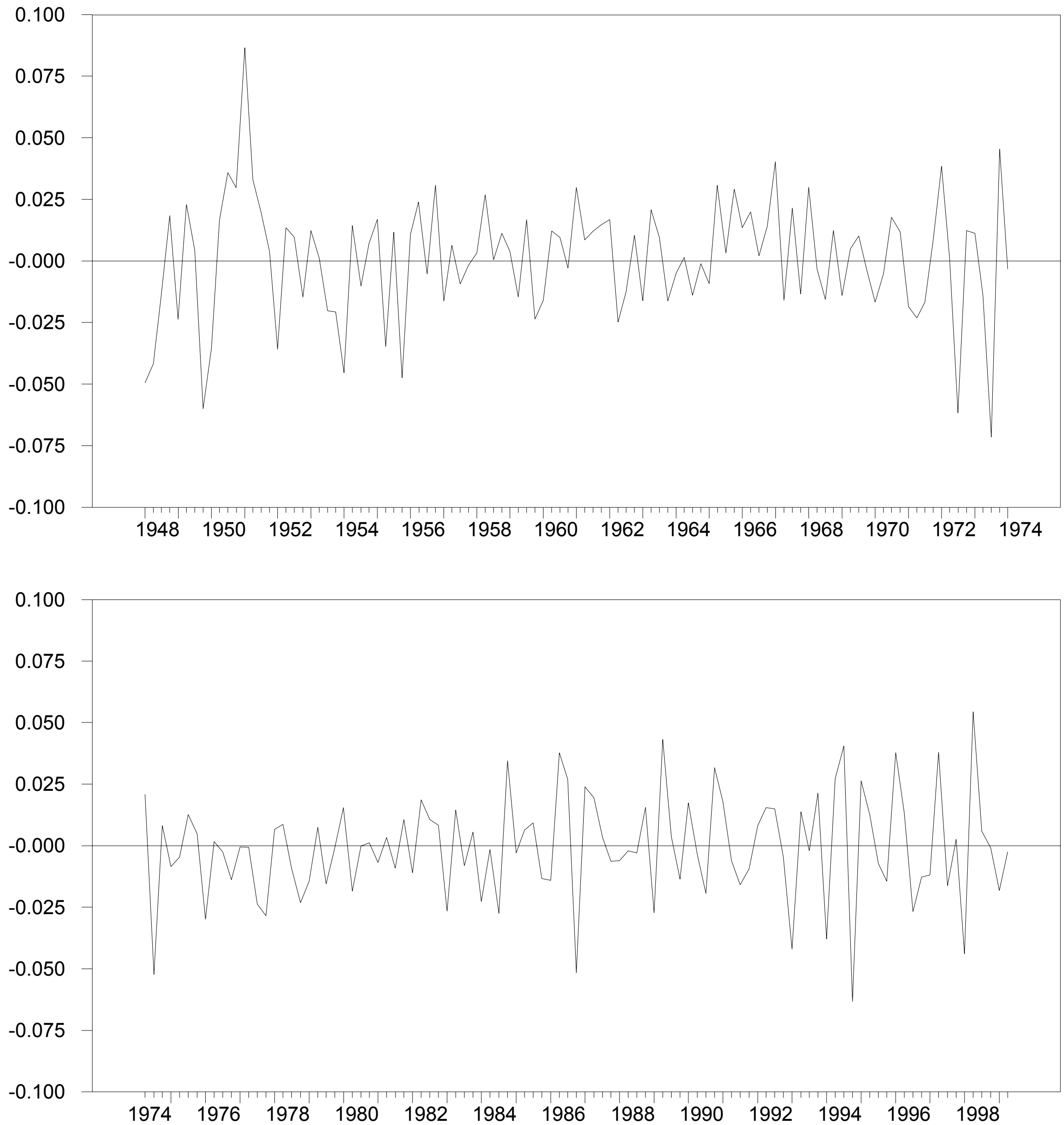

Figure 4.2: Shocks to Defense Purchases
Sample Period: 1948:1-1999:2

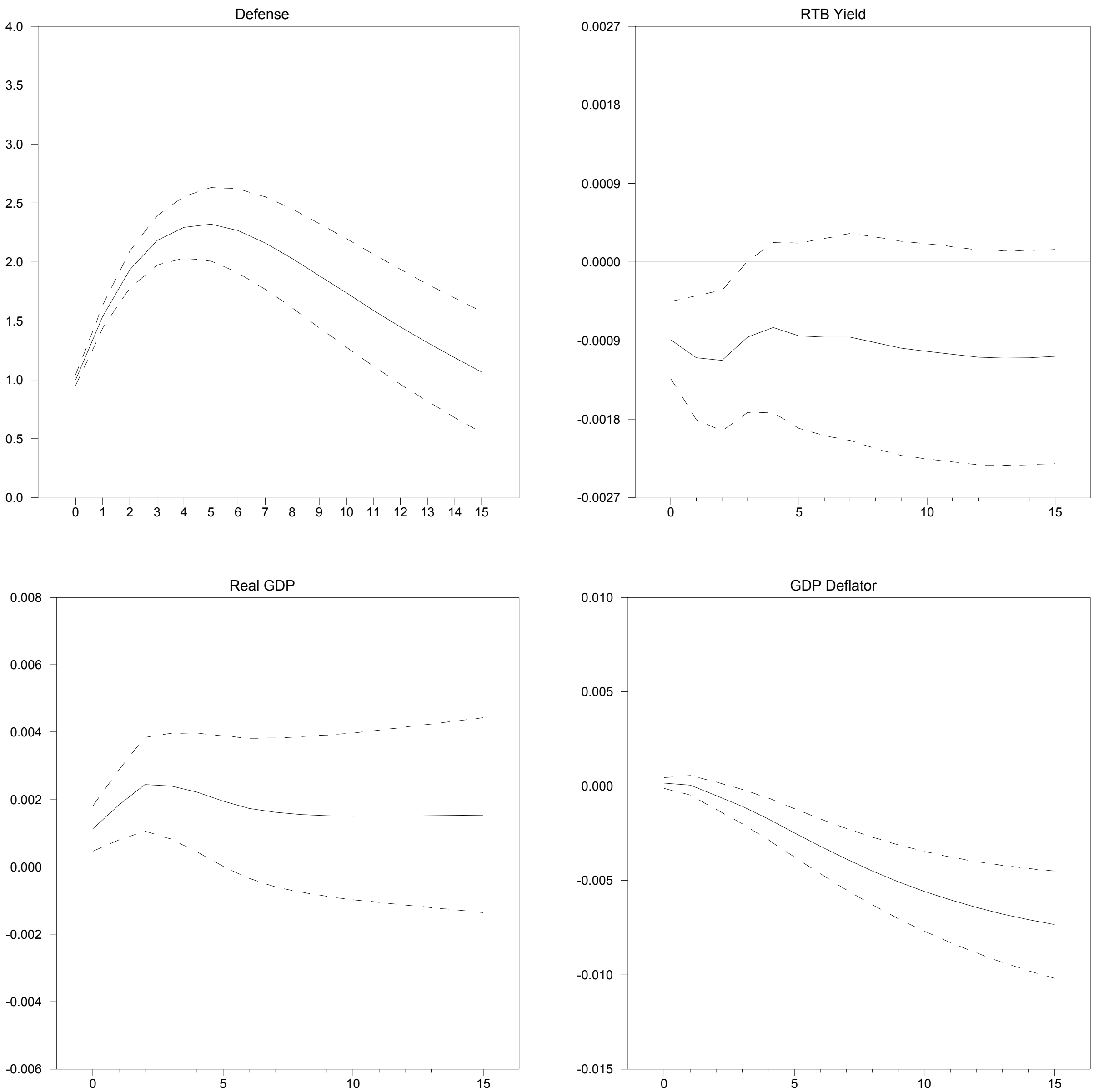

Figure 4.3: Point Estimates from Benchmark Model
Sample Period: 1948:1-1999:2

especially one and a half years after a shock. Nevertheless, it increases significantly for almost one and a half years after a shock to defense purchases.

The IRFs for RTB and the GDP deflator are inconsistent with the theoretical two-sector neoclassical models presented by Ramey and Shapiro (1997) and Edelberg, Eichenbaum, and Fisher (1999) as well as the more traditional IS-LM and one-sector neoclassical models. The IRF for RTB declines significantly for three quarters after a shock to defense purchases. Then, it remains negative, although it is no longer significantly different from zero. The IRF for the GDP deflator is very small for several periods after a shock. Then, it decreases significantly and very persistently.

Overall, like the results reported for Fatas and Mihov's model, the results presented for the benchmark model are troublesome. Although a shock to defense purchases appears to have a very persistent effect on defense purchases, the IRFs for RTB and the GDP deflator are inconsistent with the theoretical two-sector neoclassical models presented by Ramey and Shapiro (1997) and Edelberg, Eichenbaum, and Fisher (1999) as well as the more traditional IS-LM and one-sector neoclassical models.

Given the IRFs reported for RTB and the GDP deflator when the benchmark model is estimated, it is of interest to examine the sensitivity of the results computed for the benchmark model to the substitution of alternative measures of the price level and interest rates for the GDP deflator and RTB. First, the benchmark model is estimated when the consumer price index for all urban consumers (CPI), the producer price index for commodities (PCOM), and the producer price index (PPI) for finished goods are substituted, in turn, for the GDP deflator.

In Figure 4.4, the solid lines display the point estimates of the IRFs for defense purchases, real GDP, RTB, and the measures of price level substituted for the GDP deflator computed for a unit shock to defense purchases. The dashed lines display the lower and upper bounds of one-standard deviation confidence intervals.

When the alternative measures of the price level are substituted for the GDP deflator, the IRFs computed for defense purchases, real GDP, and RTB are very similar to the ones reported for the benchmark model. Furthermore, the IRF for the CPI is similar to the IRF for the GDP deflator. However, the IRFs for PCOM and the PPI for finished goods are larger than the IRF for the GDP deflator. Four years after a shock to defense purchases, the declines in PCOM and the PPI for finished goods are twice as large as the one reported for the GDP deflator.

Second, the benchmark model is estimated when real RTB and the nominal ten-year Treasury rate (LTR) are substituted, in turn, for nominal RTB in the benchmark model. In Figure 4.5, the solid lines display the point estimates of the IRFs for defense purchases, real GDP, the GDP deflator and the alternative measures of interest rates substituted for nominal RTB computed for a unit shock to defense purchases. The dashed lines display the lower and upper bounds of one-standard deviation confidence intervals

When real RTB or LTR is substituted for nominal RTB, the IRFs computed for defense purchases, real GDP, and the GDP deflator are similar to the ones reported for the benchmark model. The pattern of the IRF for real RTB is very different from the one reported for RTB. It exhibits a hump-shaped pattern, and increases significantly for more than two years. The IRF for LTR is negative at all horizons; however, it is not significantly different from zero at any horizon.

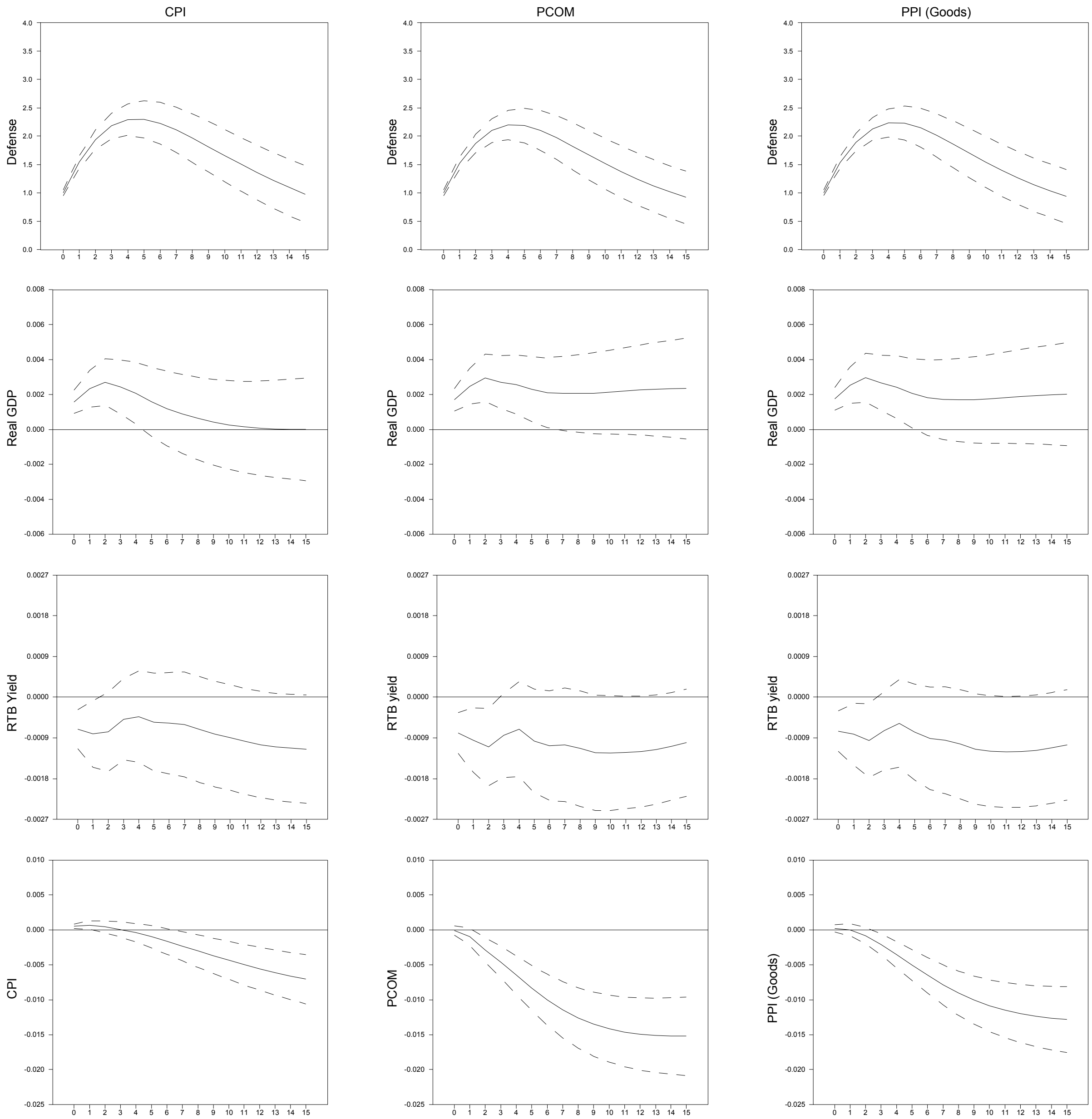

Figure 4.4: Point Estimates from Models With Alternative Measures of the Price Level
Sample Period: 1948:1-1999:2

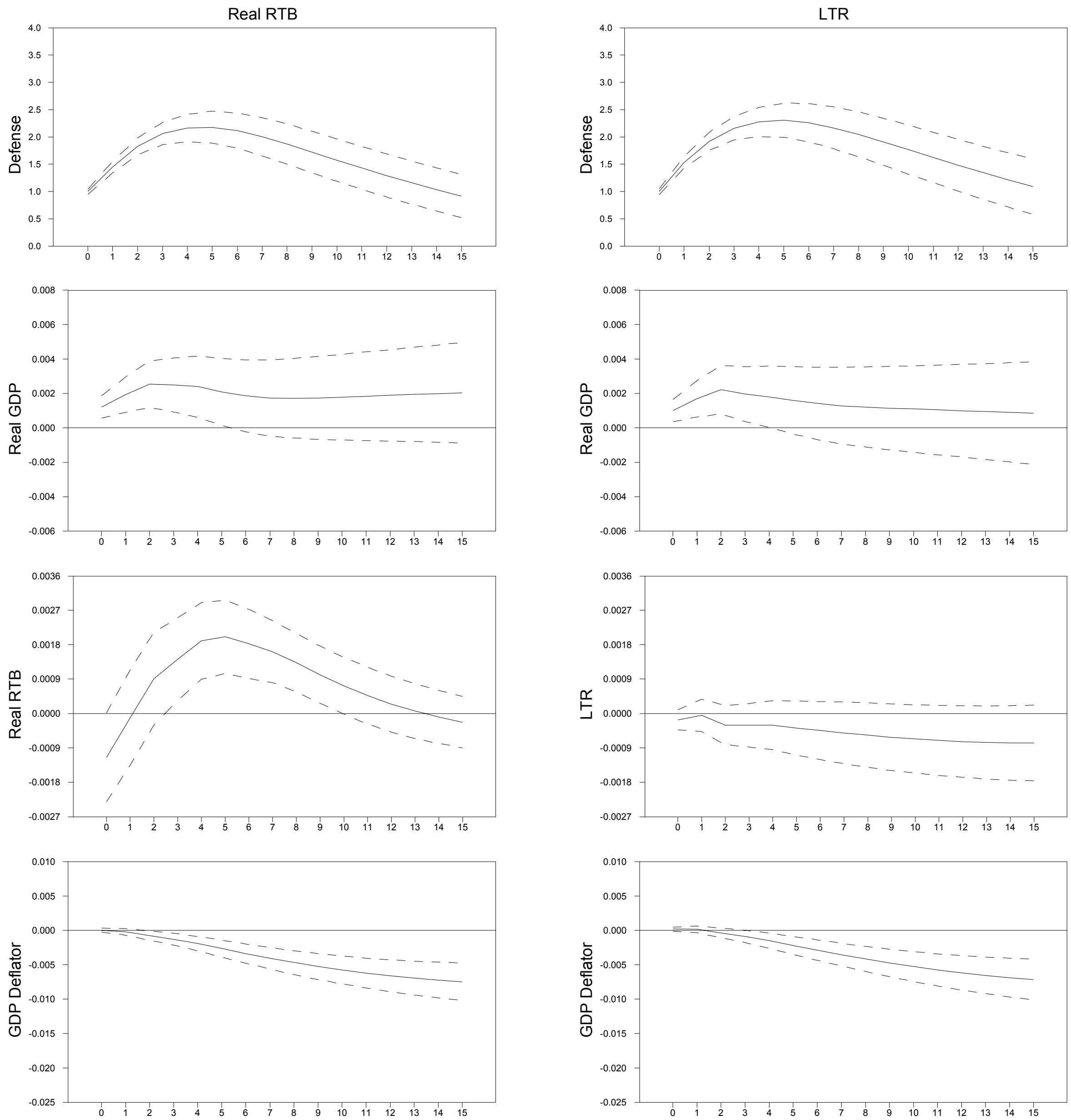

Figure 4.5: Point Estimates from Models With Alternative Measures of Interest Rates
Sample Period: 1948:1-1999:2

In conclusion, when different measures of the price level are substituted, in turn, for the GDP deflator in the benchmark model, the IRFs computed for defense purchases, real GDP, and RTB are similar to the ones reported for the benchmark model. Furthermore, like the IRF for the GDP deflator, the IRFs computed for the different measures of the price level are inconsistent with the theoretical two-sector neoclassical models presented by Ramey and Shapiro (1997) and Edelberg, Eichenbaum, and Fisher (1999) as well as the more traditional IS-LM and one-sector neoclassical models.

When real RTB or LTR is substituted for nominal RTB, the IRFs computed for defense purchases, real GDP, and the GDP deflator are similar to the ones reported for the benchmark model. Furthermore, the IRF for real RTB is consistent with the traditional IS-LM model. However, it should be noted that the increase in real RTB reported in Figure 4.5 appears driven by the decrease in the inflation rate, not an increase in nominal interest rates.

4.4 Alternative Time Trends and Lag Lengths

To compare the implications of using the Choleski decomposition and the narrative approaches presented in the previous chapters of the dissertation for estimating the effects of a shock to defense purchases, four lagged values of the endogenous variables are included in each equation of the benchmark model. Furthermore, no time trend is included. However, this specification may not be the most appropriate for the VAR system under study, and the results reported for the benchmark model may be sensitive to adding a time trend and changing the lag length used.

This section presents statistical evidence on the selection of an appropriate time trend and an adequate lag length for the variables included in the VAR system under study. It also investigates the sensitivity of the results reported for the benchmark model to adding a time trend and changing the lag length used. The methodology followed is exactly identical to the one presented in the previous chapters of the dissertation.

4.4.1 Time Trend

To select an appropriate time trend for the VAR system under study, models in which different types of time trend are added, in turn, to each equation of the benchmark model are estimated, and the corresponding Akaike Information Criterion (AIC) and Schwartz Bayesian Criterion (SBC) values are computed. Systems with no time trend, a linear trend only, linear and quadratic trends, and a "Perron-type" time trend are considered.[5] The preferred specification is the one that minimizes the AIC and SBC values.

A series of likelihood ratio test statistics is also computed. First, the null hypothesis of no time trend is tested against the alternatives of a linear trend only, linear and quadratic trends, and a "Perron-type" trend. Second, the null hypothesis of a linear trend only is tested against the alternatives of linear and quadratic trends and a "Perron-type" trend.

Table 4.1 reports the AIC and SBC values computed when the benchmark model is estimated under the alternative assumptions for the time trend. The AIC criterion implies that it is better to include a "Perron-type" time trend in the system under study. The SBC criterion implies that it is preferable not to include a time trend.

[5] The "Perron-type" time trend and the other time trends included in this chapter are discussed in detail in the second chapter of the dissertation.

Table 4.1: AIC and SBC Values for Time Trend
Benchmark Model (1948:1-1999:2)

Type of time trend	Aikaike's Information Criterion	Schwarz's Criterion
No trend	-5852.16	-5625.87
Linear trend only	-5862.86	-5623.25
"Perron-type"	-5871.03	-5618.11
Linear and quadratic trend	-5807.18	-5581.22

Table 4.2 reports the results of the likelihood ratio tests carried out. In every test, the null hypothesis is rejected. Thus, it is implied that including any type of time trend is better than including no time trend. Furthermore, it is implied that including a "Perron-type" trend or linear and quadratic trends is better than including a linear trend only.

Table 4.2: Likelihood Ratio Tests for Time Trend
Benchmark Model (1948:1-1999:2)

Null hypothesis	Alternative	Test value	P-value
No time trend	Linear trend only	16.61*	0.0023
No time trend	Linear and Quadratic trend	30.81**	0.0002
No time trend	"Perron-type" trend	35.88**	0.0000
Linear trend only	Linear and Quadratic trend	14.29*	0.0064
Linear trend only	"Perron-type" trend	19.36*	0.0130

* 4 restrictions are imposed. The critical value at a 5% significance level for a chi-square distribution with 4 degrees of freedom is 9.49.
** 8 restrictions are imposed. The critical value at a 5% significance level for a chi-square distribution with 8 degrees of freedom is 15.51.

While the statistical evidence reported above implies that it may be better to include linear and quadratic trends or a "Perron-type" trend to the benchmark model, the addition of time trends may not significantly affect the results reported for the benchmark model. If the results reported for the benchmark model are not sensitive to adding time trends, the IRFs computed for the models with time trends ought to lie within the corresponding confidence intervals reported for the benchmark model.

In Figure 4.6, the solid lines display the point estimates of the IRFs for defense purchases, real GDP, RTB, and the GDP deflator computed for a unit shock to defense purchases when the models with linear and quadratic trends or a "Perron-type" trend are estimated. The dashed lines display the confidence intervals computed for the benchmark model.

All the IRFs computed for the models with linear and quadratic trends or a "Perron-type" trend lie within the corresponding confidence intervals from the benchmark model at all horizons. Furthermore, they appear very similar to the IRFs reported for the benchmark model. Therefore, it is concluded that the results reported for the benchmark model are not sensitive to adding time trends. In particular, whether linear and quadratic trends or a "Perron-type" trend are used, the IRFs for RTB and the GDP deflator remain troublesome.

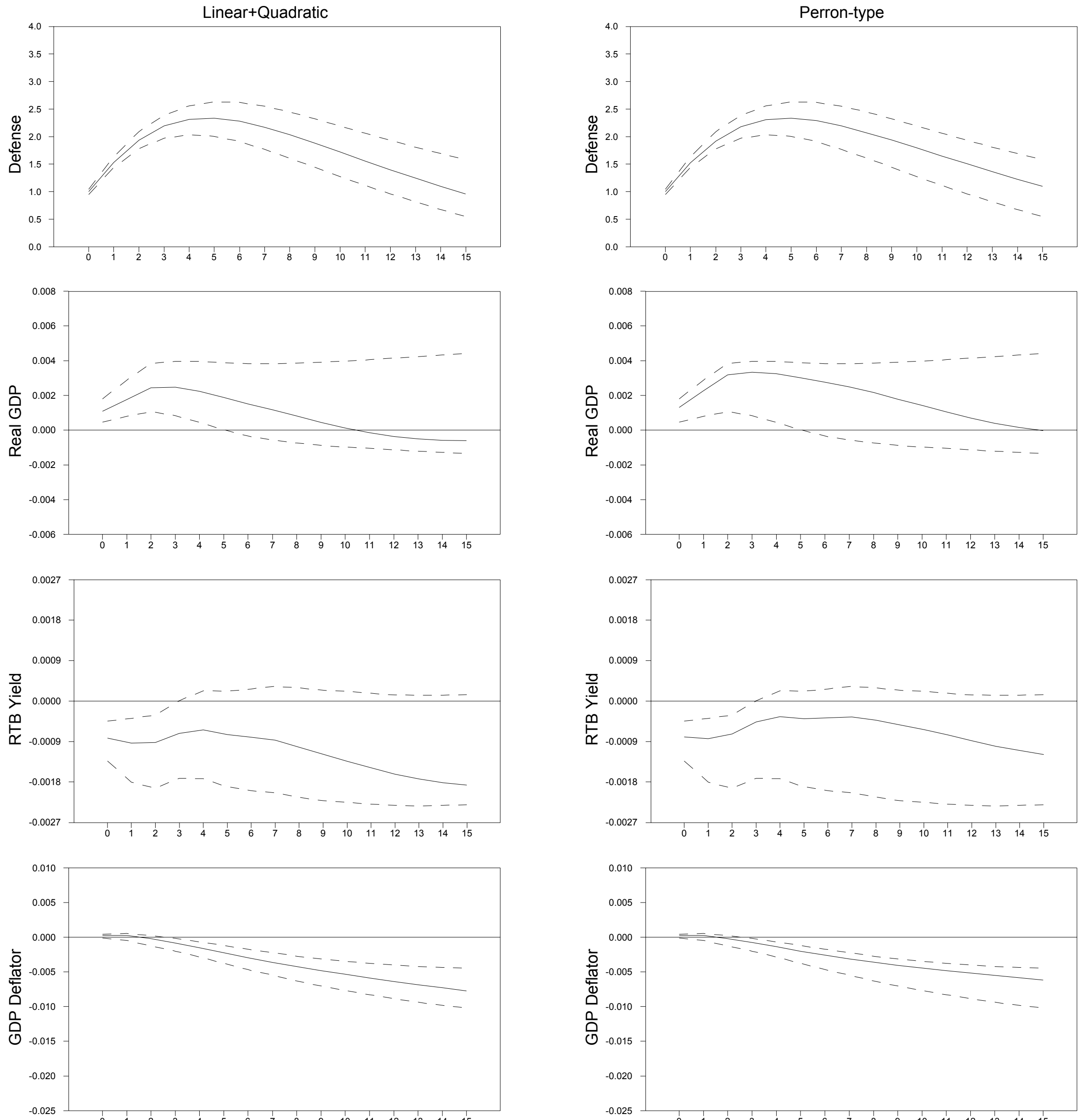

Figure 4.6: Point Estimates from Models with Alternative Time Trends
Confidence Intervals from Benchmark Model

4.4.2 Lag Length

First, VAR systems identical to the benchmark model except for the lag length used are estimated, and the corresponding AIC and SBC values are computed. Systems with one to eight lags of the endogenous variables are considered. The preferred lag length is the one that minimizes the AIC and SBC values. Second, a sequence of likelihood ratio tests is computed. The null hypothesis of seven lags versus the alternative of eight lags is tested, and then the null hypothesis of six lags versus the alternative seven lags, and so on.

Table 4.3 reports the AIC and SBC values computed for the VAR systems in which one to eight lagged values of the variables are included.[6] According to the AIC criterion, it is better to include six lagged values of the variables in the VAR system under study. The SBC criterion implies that including two lagged values is preferable.

Table 4.3: AIC and SBC Values for Lag Length
Benchmark Model (1949:1-1999:2)

Number of lags	Aikaike's Information Criterion	Schwarz's Criterion
1	-5572.34	-5479.71
2	-5743.58	-5598.01
3	-5766.16	-5567.66
4	-5782.00	-5530.57
5	-5780.55	-5476.19
6	-5832.56	-5475.27
7	-5818.94	-5408.71
8	-5808.75	-5345.57

Table 4.4 reports the results of the likelihood ratio tests carried out. The likelihood ratio statistics reported imply that the null hypotheses of seven and six lags cannot be rejected; however, the null hypothesis of five lags can be rejected. Therefore, based on the likelihood ratio tests, it is better to include six lagged values of the variables.

Table 4.4: Likelihood Ratio Tests for Lag Length
Benchmark Model (1949:1-1999:2)

Null hypothesis	Alternative	Test value*	P-value
Lag length = 7	Lag length =8	16.72	0.6713
Lag length = 6	Lag length = 7	20.48	0.4282
Lag length = 5	Lag length = 6	30.20	0.0000

* For every test we impose 20 restrictions. The critical value at a 5% significance level for a chi-square distribution with 20 degrees of freedom is 31.41.

Although the statistical evidence reported above implies that it is better to include two or six lagged values of the variables in the VAR system under study, altering the lag

[6] For comparison's sake, the AIC and SBC values and the likelihood ratio statistic are computed when the corresponding systems are estimated over the period from 1949:1 to 1999:2.

length used may not affect the results reported for the benchmark model. Therefore, the effects of using two and six lagged values of the variables on the results reported for the benchmark model are examined.

If the benchmark model is not sensitive to the lag length used, the IRFs computed for the models with two and six lags ought to lie within the corresponding confidence intervals from the benchmark model. In Figure 4.7, the solid lines display the point estimates of the IRFs for defense purchases, real GDP, RTB, and the GDP deflator computed for a unit shock to defense purchases when the models with two or six lags of the endogenous variables are estimated. The dashed lines display the confidence intervals computed for the benchmark model.

All the IRFs computed for the model with two lags lie within the confidence intervals from the benchmark model at all horizons, and they are very similar to the IRFs reported for the benchmark model. The IRF for defense purchases reported for the model with six lags lies very slightly below the lower bound of the confidence interval from the benchmark model for more than one and a half years, and then it lies within the confidence interval. However, the IRFs for real GDP, RTB, and the GDP deflator reported for the model with six lags lie within the corresponding confidence intervals from the benchmark model at all horizons.

In conclusion, except for the IRF for defense purchases computed for the model with six lags, all the IRFs reported for the models with two and six lags lie within the corresponding confidence intervals from the benchmark model at all horizons. The IRF for defense purchases computed for the model with six lags is marginally different from the one reported for the benchmark model. Therefore, it is concluded that the results reported for the benchmark model are not sensitive to changing the lag length used, except for defense purchases. In particular, whether two or six lagged values of the variables are used, the IRFs for RTB and the GDP deflator remain troublesome.

4.5 Alternative Model

The evidence reported in the last section suggests that the specification of the equations selected for the benchmark model, which is the one used by Edelberg, Eichenbaum, and Fisher (1999), may not be the best for the VAR system under study. Therefore, AIC values are computed when twelve models that include defense purchases, real GDP, RTB, and the GDP deflator are estimated using with different lag lengths and time trends.

Models with two, four, six and eight lagged values of the variables are considered as well as with no time trend, linear and quadratic trends, and a “Perron-type” trend. The model that yields the lowest AIC value is selected as the alternative model. The AIC values computed for the different models are reported in Table 4.5. As for the VAR systems with a dummy variable for exogenous shocks to defense purchases examined in the previous chapters, they indicate that the model with six lags and a “Perron-type” time trend represents the best specification for the system under study.

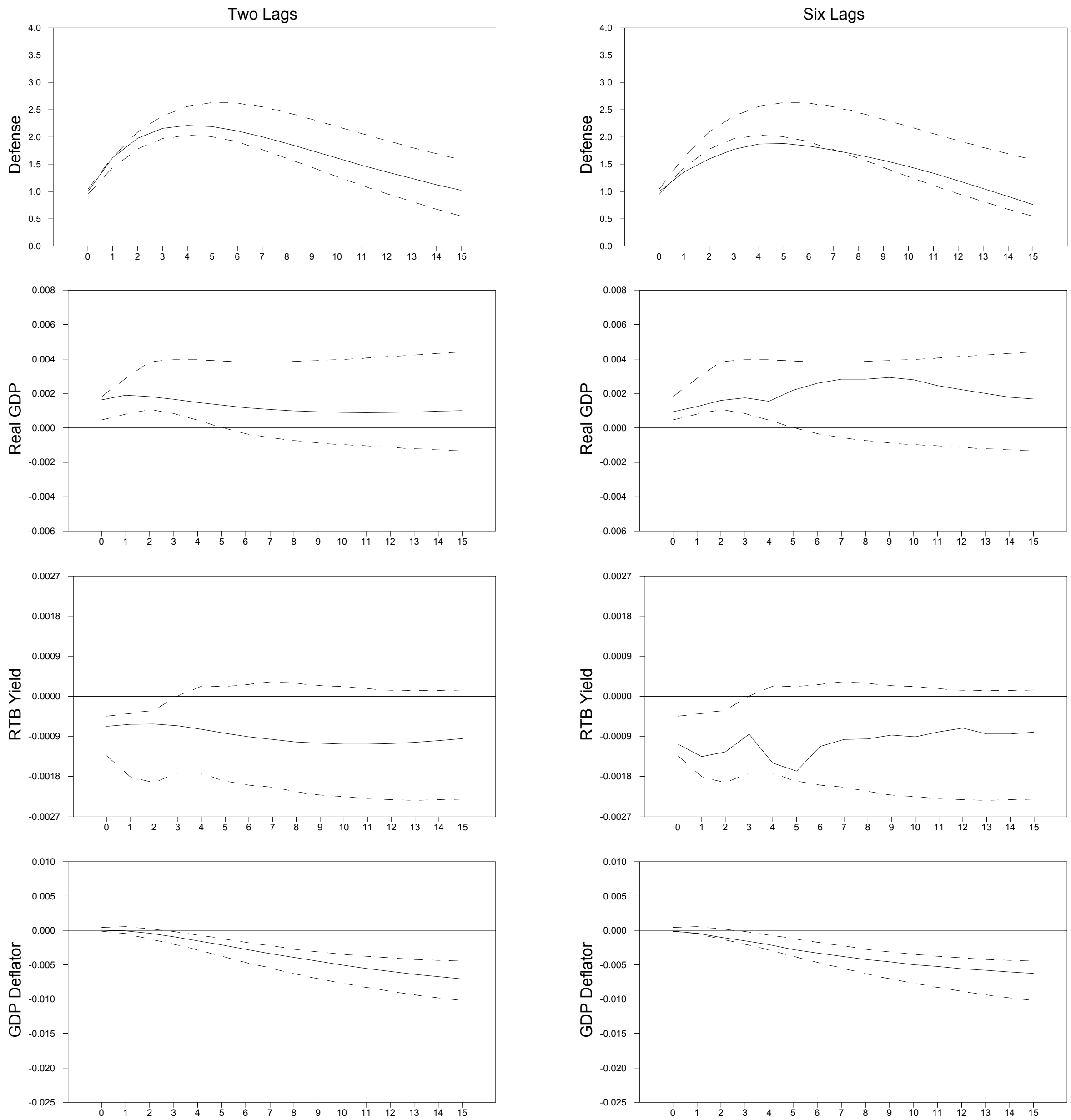

Figure 4.7: Point Estimates from Models with Alternative Lag lengths
Confidence Intervals from Benchmark Model

Table 4.5: AIC Values for Various Time Trends and Lag Lengths
Benchmark Model (1948:3-1999:2)

Number of lags	No Time Trend	Linear and Quadratic Trend	"Perron-type" Trend
2	-5715.45	-5738.87	-5743.57
4	-5753.81	-5773.51	-5782.00
6	-5805.71	-5829.91	-5832.56
8	-5785.93	-5808.39	-5808.75

In the first column of Figure 4.8, the solid lines display the point estimates of the IRFs for defense purchases, real GDP, RTB, and the GDP deflator computed for a unit shock to defense purchases when the alternative model is estimated. The dashed lines display the lower and upper bounds of one-standard deviation confidence intervals. The main difference between the benchmark and alternative models is found in the response of real GDP.

The IRF for real GDP reported for the alternative model increases significantly for three years after a shock to defense purchases, compared to one and a half years for the benchmark model. Furthermore, the IRFs for RTB and the GDP deflator are problematic. The IRF for RTB is significantly negative for a couple of periods immediately after a shock to defense purchases, and then it is not significantly different from zero. The IRF for the GDP deflator is very small and is not significantly different from zero for a year. Then, it begins to decrease steadily, and is significant after a delay of less than two years.

To further compare the results reported for the benchmark and alternative models, the IRFs for defense purchases, real GDP, RTB, and the GDP deflator computed for the benchmark model are plotted against the corresponding confidence intervals from the alternative model, which is the preferred model. If the IRFs computed for the benchmark model are not significantly different from the IRFs reported for the alternative model, they ought to lie within the corresponding confidence intervals from the alternative model.

In the second column of Figure 4.8, the solid lines display the point estimates of the IRFs reported for the benchmark model. The dashed lines display the confidence intervals computed for the alternative model. The IRF for defense purchases lies very slightly above the upper bound of the confidence interval from the alternative model for more than a year, and then it lies close to the upper bound of the confidence interval.

The IRF for real GDP computed for the benchmark model lies within the confidence interval from the alternative model until the end of the fourth year after a shock to defense purchases. After a delay of one and a half years, the IRF for RTB lies very slightly below the lower bound of the confidence interval from the alternative model for more than a year. After a delay of one and a half years, the IRF for the GDP deflator lies permanently below the lower bound of the confidence interval from the alternative model.

In conclusion, according to the AIC criterion, it seems preferable to estimate an alternative model with a "Perron-type" trend as well as six lagged values of the

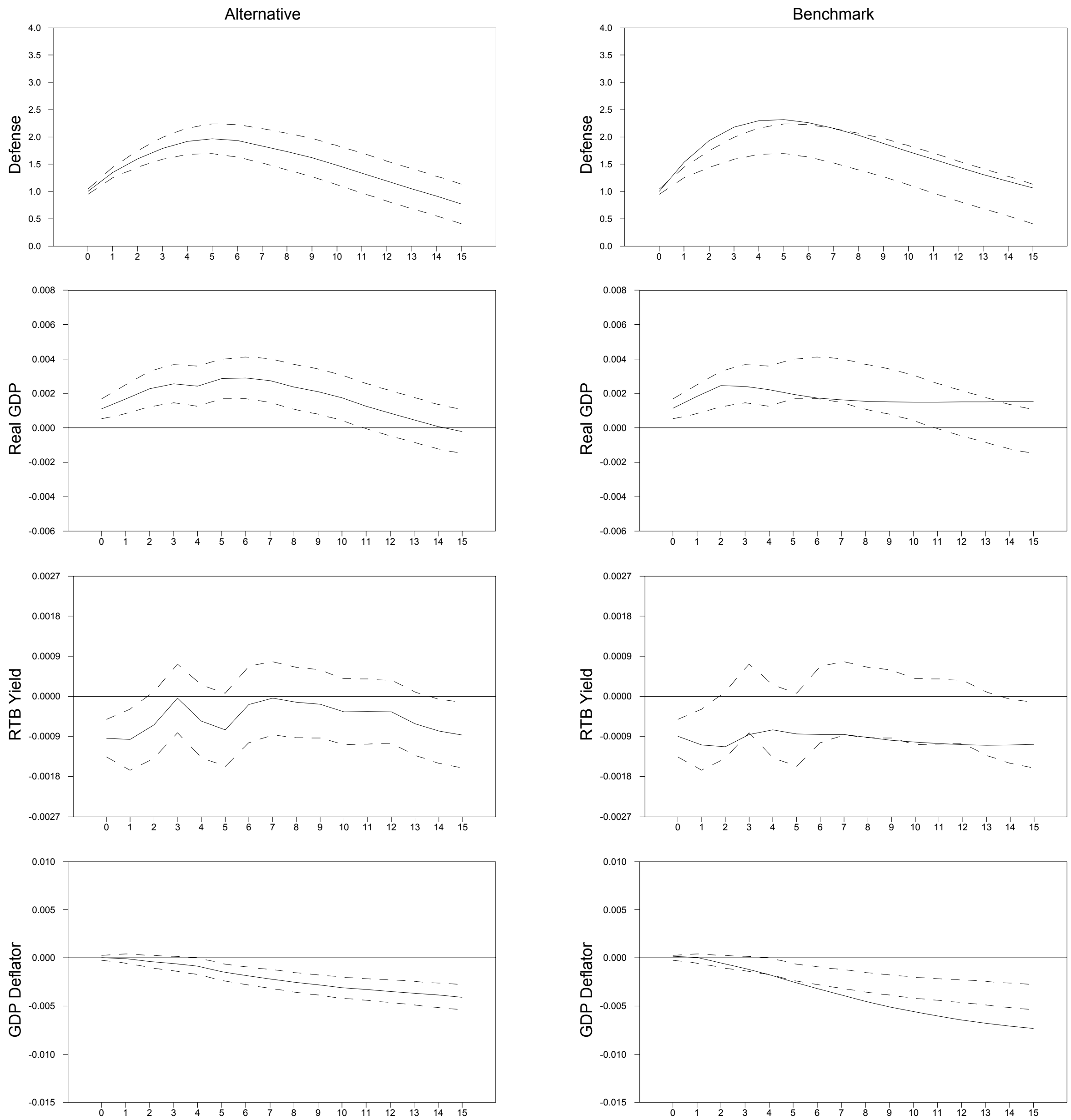

Figure 4.8: Point Estimates from Alternative Model and Benchmark Model
Confidence Interval from Alternative Model

endogenous variables. The alternative model selected in this section follows the same specification as the alternative models presented in the previous chapters.

Except for the GDP deflator, the IRFs presented for the alternative model are only moderately different from the ones reported for the benchmark model. The IRF for the GDP deflator presented for the alternative model is persistently smaller than the one reported for the benchmark model. Furthermore, as for the benchmark model, the IRFs for RTB and the GDP deflator computed for the alternative model are inconsistent with the theoretical two-sector neoclassical models presented by Ramey and Shapiro (1997) and Edelberg, Eichenbaum, and Fisher (1999) as well as the more traditional IS-LM and one-sector neoclassical models.

4.6 Extended Models

As was mentioned before, Edelberg, Eichenbaum, and Fisher (1999) argue that inference reported using the Choleski decomposition appears fragile to perturbations in the list of variables used. Garcia-Mila (1989), and Yuan and Li (1999) do not address this issue. Fatas and Mihov (2000) estimate an extended model to examine the robustness of the IRFs computed for their benchmark model; however, they do not report their results.

This section investigates the sensitivity of the results reported for defense purchases, real GDP, RTB, and the GDP deflator to adding an endogenous variable or an exogenous dummy variable to the alternative model. Eighteen variables are considered. They are the ones used in the studies of the narrative approaches presented in the previous chapters of the dissertation. First, the effects of the shocks to defense purchases in models that alternatively include fiscal variables are examined. Then, the effects of the shocks in models that alternatively include consumption, investment, and labor market variables are investigated.

Next, the effects of the shocks in models that alternatively include the Romers' monetary policy dummy variable, the monetary base, a measure of long-term interest rates, Hamilton's oil price dummy variable, the PPI for crude fuel, and the Ramey-Shapiro dummy variable are presented. The Ramey-Shapiro dummy variable is added to the alternative model to control for the effects of the major military build-ups that took place in the post-World War II era, in particular the Korean War and Vietnam War build-ups, on the results reported for the alternative model.

The methodology used to examine the sensitivity of the results reported for the alternative model to adding any of the variables under consideration is the same as the one presented in the previous chapters for the narrative approaches. First, an extended version of the alternative model is estimated that includes defense purchases, real GDP, RTB, the GDP deflator, and the variable under consideration. Six lagged values of the variable under consideration are included if it is endogenous. The contemporaneous and six lagged values are included if it is an exogenous dummy variable.

Then, the IRFs for defense purchases, real GDP, RTB, and the GDP deflator are computed for a unit shock to defense purchases and plotted against the corresponding confidence intervals reported for the alternative model. If the results reported for the alternative model are not sensitive to perturbations in the list of variables used, the IRFs computed for the extended model ought to lie within the corresponding confidence intervals from the alternative model.

4.6.1 Fiscal Variables

This sub-section presents evidence on the effects of shocks to defense purchases in models that alternatively include non-defense purchases, real federal government receipts, and the real federal government deficit. The logarithmic values of the fiscal variables are used except for the deficit, which takes negative values. To construct the measures of real federal government receipts and the real federal government deficit, the current values of these variables in billions of dollars are deflated by the CPI. Non-defense purchases are in billions of chained (1992) dollars.[7]

It is presumed that decisions with regard to defense purchases come before decisions with regard to non-defense purchases, real federal government receipts, and the real federal government deficit.[8] Therefore, defense purchases are ordered first in the Choleski decomposition used to identify the shocks to defense purchases. The fiscal variable under study is ordered second, real GDP is ordered third, RTB is ordered fourth, and the GDP deflator is ordered last. Shocks to the fiscal variables under study are constrained not to have a contemporaneous effect on defense purchases; however, they may have a contemporaneous effect on real GDP, RTB and the GDP deflator.

In Figure 4.9, the point estimates of the IRFs for defense purchases, real GDP, RTB, and the GDP deflator computed when the fiscal variables are added, in turn, to the alternative model are plotted against the corresponding confidence intervals from the alternative model. The solid lines display the point estimates of the IRFs. The dashed lines display the confidence intervals from the alternative model, which are presented in the previous section.

When non-defense purchases or real federal government receipts are added to the alternative model, the IRFs computed for defense purchases lie very slightly below the lower bound of the confidence interval from the alternative model in the second year after a shock to defense purchases. When the real federal government deficit is added to the alternative model, the IRF computed for defense purchases lies within the confidence interval from the alternative model at all horizons.

The IRFs for real GDP, RTB and the GDP deflator computed for all the models with an additional fiscal variable lie on or within the corresponding confidence intervals from the alternative model at all horizons. However, it is noted that the IRF for the GDP deflator computed for the model with non-defense purchases lies persistently on the lower bound of the confidence from the corresponding confidence intervals.

Overall, except for defense purchases, the IRFs computed when fiscal variables are added, in turn, to the alternative model are not significantly different from the corresponding IRFs reported for the alternative model at any horizon. The IRFs for defense purchases computed for the models with non-defense purchases and real federal government receipts are marginally and temporarily smaller than the one reported for the alternative model. Therefore, it is concluded that the results reported for the alternative model are not very sensitive to adding fiscal variables.

[7] The different extended models estimated in this section and the variables included in these extended models are identical to the ones presented in the previous chapters. They are more thoroughly discussed in the first chapter of the dissertation.

[8] Similar assumptions are made by Blanchard and Perotti (1999) and Fatas and Mihov (2000).

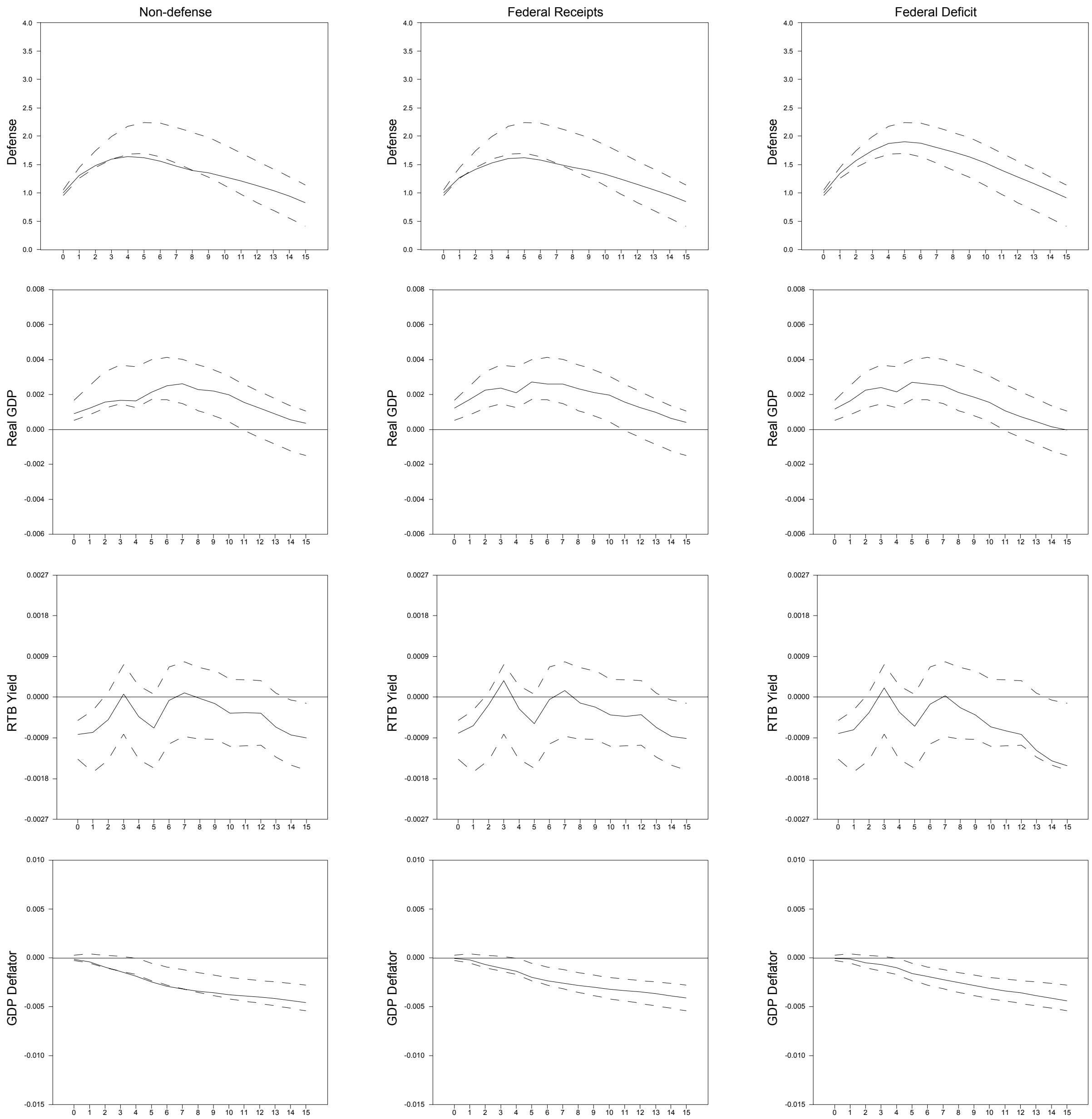

Figure 4.9: Point Estimates from Models with a Fiscal Variable
Confidence Interval from Alternative Model

4.6.2 Sectoral Variables

This sub-section presents evidence on the effects of shocks to defense purchases in models that alternatively include components of consumption and investment. Following Edelberg, Eichenbaum, and Fisher (1999), consumption and investment are broken down into three components: consumption of non-durables and services, residential investment plus consumption of durables, and non-residential investment.

This sub-section also presents evidence on the effects of shocks to defense purchases in models that alternatively include measures of employment, real wages, and real compensation. First, employment in the private sector, employment in the non-durables manufacturing sector, and employment in the durables manufacturing sector are examined. Then, real wages in private industry, real compensation in the manufacturing sector, and real compensation in the business sector are considered.

The logarithmic values of the measures of consumption, investment, employment, real wages and real compensation are included in the models estimated. To construct the measures of real compensation and real wages, the nominal values of these variables are deflated by the CPI. The other additional sectoral variables examined hereafter are in billions of chained (1992) dollars.

The measures of consumption, investment, employment, real wages and real compensation are ordered last in the Choleski decomposition used to identify shocks to defense purchases. Defense purchases are ordered first, real GDP is ordered second, RTB is ordered third, and the GDP deflator is ordered fourth. It is assumed that shocks to the sectoral variables are constrained not to have a contemporaneous effect on the other variables in the systems estimated; however, shocks to the other variables in the systems may affect the sectoral variables contemporaneously.

In Figure 4.10, the point estimates of the IRFs for defense purchases, real GDP, RTB, and the GDP deflator computed when the consumption and investment variables listed above are added, in turn, to the alternative model are plotted against the corresponding confidence intervals from the alternative model. The solid lines display the point estimates of the IRFs. The dashed lines display the confidence intervals from the alternative model. All the IRFs reported for the models with a component of consumption and investment lie well within the corresponding confidence intervals from the alternative model at all horizons.

In Figure 4.11, the point estimates of the IRFs for defense purchases, real GDP, RTB, and the GDP deflator computed when employment in private industry, employment in the non-durables manufacturing sector, and employment in the durables manufacturing sector are added, in turn, to the alternative model are plotted against the corresponding confidence intervals from the alternative model. The solid lines display the point estimates of the IRFs. The dashed lines display the confidence intervals from the alternative model.

When employment in private industry or employment in the non-durables manufacturing sector is added to the alternative model, all the IRFs reported lie well within the corresponding confidence intervals from the alternative model at all horizons. When employment in the durables manufacturing sector is added to the alternative model, the IRFs for defense purchases and the GDP deflator lie within or on the corresponding confidence intervals from the alternative model.

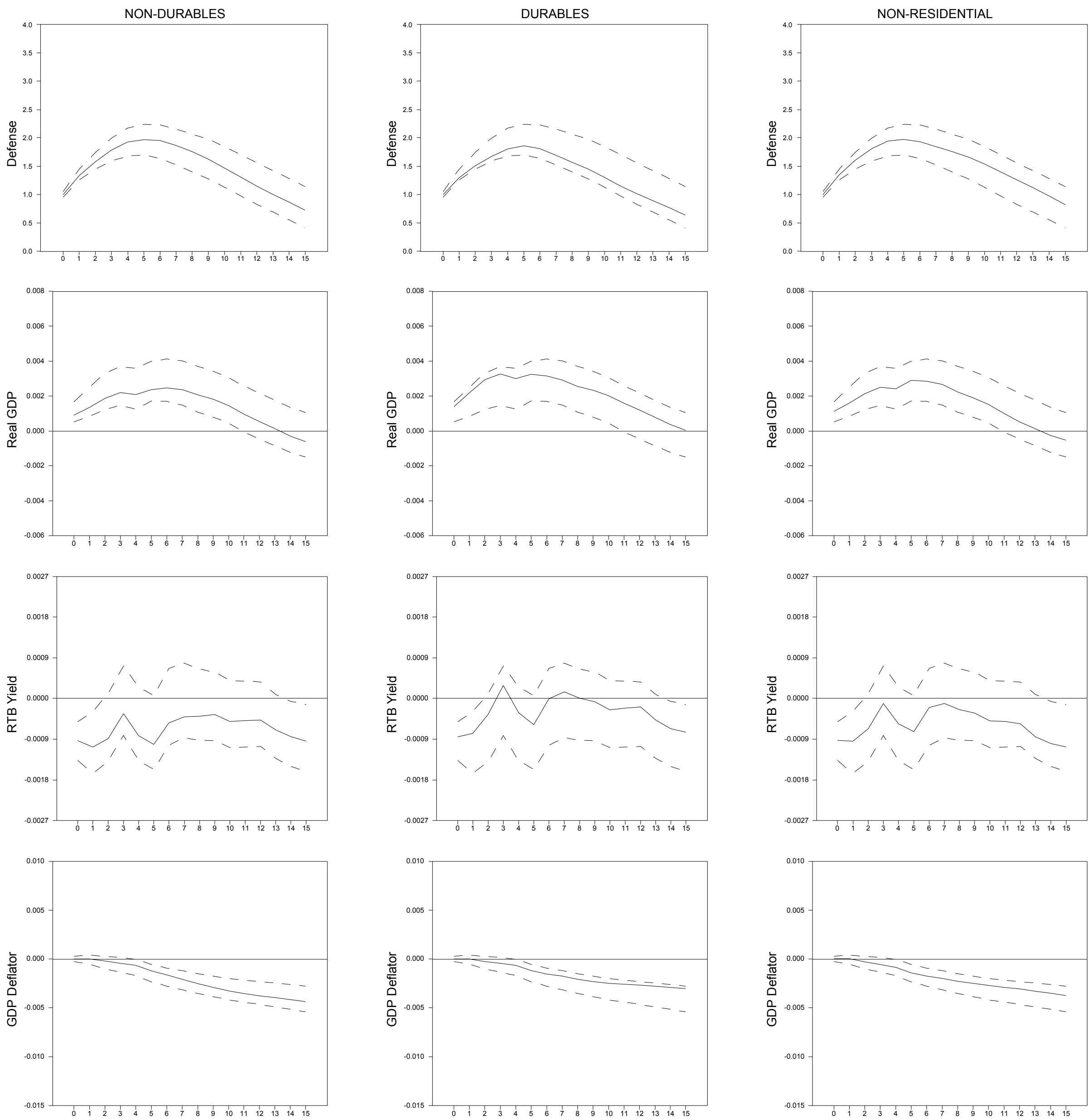

Figure 4.10: Point Estimates from Models with a Consumption or Investment Variable
Confidence Intervals from Alternative Model

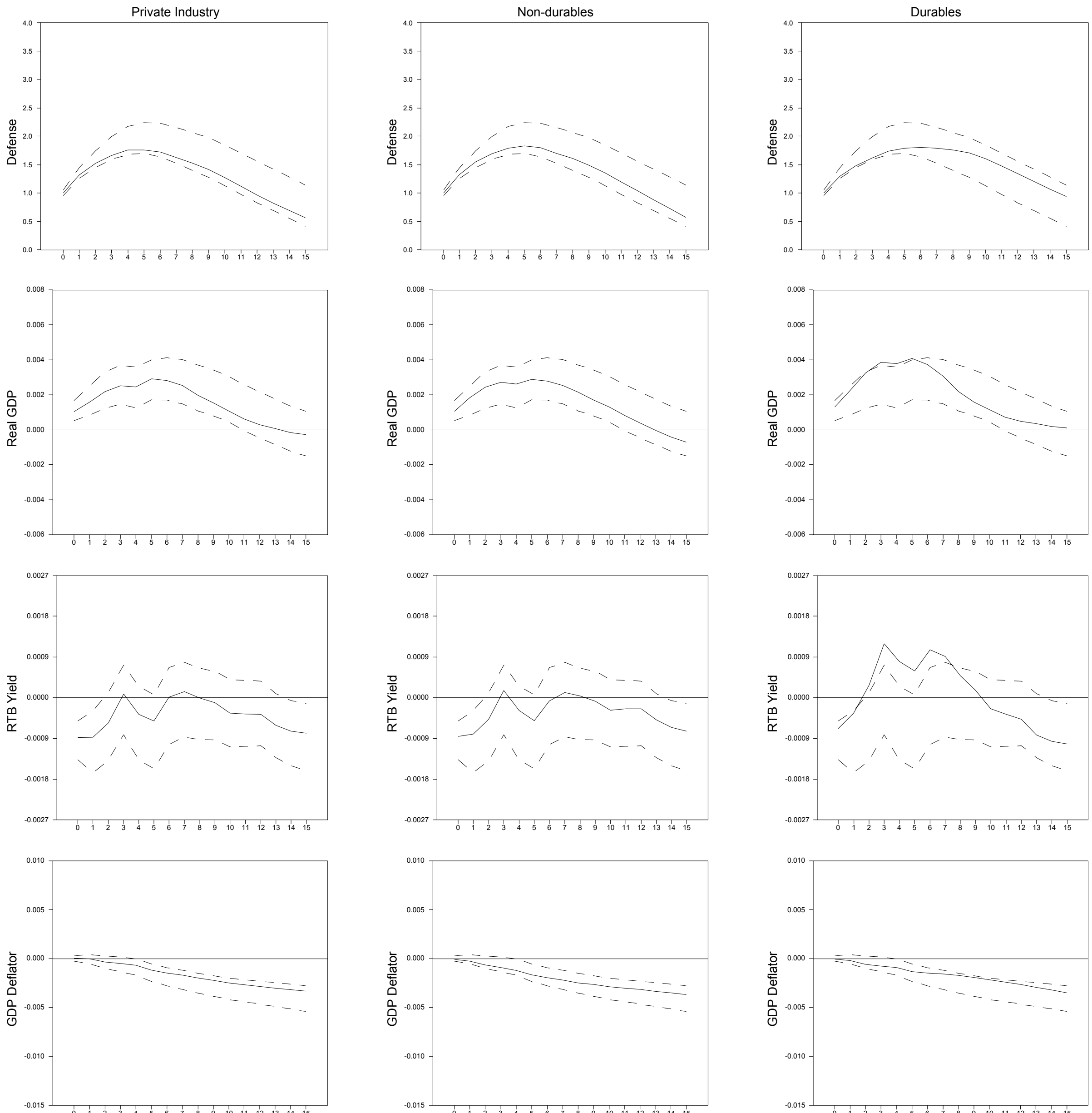

Figure 4.11: Point Estimates from Models with an Employment Variable
Confidence Intervals from Alternative Model

However, the IRF for real GDP computed for the model with employment in the durables manufacturing sector lies very slightly above the upper bound of the confidence interval from the alternative model for several periods in the first and second years after a shock to defense purchases. After a delay of less than two quarters, the IRF for RTB lies above the upper bound of the confidence interval from the alternative model for more than one and a half years.

In Figure 4.12, the point estimates of the IRFs for defense purchases, real GDP, RTB and the GDP deflator computed when real wages in private industry, real compensation in the manufacturing sector, and real compensation in the business sector are added, in turn, to the alternative model are plotted against the corresponding confidence intervals from the alternative model. The solid lines display the point estimates of the IRFs. The dashed lines display the confidence intervals from the alternative model.

Since the series for compensation in the manufacturing sector is not available before 1949:1, the model with real compensation in the manufacturing sector is estimated from 1950:3 to 1999:2, and the IRFs reported for this model are plotted against the confidence intervals computed for the same sample period. When the different measures of real wages and real compensation are added, in turn, to the alternative model, all the IRFs reported lie well within the corresponding confidence intervals from the alternative model at all horizons.

Overall, except when employment in the durables manufacturing sector is added to the alternative model, all the IRFs computed when consumption, investment, employment, real wages, and real compensation variables are added, in turn, to the alternative model are not significantly different from the corresponding IRFs reported for the alternative model at any horizon.

The IRF for RTB, and to lesser extent the IRF for real GDP, computed for the model with employment in the durables manufacturing sector are significantly and temporarily different from the ones reported for the alternative model. Therefore, it is concluded that the results reported for the alternative model are not sensitive to adding sectoral variables, except for employment in the durables manufacturing sector.

4.6.3 Additional Macroeconomic Variables

This sub-section presents evidence on the effects of shocks to defense purchases in models that include the Romers' monetary policy dummy variable, the monetary base, and LTR. It also investigates the effects of shocks to defense purchases in models that include Hamilton's oil price dummy variable, the PPI for crude fuel, and the Ramey-Shapiro dummy variable.

For the model with the monetary base, it is assumed that the monetary policy authorities do not respond immediately to developments in the economy. Therefore, the monetary base is ordered last in the Choleski decomposition used to identify the shocks to defense purchases. Defense purchases are ordered first, real GDP is ordered second, RTB is ordered third, and the GDP deflator is ordered fourth. Shocks to the monetary base are constrained not to have a contemporaneous effect on the other variables in the system; however, shocks to the other variables may have a contemporaneous effect on the monetary base.

For the model with LTR, this variable is ordered fourth in the Choleski decomposition used to identify the shocks to defense purchases. It is ordered before the

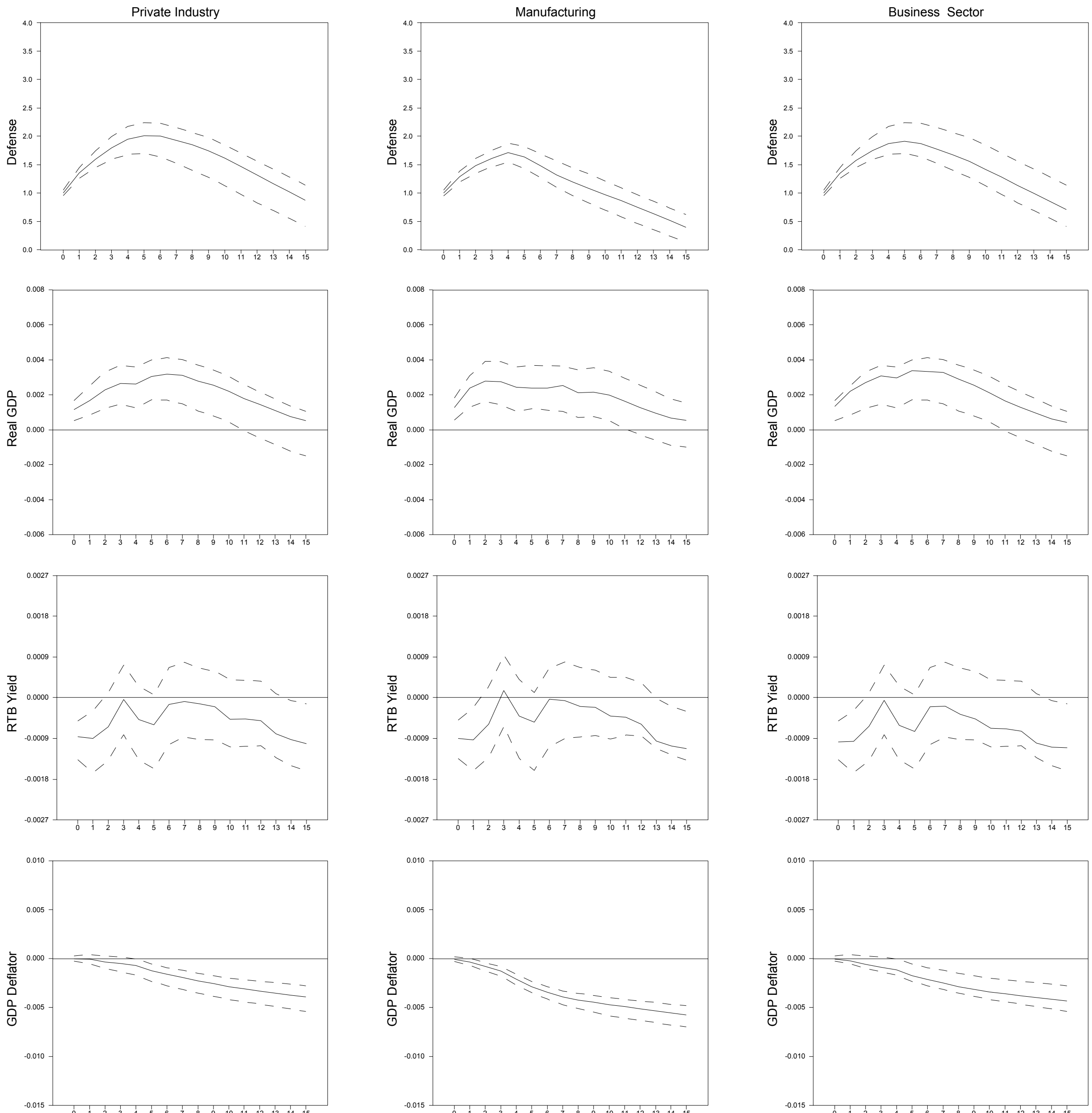

Figure 4.12: Point Estimates from Models with a Measure of Real Wages or Real Compensation
Confidence Intervals from Alternative Model

GDP deflator but after defense purchases, real GDP, and RTB. It is assumed that shocks to LTR are constrained not to have a contemporaneous effect on defense purchases, real GDP, and RTB; however, they may have a contemporaneous effect on the GDP deflator.

In Figure 4.13, the point estimates of the IRFs for defense purchases, real GDP, RTB, and the GDP deflator computed when the monetary variable variables and LTR are added, in turn, to the alternative model are plotted against the corresponding confidence intervals from the alternative model. The solid lines display the point estimates of the IRFs. The dashed lines display the confidence intervals from the alternative model.

When the Romers' monetary policy dummy variable or the monetary base is added to the alternative model, the IRFs reported for defense purchases, real GDP and the GDP deflator lie within the corresponding confidence intervals from the alternative model at all horizons. Furthermore, when LTR is added to the alternative model, all the IRFs reported lie well within the corresponding confidence intervals from the alternative model at all horizons.

However, the IRF for RTB computed for the model with the Romers' dummy variable lies very slightly above the upper bound of the confidence interval from the alternative model for several periods in the second year after a shock to defense purchases. In contrast, the IRF for RTB computed for the model with the monetary base lies very slightly below the lower bound of the confidence interval from the alternative model in the third year after a shock.

In Figure 4.14, the point estimates of the IRFs computed when Hamilton's oil price dummy variable, the PPI for crude fuel, and the Ramey-Shapiro dummy variables are added, in turn, to the alternative model are plotted against the corresponding confidence intervals from the alternative model. The solid lines display the point estimates of the IRFs. The dashed lines display the confidence intervals from the alternative model.

When Hamilton's oil price dummy variable is added to the alternative model, the IRF computed for defense purchases lies close to or slightly below the lower bound of the confidence interval from the alternative model at all horizons. The IRF for real GDP lies below the lower bound of the confidence interval from the alternative model for more than two years after a shock to defense purchases. Furthermore, when a one standard error confidence interval is computed, the IRF for real GDP is not significantly different from zero at any horizon. The IRFs for RTB and the GDP deflator lie on or within the corresponding confidence intervals from the alternative model at all horizons.

When the PPI for crude fuel is added to the alternative model, all the IRFs computed lies within the corresponding confidence intervals from the alternative model at all horizons. When the Ramey-Shapiro dummy variable is added to the alternative model, the IRFs computed for defense purchases, real GDP and the GDP deflator lie within or on the corresponding confidence intervals from the alternative model at all horizons.

However, the IRF for RTB computed for the model with the Ramey-Shapiro dummy variable lies slightly below the lower bound of the confidence interval from the alternative model for several periods in the first and second year after a shock to defense purchases. Furthermore, it is noted that the patterns of the IRFs for real GDP and RTB computed for the model with the Ramey-Shapiro dummy variable are different from the ones reported for the alternative model.

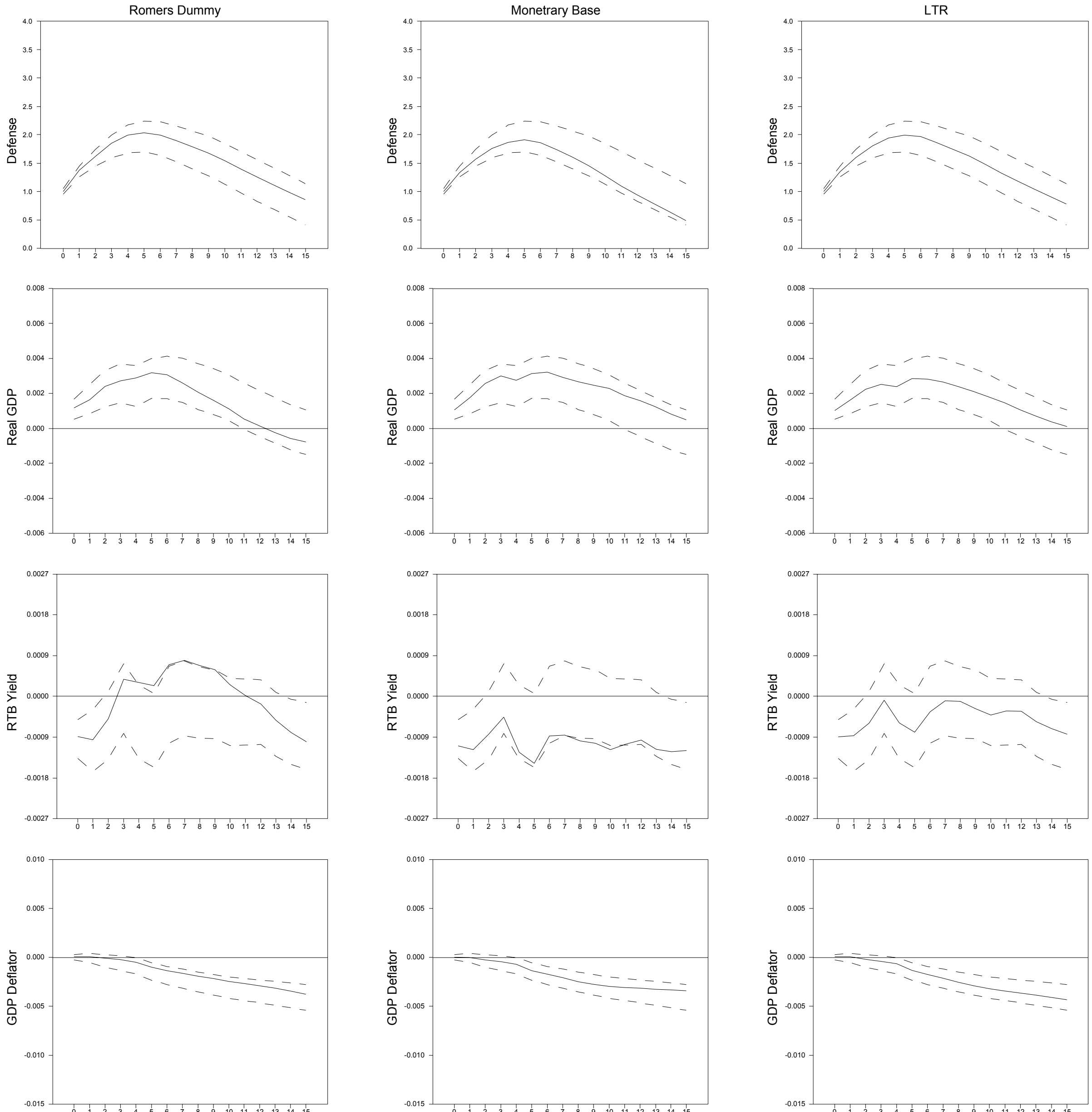

Figure 4.13: Point Estimates from Models with an Additional Macroeconomic Variable
Confidence Intervals from Alternative Model

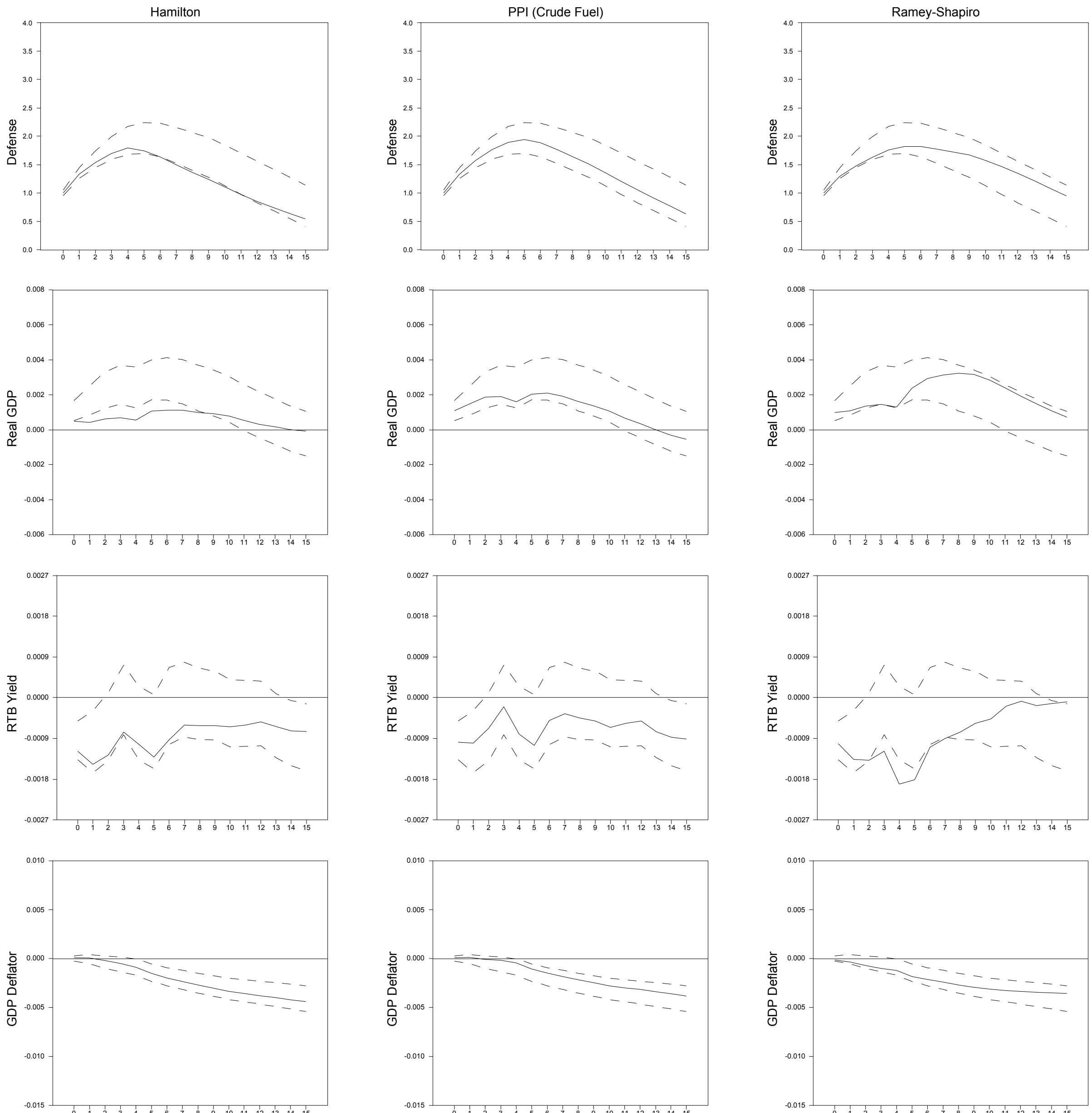

Figure 4.14: Point Estimates from Models with an Additional Macroeconomic Variable
Confidence Intervals from Alternative Model

Overall, the differences in the IRFs reported for the models with an additional macroeconomic variable and the alternative model are only minor, except for the model with Hamilton's oil price dummy. In this case, there is a major difference for real GDP.Therefore, it is concluded that the results reported for the alternative model are not sensitive to adding the additional macroeconomic variables under examination in this sub-section, except for Hamilton's oil price dummy.

4.6.4 Responses of Fiscal and Monetary Variables

It is of interest to determine whether the shocks identified using the Choleski decomposition coincide not only with increases in defense purchases but also changes in other dimensions of fiscal policy or changes in monetary policy. Therefore, this sub-section presents the effects of a shock to defense purchases on some of the fiscal and monetary variables added to the alternative model in the previous sub-section.

As in the studies of the narrative approaches, the variables selected are non-defense purchases, real federal government receipts, the real federal government deficit, and the monetary base. In Figure 4.15, the solid lines display the point estimates of the IRFs computed for the additional fiscal variables and the monetary base when the extended models that include these variables are estimated. The dashed lines display the lower and upper bounds of one-standard deviation confidence intervals from the alternative model.

The effects of an exogenous shock to defense purchases on the additional fiscal variables and the monetary base reported using the Choleski decomposition are different from the ones presented in previous chapters of the dissertation using the narrative approaches. The IRF for non-defense purchases exhibits a hump shaped pattern, and increases significantly for a quarter at the end of the first year after a shock to defense purchases.

The IRF for real federal government receipts increases significantly in the period of a shock to defense purchases, and except for two quarters, it remains positive and significant for three years. Except for a quarter, the IRF for real federal government deficit is negative at all horizons. However, it is only marginally significant at the end of the fourth year after a shock to defense purchases.

The IRF computed for the real federal government deficit may be consistent with the IRFs reported for government purchases and receipts. It implies that, as government receipts rise persistently after a shock to defense purchases, the government is able to finance the increase in defense purchases without a significant deterioration in its deficit for four years. Then, as the increase in government receipts comes to an end, the government deficit begins to deteriorate slightly.

The IRF for the monetary base exhibits a hump-shaped pattern, and is very persistent. It increases significantly for almost three years after a shock to defense purchases. This result implies that the shocks to defense purchases identified using the Choleski decomposition may be associated with persistent changes in monetary policy, which is consistent with the evidence reported by Caplan (1999) for instance.

Overall, the IRFs for the fiscal variables and the monetary base presented in this sub-section indicate that the shocks to defense purchases identified using the Choleski decomposition coincide with significant and very persistent changes in the monetary base, but not with significant changes in non-defense purchases. Furthermore, like the results reported for the additional fiscal variables using the narrative approaches, the ones

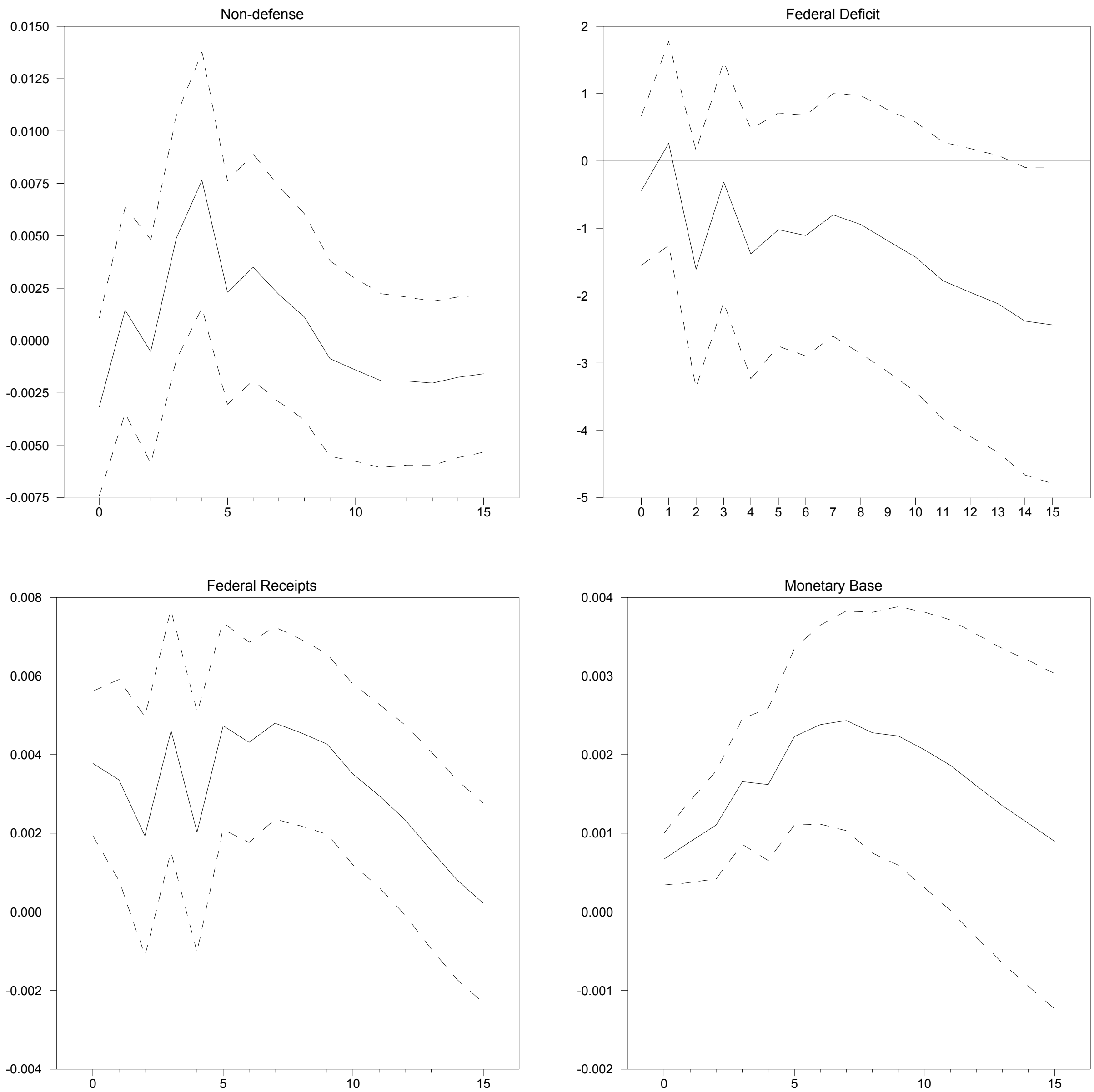

Figure 4.15: Point Estimates of the IRFs for Fiscal and Monetary Variables
Sample Period: 1948:3-1999:2

presented using the Choleski decomposition imply that the federal government is able to finance military build-ups through increases in revenues.

4.7 Alternative Sample Periods

As was mentioned before, Edelberg, Eichenbaum, and Fisher (1999) also argue that inference reported using the Choleski decomposition appears fragile to perturbations in the sample period used. Garcia-Mila (1989), Yuan and Li (1999), and Fatas and Mihov (2000) do not address this issue. This section provides evidence on the sensitivity of the results reported for the alternative model to perturbations in the sample period used following the same methodology as the one presented for the narrative approaches in the previous chapters of the dissertation.

First, the alternative model is estimated over four sub-sample periods. The early and late sub-sample periods span 1948:3 to 1973:1 and 1960:1 to 1999:2, respectively. The next sub-sample periods selected span 1950:1 to 1999:2 and 1948:3 to 1989:4, which corresponds to the Cold War era. Then, the point estimates of the IRFs for defense purchases, real GDP, RTB, and the GDP deflator are computed for a unit shock to defense purchases.

Finally, the IRFs computed for each sub-sample period are plotted along with the corresponding confidence intervals for the whole sample period. If the results reported for the alternative model are not sensitive to perturbations in the sample period used, the IRFs computed for the different sub-sample periods ought to lie within the corresponding confidence intervals from the whole sample period.

In the first and second columns of Figure 4.16, the solid lines display the point estimates of the IRFs for defense purchases, real GDP, RTB, and the GDP deflator computed when the alternative model is estimated over the early and late sub-sample periods, respectively. The dashed lines display the confidence intervals reported for the whole sample period.

When the alternative model is estimated over the early sub-sample period, the IRF computed for defense purchases lies slightly above the upper bound of the confidence interval reported for the whole sample period for almost two years after a shock to defense purchases. In contrast, the IRF for real GDP lies slightly below the lower bound of the confidence interval from the whole sample period for two quarters. Then, it lies within the confidence interval for one and a half years, and finally it remains below the lower bound of the confidence interval.

The IRF for RTB computed for the early sub-sample period lies slightly above the confidence interval from the whole sample period for a quarter after a shock to defense purchases; however, it remains negative. Then, it lies on or within the confidence interval. The IRF for the GDP deflator lies slightly above the upper bound of the confidence interval from the whole sample period at all horizons.

When the alternative model is estimated over the late sub-sample period, the IRF computed for defense purchases lies below the lower bound of the confidence interval from the whole sample period for two and a half years after a shock to defense purchases. Furthermore, it exhibits a pattern very different from one reported for the whole sample period. However, the IRFs reported for real GDP, RTB and the GDP deflator lie on or within the corresponding confidence intervals from the whole sample period at all horizons.

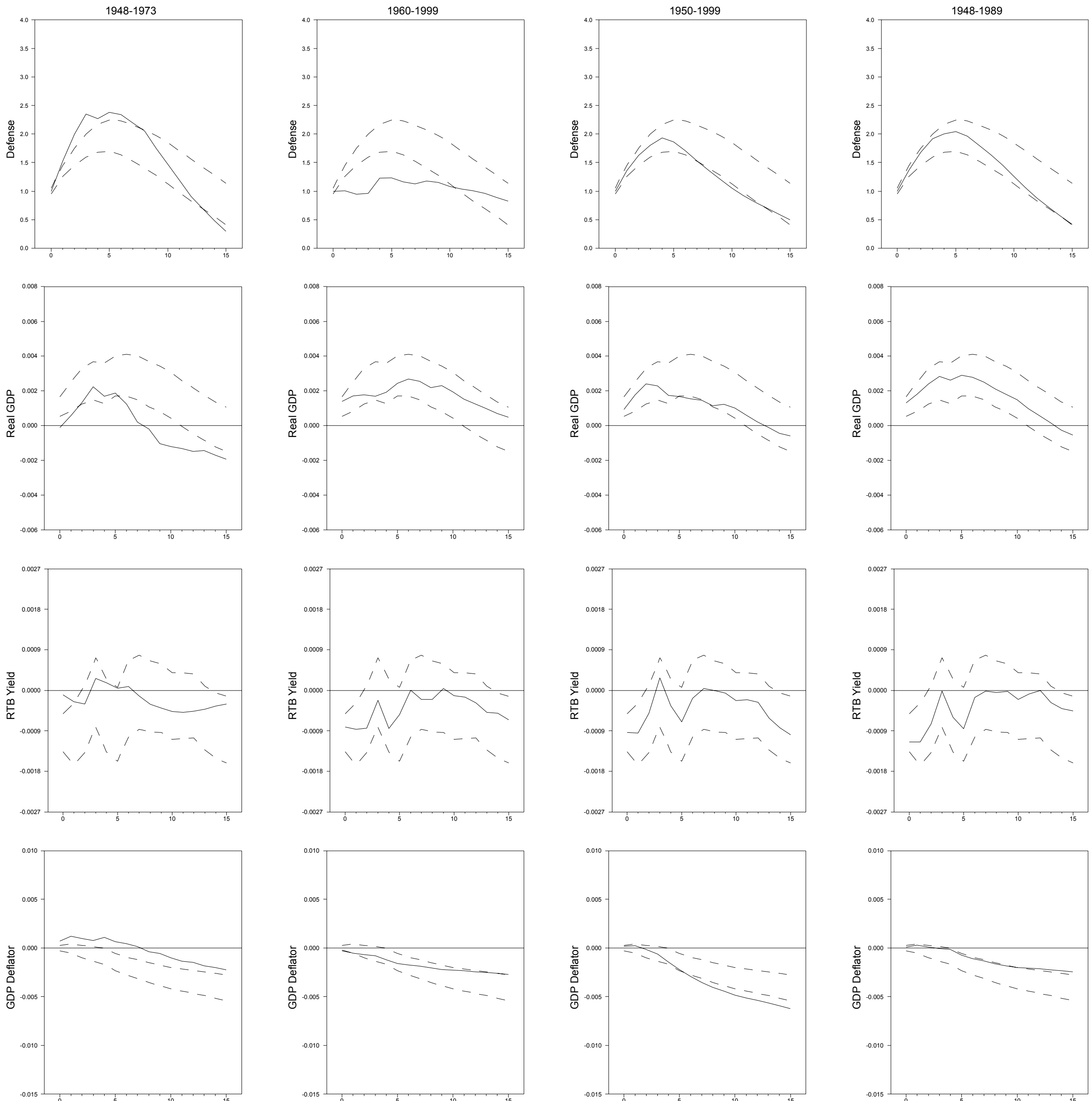

Figure 4.16: Point Estimates from Alternative Sample Periods
Confidence Intervals from the Whole Sample Period

In the third and fourth columns of Figure 4.16, the solid lines display the point estimates of the IRFs for defense purchases, real GDP, RTB, and the GDP deflator computed when the alternative model is estimated over the sub-sample period 1950:1 to 1999:2 and the Cold War era, respectively. The dashed lines display the confidence intervals reported for the whole sample period.

When the alternative model is estimated over the sub-sample period 1950:1 to 1999:2, the IRF computed for defense purchases lies within the confidence interval from the whole sample period for almost two years after a shock to defense purchases. Then, it lies very slightly below the lower bound of the confidence interval for more than a year.

After a delay of a year, the IRF for real GDP computed for the sub-sample period 1950:1 to 1999:2 lies very slightly below the lower bound of the confidence interval from the whole sample period for less than a year. The IRF for RTB lies within the confidence interval from the whole sample period at all horizons. After a delay of one and a half years, the IRF for real GDP lies slightly below the lower bound of the confidence interval from the whole sample period.

When the alternative model is estimated over the Cold War era, the IRFs reported for defense purchases, real GDP, and RTB lie within or on the confidence interval from the whole sample period at all horizons. The IRF for the GDP deflator lies very close to the upper bound of the confidence interval from the whole sample period for three years, and then it lies very slightly above the upper bound of the confidence interval.

Overall, when the alternative model is estimated for the early sub-sample period, the IRF computed for defense purchases is significantly larger than the one reported for the whole sample period for two years. However, the IRFs for real GDP and the GDP deflator are significantly and persistently smaller than the ones reported for the whole sample period. The IRF for RTB is significantly, although briefly, smaller than the one reported for the whole sample period.

When the alternative model is estimated for the late sub-sample period, the IRF computed for defense purchases is much smaller than the one reported for the whole sample period. However, the IRFs for real GDP, RTB, and the GDP deflator are not significantly different from the ones reported for the whole sample period.

When the alternative model is estimated for the sub-sample period 1950:1 to 1999:2, the IRFs computed for defense purchases, real GDP and the GDP deflator are marginally different from the ones presented for the whole sample period. The IRF reported for RTB is not significantly different from the one presented for the whole sample period.

When the alternative model is estimated for the Cold War era, the IRFs reported for defense purchases, real GDP and RTB are not significantly different from the ones presented for the whole sample period. The IRF reported for the GDP deflator is marginally different from the one presented for the whole sample period.

Like the results presented for the narrative approaches, the IRFs computed for the different sub-sample periods imply that the IRFs reported for the alternative model using the Choleski decomposition to identify shocks to defense purchases are sensitive to perturbations in the sample period. In particular, the IRF for defense purchases reported for the late sub-sample period, which excludes the Korean War era, is much smaller and appears to exhibit a pattern very different from the one reported for the other sub-sample periods.

To further examine the sensitivity of the results reported for the alternative model to perturbations in the sample period, Figure 4.17 presents the point estimates and confidence intervals of the IRFs computed for a unit shock to defense purchases when the alternative model is estimated over the early and late sub-sample periods. The solid lines display the point estimates of the IRFs for defense purchases, real GDP, RTB, and the GDP deflator. The dashed lines display the lower and upper bounds of one-standard deviation confidence intervals from these samples, not the full sample.

The pattern of the IRF for defense purchases reported for the early sub-sample period is similar to the one reported for the whole sample period; however; the peak effect of a shock reported for the early sub-sample is slightly larger than for the whole sample period. Yet, the increase in real GDP reported for the early sub-sample period is only significant for a year, compared to three years for the whole sample period.

The IRF for RTB reported for the early sub-sample period is very small, and is never significantly different from zero. The IRF for the GDP deflator increases significantly, although very marginally, for two periods after a shock to defense purchases. Then, it begins to gradually decrease, and is very marginally significant in the fourth year after a shock.

The pattern of the IRF for defense purchases computed for the late sub-sample period is very different from the one reported for the whole sample period. It is relatively flat, and much smaller than the IRF reported for the whole sample. However, the IRFs and confidence intervals computed for real GDP, RTB, and the GDP deflator are similar to the ones reported for the whole sample period. In particular, the IRF for RTB is temporarily and significantly negative and the IRF for the GDP deflator is significantly and persistently negative.

Overall, while the pattern and magnitude of the IRF for defense purchases reported the early sub-sample are similar to the ones presented for the whole sample period, the IRF reported the late sub-sample increases much more gradually and is dramatically smaller than the one presented for the whole sample period.

Furthermore, like the IRFs for real GDP, RTB, and the GDP deflator reported the whole sample period, the ones presented for the early and late sub-sample periods remain problematic. However, it is noted that while the IRFs for RTB and the GDP deflator reported for the whole sample period are significantly negative at certain horizons, the ones presented for the early sub-sample period are not significantly different from zero at any horizon.

4.8 New Orders of Defense Products

The IRFs reported in this chapter for the shocks to defense purchases identified using a Choleski decomposition, in particular for RTB and the GDP deflator, are inconsistent with the theoretical two-sector neoclassical models presented by Ramey and Shapiro (1997) and Edelberg, Eichenbaum, and Fisher (1999) as well as the more traditional IS-LM and one-sector neoclassical models.

As was mentioned before, Ramey and Shapiro (1997) and Edelberg, Eichenbaum, and Fisher (1999) argue that many shocks to defense purchases identified using a Choleski decomposition may not be unanticipated, and hence exogenous. Therefore, it is interesting to estimate the effects of exogenous shocks to defense spending when new orders of defense products are substituted for defense purchases in the alternative model.

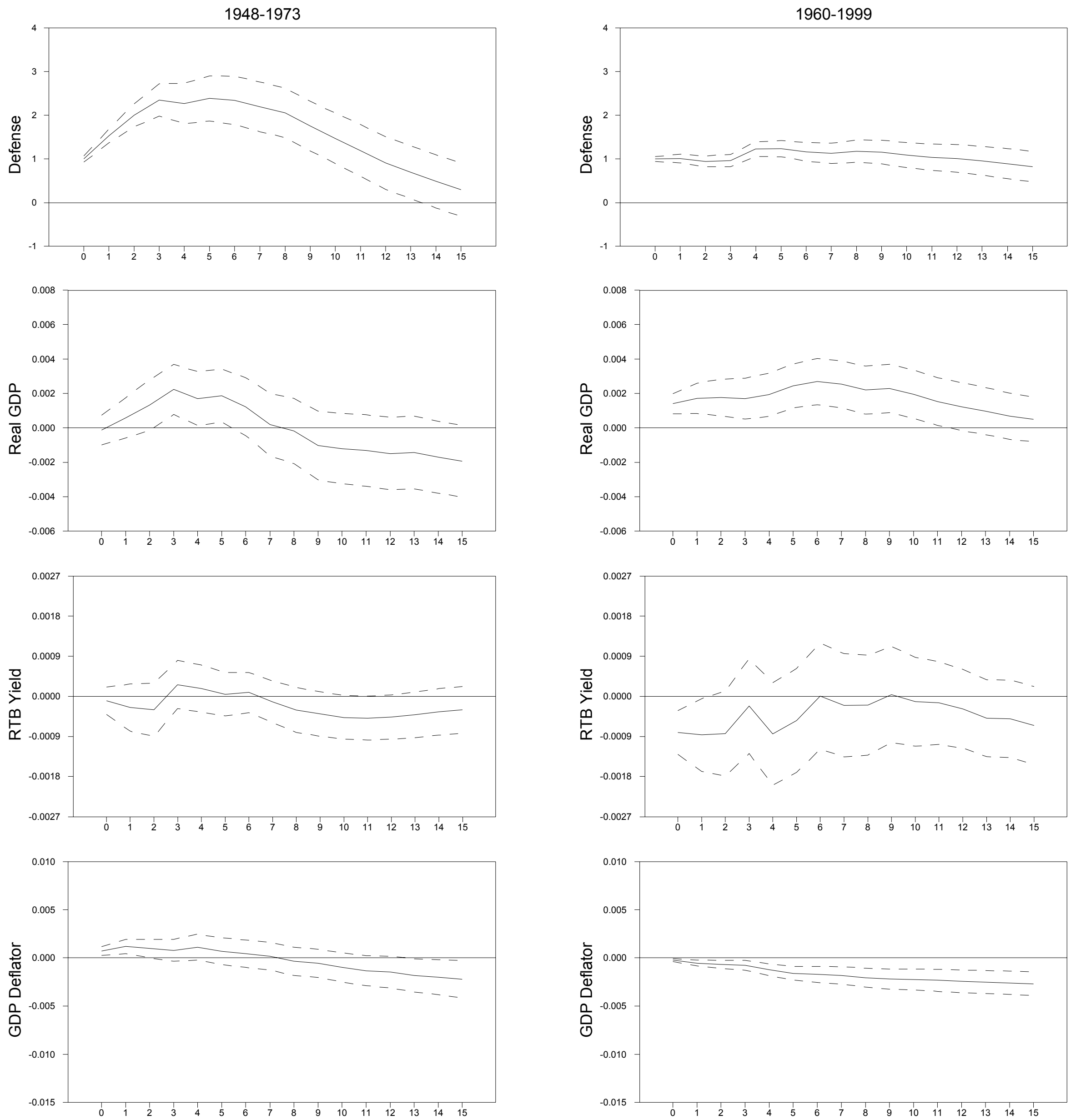

Figure 4.17: Point Estimates from Alternative Sample Periods
Confidence Intervals from Alternative Sample Periods

New orders of defense products are a monthly series from a set of 256 data series commonly known as the US Business Cycle Indicators (BCI) series that are used for tracking and predicting U.S business activity. The series were published in the *Survey of Current Business* by the Bureau of Economic Analysis as well as the Current Industrial Report published by the Bureau of the Census. They are now published by the Conference Board in a periodical named *Business Cycle Indicators*.

The data for new orders of defense products are available since the first month of 1968. In order to examine the macroeconomic effects of exogenous shocks to new orders of defense products, quarterly data are constructed by adding the monthly data within each quarter from the sample period 1968:1 to 1999:2. Furthermore, since the data for new orders of defense products are originally in billions of current dollars, they are deflated by the CPI deflator.[9]

According to the Bureau of the Census, new orders, "are net of order cancellations and include orders received and filled during the month as well as orders received for future delivery. They also include the value of contract changes which increase or decrease the value of the unfilled orders to which they relate" (Bureau of the Census, 1995). Defense products represent one of eight market categories that are used to separate manufacturing industries in the "Manufacturers' Shipments, Inventories, and Orders" survey.

According to the Bureau of the Census, defense products includes the following sub-categories: small arms and ordnance, communication equipment, aircraft and parts, missiles, space vehicles, and parts, ships and parts, and other parts that fall into the category defense products. Ramey and Shapiro (1997) who show that military build-ups tend to be concentrated in the industries included in defense products argue, "… Not only are government spending increases heavily concentrated in a few industries, but it is also the case that government is the primary purchaser of goods from these industries" (Ramey and Shapiro 1997, p. 6). The industries listed above represent five of the eight industries they specifically mentioned in their study.

In the first panel of Figure 4.18, the dashed line presents the evolution of new orders of defense products from 1968:1 to 1999:2, and the solid line presents the evolution of defense purchases. For simplicity's sake, new orders of defense products are hereafter referred to as new orders. The values of the series for new orders are much smaller than the ones reported for defense purchases. Furthermore, the changes in the trend for new orders appear to precede the changes in the trend for defense purchases by one to two years; however, the pattern of the series for new orders is relatively similar to the one reported for defense purchases.

To examine the relations between the series for the shocks to defense purchases and the shocks to new orders, the cross-correlation coefficients of the series for the shocks to defense purchases and the current and lagged series for the shocks to new orders are computed. All the cross-correlation coefficients computed are less than 0.25, which implies that the series for the shocks to defense purchases and shocks to new orders are moderately correlated.

To estimate the macroeconomic effects of exogenous shocks to new orders, a VAR system identical to the alternative model, except that new orders are substituted for

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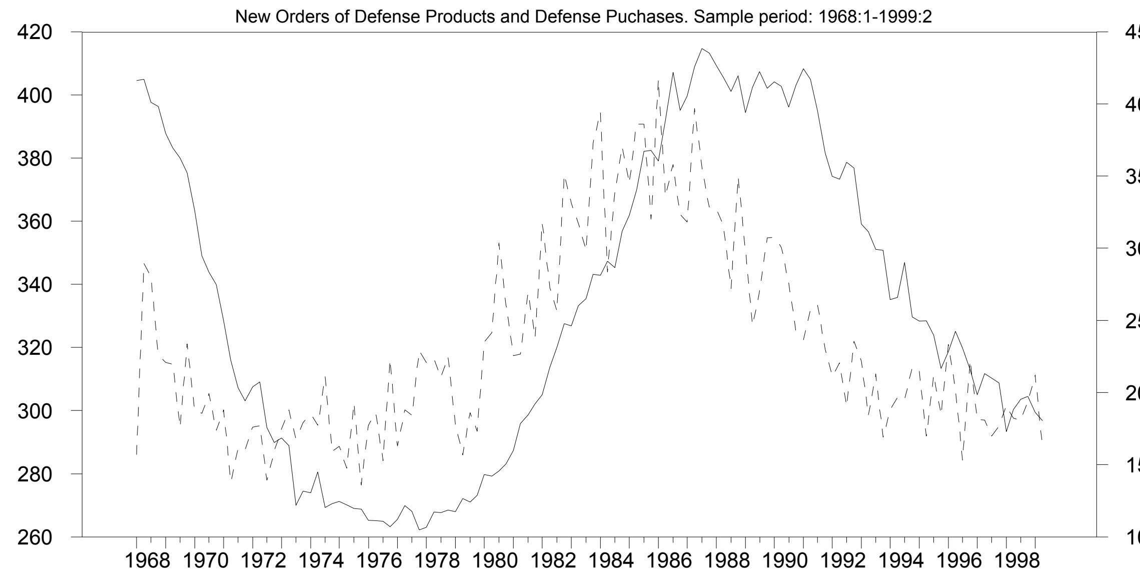
[9] The results computed when new orders of defense products are deflated by the GDP deflator are essentially identical to the ones reported hereafter.



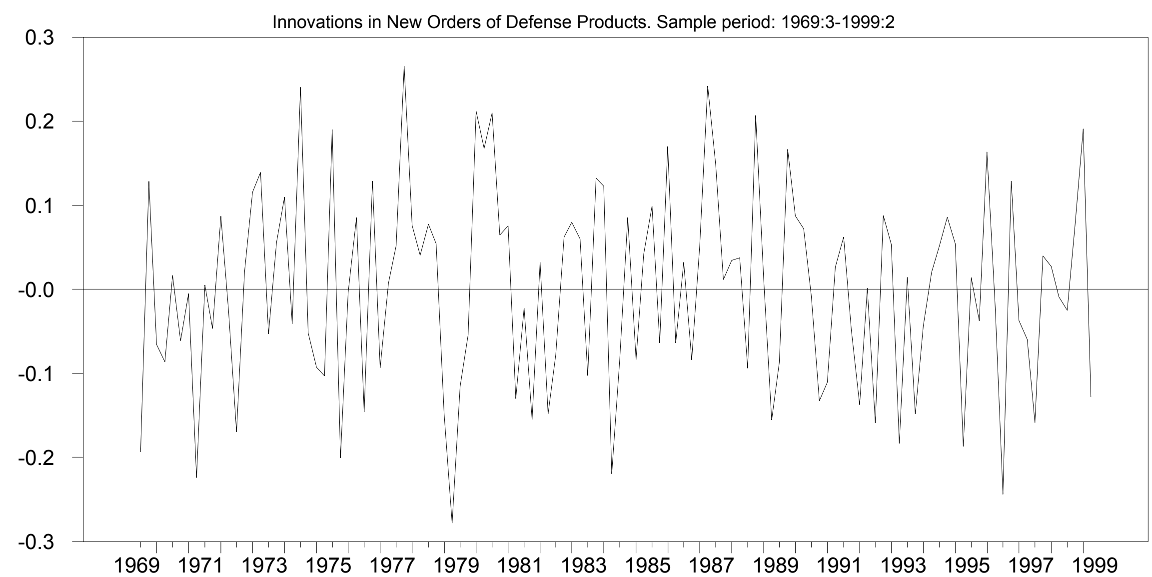


Figure 4.18: New Orders of Defense Products and Shocks to New Orders of Defense Products
Sample Period: 1969:3-1999:2

defense purchases is estimated for the sample period 1969:3 to 1999:2. Data from 1968:1 to 1969:2 are used as pre-sample data. As was mentioned before, when a Choleski decomposition is used to identify exogenous policy shocks, including new orders as the policy variable in a VAR system rather than defense purchases presents three major relative advantages.

First, since new orders include orders received for future delivery, they contain information about future flows of defense purchases. Second, since shocks to new orders of defense products are recorded before shocks to defense purchases, they are less likely to be anticipated. Third, since new orders are recorded in the data before production begins, they are not affected by shocks in the private sector that lead to changes in delivery schedules. As a result, the shocks to new orders identified using a Choleski decomposition are more likely to be truly unanticipated, and hence exogenous, than the shocks to defense purchases.

To present the effects of exogenous shocks to new orders, the IRFs for new orders, real GDP, RTB, and the GDP deflator are computed for a unit shock to new orders following the same procedure as the one used earlier for the alternative model. In the Choleski decomposition used to identify the shocks to new orders, new orders are ordered before real GDP, RTB and the GDP deflator, respectively. In the second panel of Figure 4.18, the solid line displays the shocks to new orders identified using the Choleski decomposition when the model with new orders is estimated from 1969:3 to 1999:2. The shocks identified do not exhibit any particular pattern, and no shock appears much larger than others.

In the first column of Figure 4.19, the solid lines display the point estimates of the IRFs computed for a unit shock to new orders. The dashed lines display the lower and upper bounds of one standard error confidence intervals computed using a Monte Carlo integration procedure. The quarter following a shock to new orders, their IRF decreases dramatically; however, it remains intermittently significant for almost three years after a shock.

The IRFs for real GDP, RTB, and the GDP deflator increase significantly for one and a half years after a shock to new orders. The IRFs for real GDP and RTB exhibits a hump-shaped pattern. They increase for more than a year after a shock, and then they quickly return toward their original values. The IRF for the GDP deflator increases gradually but persistently.

In the second column of Figure 4.19, the solid lines display the point estimates of the IRFs for defense purchases, real GDP, RTB, and the GDP deflator computed for a unit shock to defense purchases when the alternative model is estimated over the sample period 1969:3 to 1999:2. The dashed lines display the lower and upper bounds of one standard error confidence intervals.

As was reported for the whole sample period, the IRFs for RTB and the GDP deflator computed for a shock to defense purchases over the sample period 1969:3 to 1999:2 are inconsistent with the theoretical two-sector neoclassical models presented by Ramey and Shapiro (1997) and Edelberg, Eichenbaum, and Fisher (1999) as well as the more traditional IS-LM and one-sector neoclassical models.

Overall, when a VAR system identical to the alternative model, except that new orders of defense products are substituted for defense purchases, is estimated over the sample period 1969:3 to 1999:2, the IRFs reported for a shock to new orders are

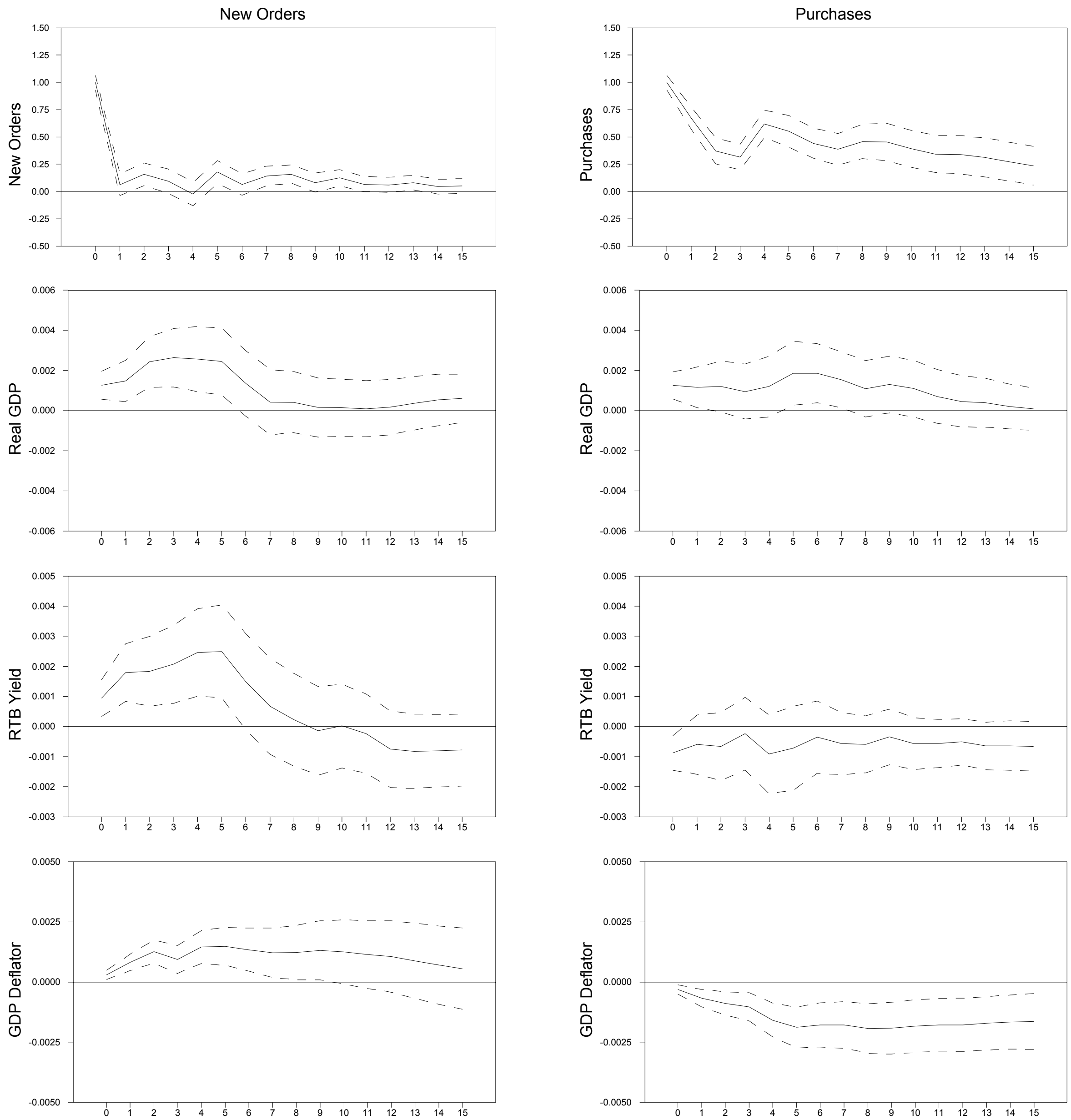


Figure 4.19: Point Estimates from Models with New Orders of Defense Products and Defense Purchases
Sample Period: 1969:3-1999:2

consistent with the traditional IS-LM model. They imply that output, interest rates, and the price level increase immediately and significantly for one and a half years in response to a positive shock to government purchases.

Furthermore, the IRFs for real GDP, RTB, and the GDP deflator computed for the alternative model over the sample period 1969:3 to 1999:2 are very different from the ones reported for the model with new orders of defense products. In particular, the IRFs for RTB and the GDP deflator, are problematic. Therefore, it is concluded that the shocks to new orders of defense products identified using a Choleski decomposition are better measures of exogenous shocks to defense spending than shocks to defense purchases.

4.9 Robustness of the Results Reported For the Model with New Orders of Defense Products

This section investigates the sensitivity of the results reported for new orders, real GDP, RTB, and the GDP deflator to adding an endogenous variable or an exogenous dummy variable to the model with new orders. Furthermore, it presents the IRFs computed for fiscal variables and the monetary base. The variables added to the model with new orders, and the methodology used to examine the sensitivity of the results reported for this model to adding any of the variables selected, are the same as the ones used earlier for the alternative model.

This section also examines the sensitivity of the results reported for the model with new orders to perturbations in the sample period. The model with new orders is estimated over two sub-sample periods, and the IRFs for new orders, real GDP, RTB, and the GDP deflator are computed for a unit shock to new orders. If the results reported for the model with new orders are not sensitive to perturbations in the sample period used, the IRFs computed for the sub-sample periods ought to lie within the corresponding confidence intervals from the whole sample period.

The first sub-sample period selected spans 1969:3 to 1989:4. It excludes the data from the post-Cold War era, which represent one-third of the data from the whole sample period. The second sub-sample period selected spans 1973:2 to 1999:2. It begins with the oil crisis of 1973-1974, which may have affected the structural relations among the variables in the model estimated.

4.9.1 Extended Models

First, the effects of the shocks to new orders are examined in models that alternatively include fiscal variables. In Figure 4.20, the solid lines display the point estimates of the IRFs for new orders, real GDP, RTB, and the GDP deflator computed when non-defense purchases, real federal government receipts, and the real federal government deficit are added, in turn, to the model with new orders. The dashed lines display the corresponding confidence intervals from the model with new orders.

When non-defense purchases or real federal government receipts are added to the model with new orders, all the IRFs reported lie on or within the corresponding confidence intervals from the model with new orders at all horizons. However, a year after a shock to new orders, the pattern of the IRF for real GDP computed for the model with non-defense purchases is notably different from the one reported for the model with new orders.

When the real federal government deficit is added to the model with new orders, the IRF computed for new orders lies within the confidence interval from the model with new orders. The IRFs for real GDP and RTB lie within the corresponding confidence

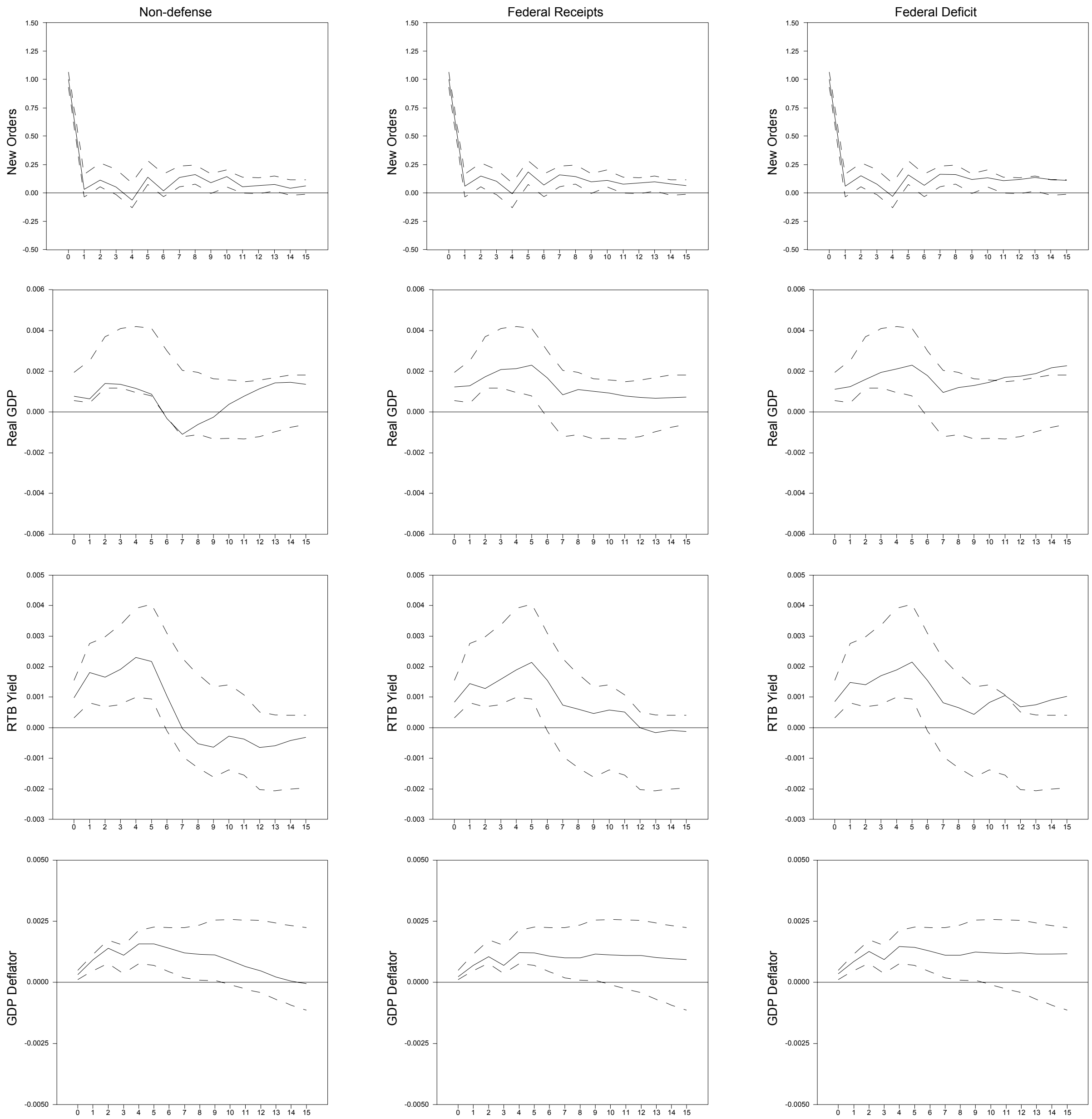


Figure 4.20: Point Estimates from Models with New Orders of Defense Products and a Fiscal Variable
Confidence Intervals from Models with New Orders of Defense Products

intervals from the model with new orders for two and a half years, and then they lie slightly above the upper bounds of the corresponding confidence intervals. The IRF for the GDP deflator lie within the confidence interval from the model with new orders at all horizons.

Overall, the IRFs computed when fiscal variables are added, in turn, to the model with new orders indicate that the results reported for the model with new orders are not sensitive to adding fiscal variables, except for the real federal government deficit. In this case, the IRFs for real GDP and RTB are significantly different at long horizons from the ones reported for the model with new orders.

In Figure 4.21, the solid lines display the point estimates of the IRFs for new orders, real GDP, RTB, and the GDP deflator computed when consumption of non-durables and services, residential investment plus consumption of durables, and non-residential investment are added, in turn, to the model with new orders. The dashed lines display the corresponding confidence intervals from the model with new orders. When consumption of non-durables and services is added to the model with new orders, all the IRFs reported lie within or on the corresponding confidence intervals from the model with new orders at all horizons.

When residential investment plus consumption of durables are added to the model with new orders, the IRFs reported for new orders, RTB, and the GDP deflator lie within or on the corresponding confidence intervals from the model with new orders at all horizons. After a delay of several quarters, the IRF for real GDP lies below the lower bound of the confidence interval from the model with new orders for a year, and then it lies within the confidence interval.

When non-residential investment is added to the model with new orders, the IRFs reported for new orders, real GDP, and the GDP deflator lie within or on the corresponding confidence intervals from the model with new orders at all horizons. The IRF for RTB lies very slightly below the lower bound confidence intervals from the model with new orders for several quarters in the second year after a shock to new orders.

Overall, the IRFs computed when consumption and investment variables are added, in turn, to the model with new orders indicate that the results reported for the model with new orders are not very sensitive to adding consumption and investment variables, except for residential investment plus consumption of durables. In this case, the IRF computed for real GDP is different from the one reported for the model with new orders.

In Figure 4.22, the solid lines display the point estimates of the IRFs for new orders, real GDP, RTB, and the GDP deflator computed when employment in private industry, employment in the non-durables manufacturing sector, and employment in the durables manufacturing sector are added, in turn, to the model with new orders. The dashed lines display the corresponding confidence intervals from the model with new orders. When a measure of employment is added to the model with new orders, all the IRFs reported lie within or on the corresponding confidence intervals from the model with new orders at all horizons.

In Figure 4.23, the solid lines display the point estimates of the IRFs for new orders, real GDP, RTB, and the GDP deflator computed when real wages in private industry, real compensation in the manufacturing sector, and real compensation in the business sector are added, in turn, to the model with new orders. The dashed lines display

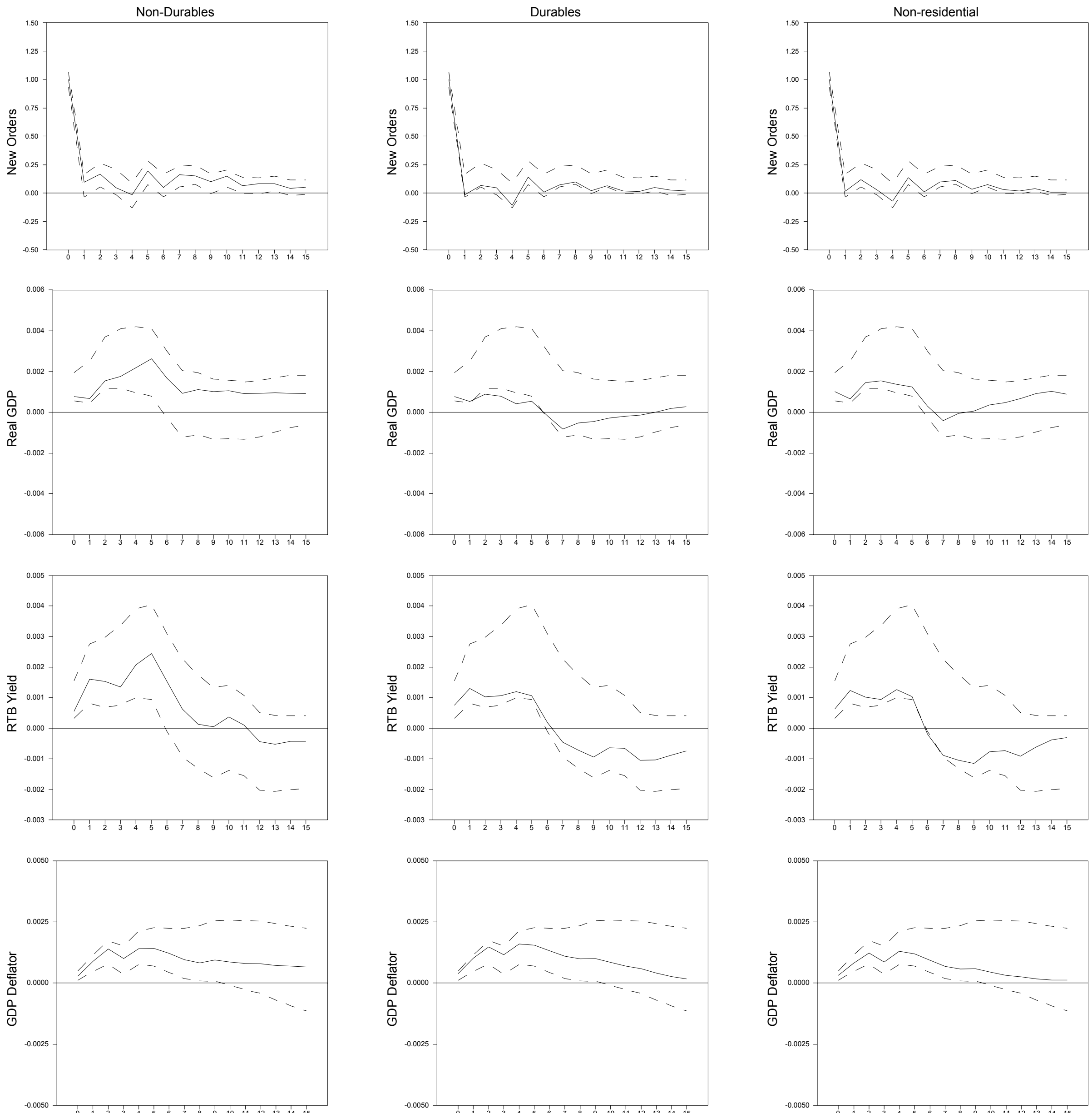


Figure 4.21: Point Estimates from Models with New Orders of Defense Products and a Consumption or Investment Variable
Confidence Intervals from Models with New Orders of Defense Products

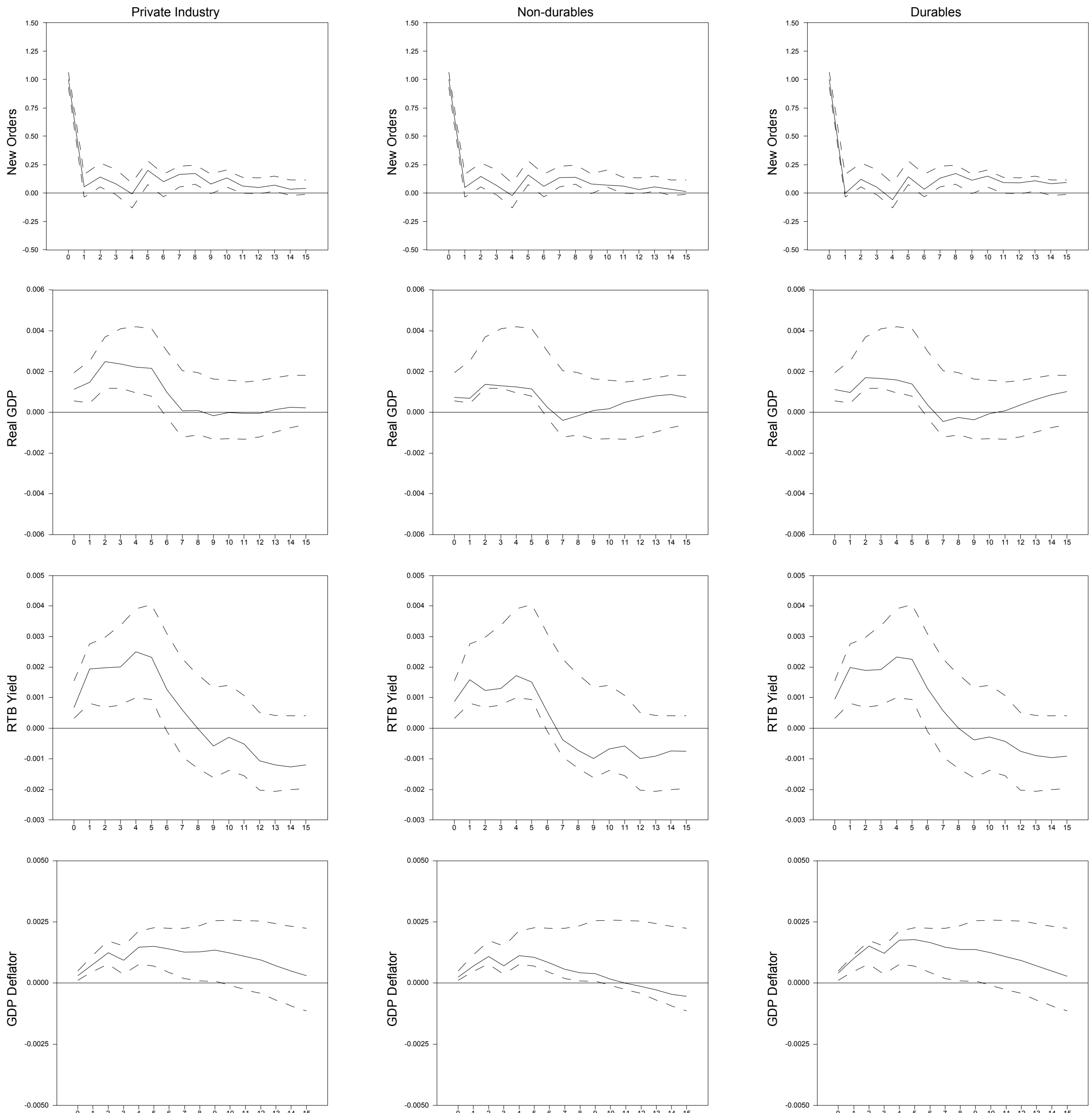


Figure 4.22: Point Estimates from Models with New Orders of Defense Products and an Employment Variable
Confidence Intervals from Models with New Orders of Defense Products

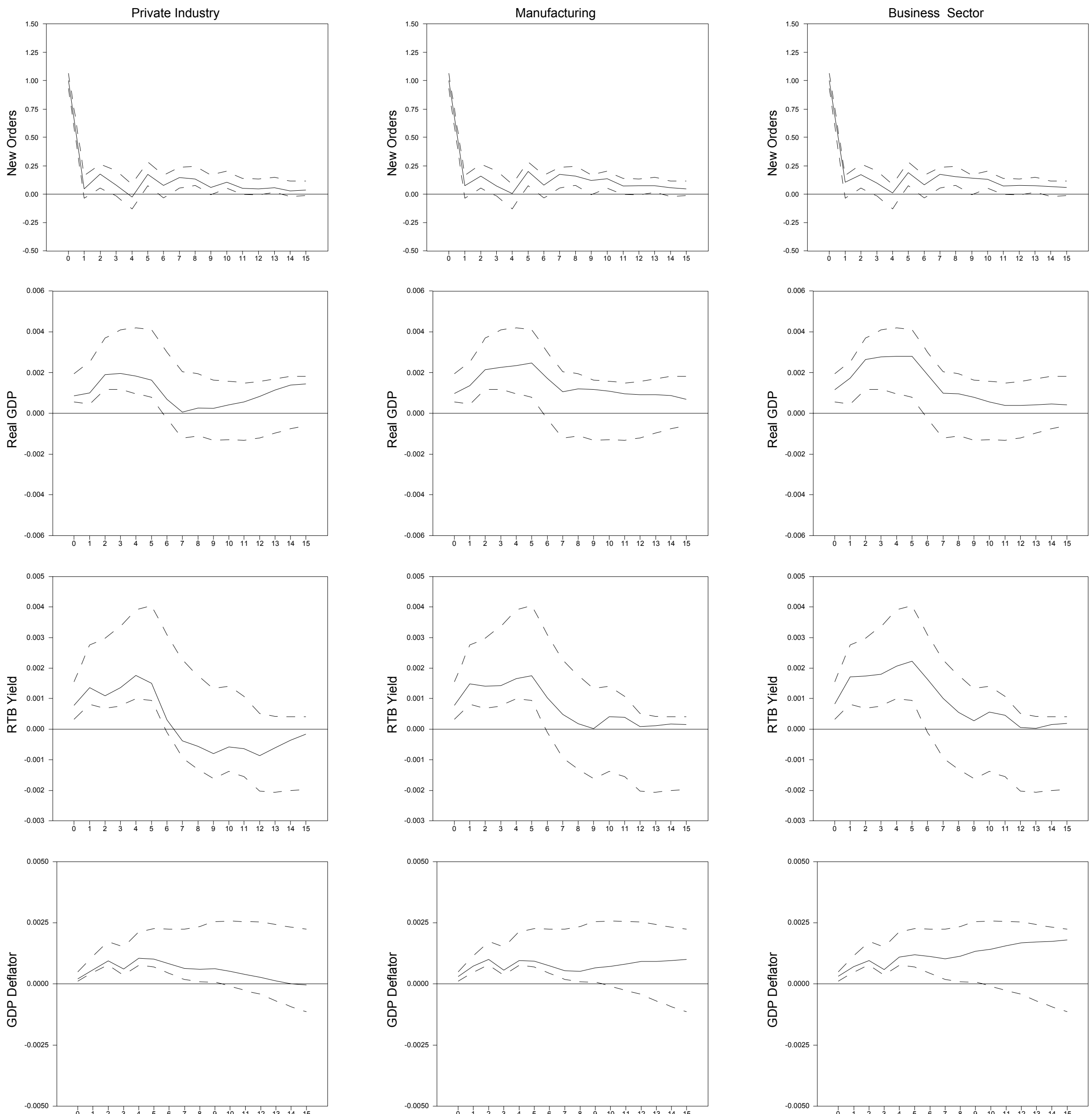


Figure 4.23: Point Estimates from Models with New Orders of Defense Products and a Measure of Real Wages or Real Compensation
Confidence Intervals from Models with New Orders of Defense Products

the corresponding confidence intervals from the model with new orders. When a measure of real wages or real compensation is added to the model with new orders, all the IRFs reported lie within the corresponding confidence intervals from the model with new orders at all horizons.

Overall, the IRFs computed when a measure of employment, real wages, or real compensation are added, in turn, to the model with new orders indicate that the results reported for the model with new orders are not sensitive to adding measures of employment, real wages, or real compensation.

In Figure 4.24, the solid lines display the point estimates of the IRFs for new orders, real GDP, RTB, and the GDP deflator computed when the Romers' monetary policy dummy variable, the monetary base, and LTR are added, in turn, to the model with new orders. The dashed lines display the corresponding confidence intervals from the model with new orders.

When the Romers' monetary policy dummy variable is added to the model with new orders, the IRF reported for RTB lies very slightly below the lower bound of the confidence interval from the model with new orders in the period of a shock to new orders. Then, it lies within the confidence interval. The IRFs for real GDP, RTB, the GDP deflator lie within or on the corresponding confidence intervals from the model with new orders at all horizons. When the monetary base or LTR is added to the model with new orders, all the IRFs reported lie within or on the corresponding confidence intervals from the model with new orders.

In Figure 4.25, the solid lines display the point estimates of the IRFs for new orders, real GDP, RTB, and the GDP deflator computed when Hamilton's oil price dummy variable, the PPI for crude fuel, and the Ramey-Shapiro dummy variable are added, in turn, to the model with new orders. The dashed lines display the corresponding confidence intervals from the model with new orders. Ramey and Shapiro (1997) identify only three exogenous military build-ups in the post-World war II era, and only the last one occurred during the sample period 1969:3 to 1999:2. Therefore, when the Ramey-Shapiro dummy variable is added to the model with new orders, it takes the value one in 1980:1, and zero otherwise.

When Hamilton's oil price dummy variable or the PPI for crude fuel is added to the model with new orders, all the IRFs reported lie within or on the corresponding confidence intervals from the model with new orders. When the Ramey-Shapiro dummy variable is added to the model with new orders, the IRFs for new orders and the GDP deflator lie within or on the corresponding confidence intervals from the model with new orders.

However, when the Ramey-Shapiro dummy variable is added to the model with new orders, the IRF for real GDP does not begin to return toward its original value until two years after a shock to new orders, and it lies very slightly above the upper bound of the confidence interval from the model with new orders for more than a year. The IRF for RTB is small at all horizons, and after a delay of several quarters, it lies below the lower bound of the confidence interval from the model with new orders for more than a year.

Overall, the IRFs computed when the Romers' monetary policy dummy variable, the monetary base, LTR, Hamilton's oil price dummy variable, the PPI for crude fuel, and the Ramey-Shapiro dummy variable are added, in turn, to the model with new orders

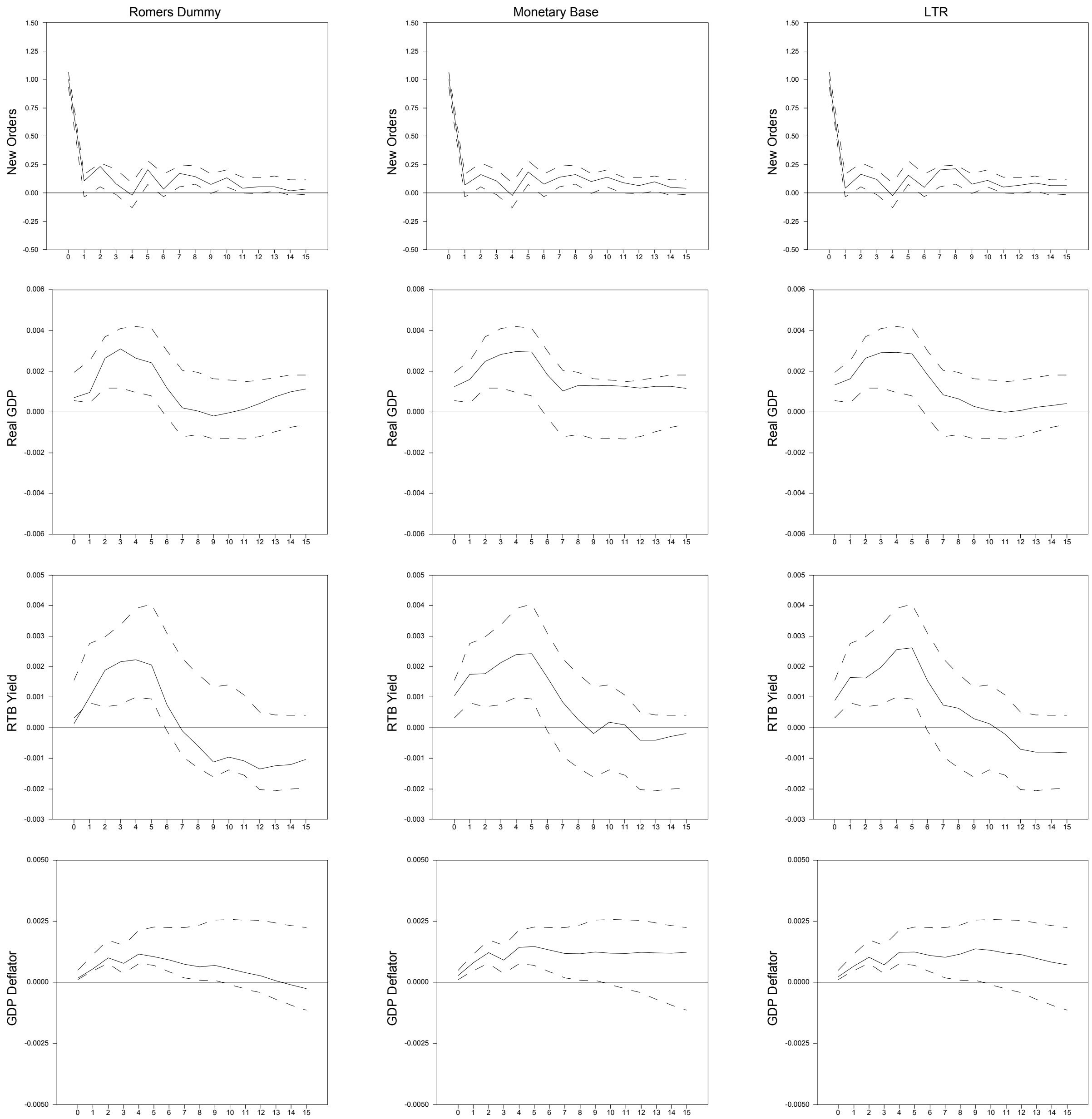


Figure 4.24: Point Estimates from Models with New Orders of Defense Products and an Additional Macroeconomic Variable
Confidence Intervals from Models with New Orders of Defense Products

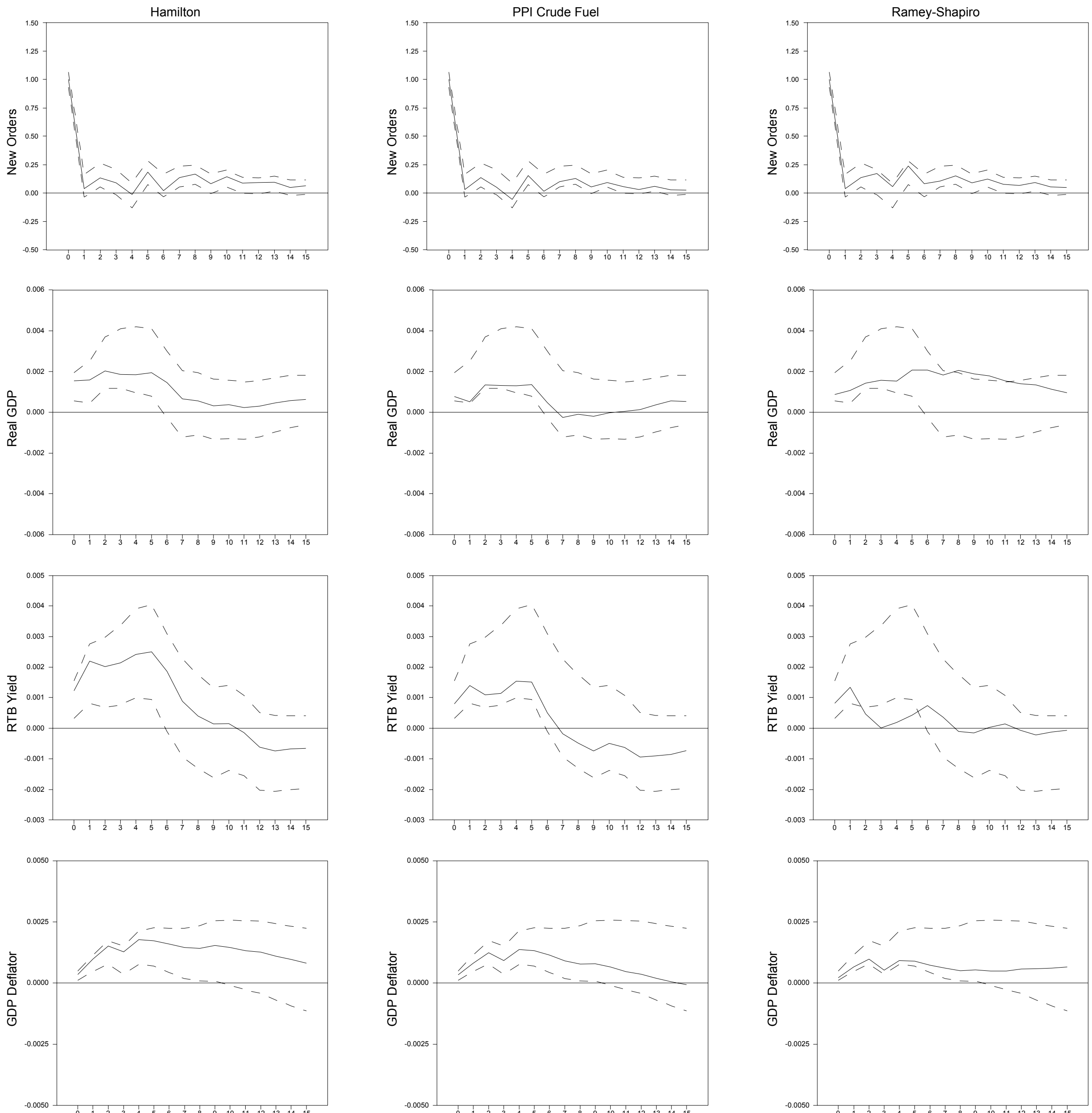


Figure 4.25: Point Estimates from Models with New Orders of Defense Products and an Additional Macroeconomic Variable
Confidence Intervals from Models with New Orders of Defense Products

indicate that the results reported for the model with new orders are not sensitive to adding these variables, except for the Ramey-Shapiro dummy variable. In this case, the IRF for RTB, and to a lesser extent real GDP, are different from the ones reported for the model with new orders.

As was done for the alternative model, it is of interest to present the effects of a unit shock to new orders on non-defense purchases, real federal government receipts, the real federal government deficit, and the monetary base. In Figure 4.26, the solid lines display the point estimates of the IRFs computed for these fiscal variables and the monetary base when they are added, in turn, to the model with new orders. The dashed lines display the lower and upper bounds of one-standard deviation confidence intervals.

The IRF for non-defense purchases exhibits a u-shaped pattern. It drops sharply for a year after a shock to new orders, and then it gradually returns to its original value. Overall, it decreases significantly for more than a year. The IRF for real federal government receipts rises significantly in the period of a shock to new orders. Then, it exhibits a tendency to decline; however, it remains positive at all horizons, and it is significant for one and a half years.

The IRF for the real federal government deficit increases significantly for three years after a shock to new orders. It implies that the government deficit improves immediately and persistently after an increase in government purchases. This result is consistent with the patterns of the IRFs reported for new orders, non-defense purchases, and for real federal government receipts.

The IRF for the monetary base exhibits a u-shaped pattern, and is very persistent. It declines significantly for almost three years after a shock to new orders. This result implies that the shocks to new orders may be associated with persistent changes in monetary policy, which is consistent with the evidence reported by Caplan (1999) for instance.

Overall, the IRFs for the fiscal variables and monetary base presented in this sub-section indicate that the shocks to new orders of defense products identified using the Choleski decomposition coincide with significant and persistent changes in non-defense purchases, real federal government receipts, the real federal government deficit, and the monetary base. Furthermore, the IRFs computed for the fiscal variables imply that the federal government is able to finance military increases in new orders of defense products through decreases in non-defense purchases and increases in revenues.

4.9.2 Alternative Sample Periods

As was mentioned before, to examine the sensitivity of the results reported for the model with new orders to perturbations in the sample period used, the model with new orders is estimated over the sub-sample periods 1969:3 to 1989:4 and 1973:2 to 1999:2. Then, the IRFs for new orders, real GDP, RTB, and the GDP deflator computed for a unit shock to new orders are plotted against for the corresponding confidence intervals reported for the whole sample period.

In the first and second columns of Figure 4.27, the solid lines display the point estimates of the IRFs for new orders, real GDP, RTB, and the GDP deflator computed when the model with new orders is estimated over the sub-sample periods 1969:3 to 1989:4 and 1973:2 to 1999:2, respectively. The dashed lines display the confidence intervals reported for the whole sample period.

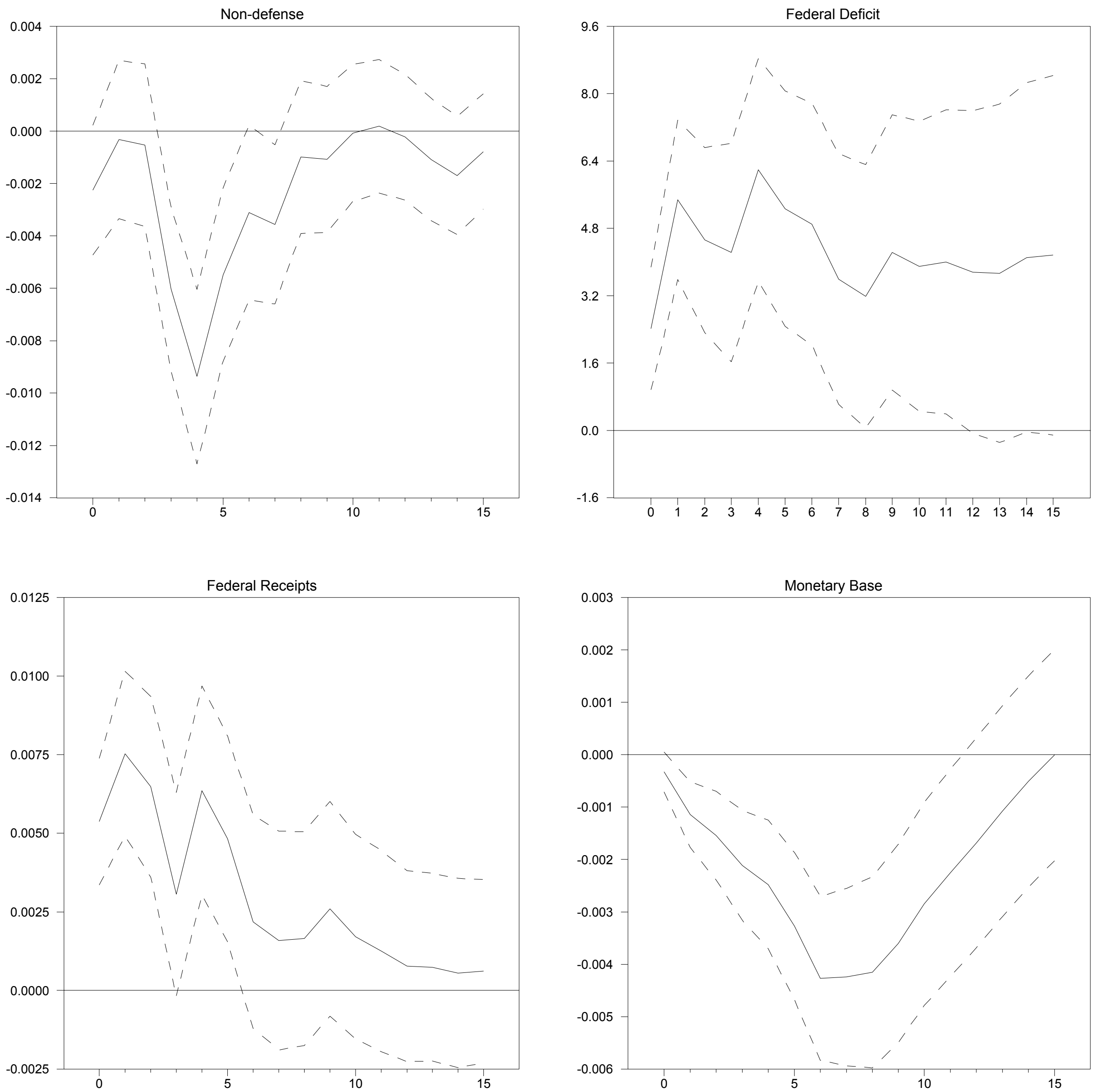


Figure 4.26: Point Estimates of the IRFs for Fiscal and Monetary Variables
Models with New Orders of Defense Products

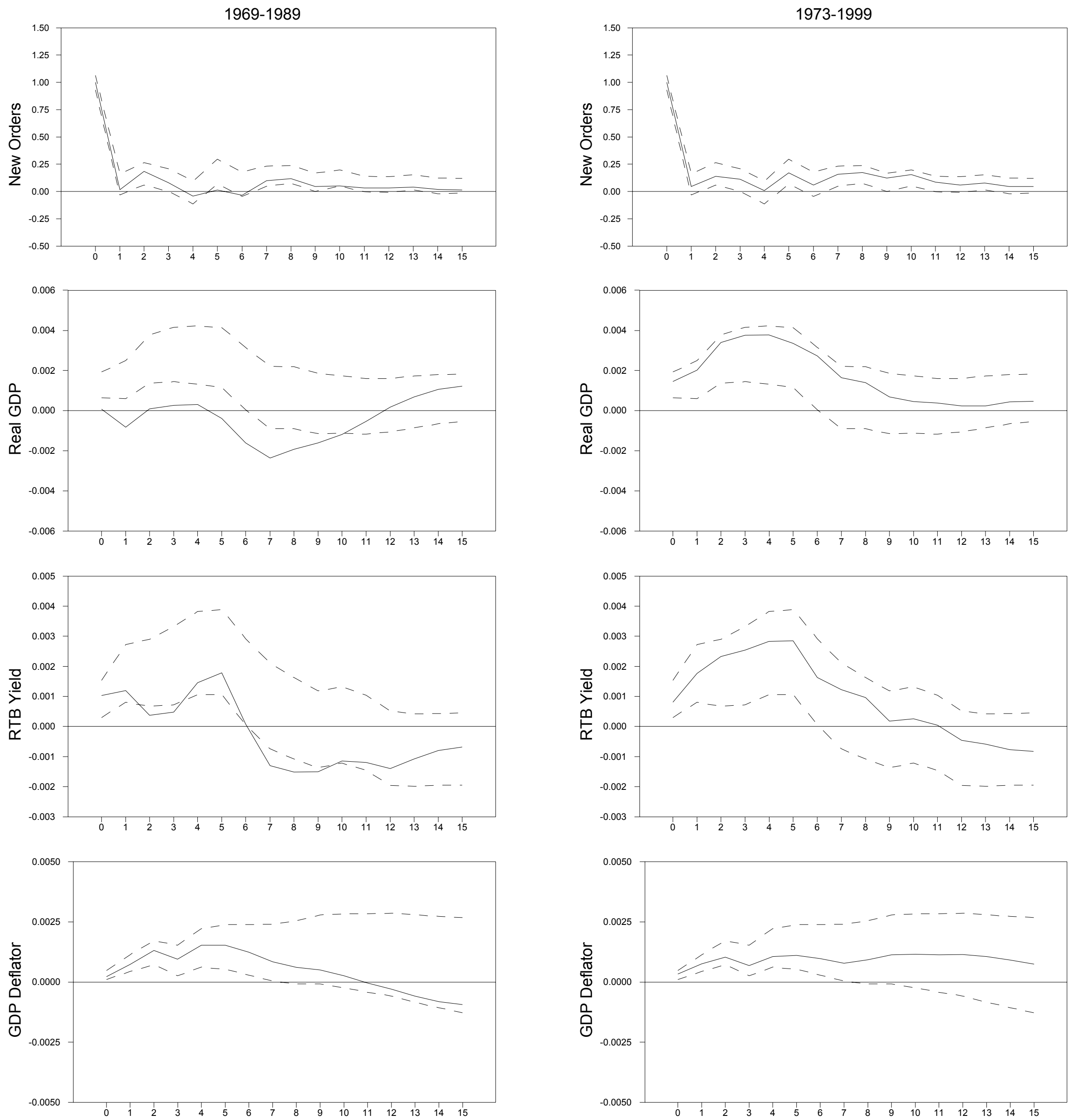


Figure 4.27: Point Estimates from Alternative Sample Periods for Model with New Orders of Defense Products
Confidence Intervals from the Whole Sample Period

When the model with new orders is estimated over the sub-sample period 1969:3 to 1989:4, the IRFs computed for new orders and the GDP deflator lie within the corresponding confidence intervals from the whole sample period at all horizons. However, the IRF computed for real GDP lies continually below the lower bound of the confidence interval from the whole sample period for more than two years. The IRF computed for RTB lies intermittently below the lower bound of the confidence interval from the whole sample period for more than two years.

When the model with new orders is estimated over the sub-sample period 1973:2 to 1999:2, all the IRFs computed lie within the corresponding confidence intervals from the whole sample period at all horizons, and their patterns are similar to the ones reported for the whole sample period.

Therefore, when the model with new orders is estimated for the sample period 1969:3 to 1989:4, it is concluded that the IRFs for real GDP and RTB appear sensitive to perturbations in the sample period used. However, when this model is estimated for the sample period 1973:2 to 1999:2, none of the IRFs appears sensitive to perturbations in the sample period used.

To further examine the sensitivity of the results reported for the model with new orders to perturbations in the sample period, Figure 4.28 presents the point estimates and confidence intervals of the IRFs computed for a unit shock to new orders when the model with new orders is estimated over the sub-sample periods 1969:3 to 1989:4 and 1973:2 to 1999:2. The solid lines display the point estimates of the IRFs for new orders, real GDP, RTB, and the GDP deflator. The dashed lines display the lower and upper bounds of one-standard deviation confidence intervals from these sample periods, not the full sample period.

The patterns and magnitudes of the IRF for new orders reported for the sub-sample periods 1969:3 to 1989:4 and 1973:2 to 1999:2 are similar to the ones presented for the whole sample period. Furthermore, the patterns and magnitudes of the IRF for real GDP, RTB, and the GDP deflator reported for the sub-sample period 1973:2 to 1999:2 are similar to the ones presented for the whole sample period.

However, the patterns of the IRF for real GDP and RTB reported for the sub-sample period 1969:3 to 1989:4 are quite different from the ones presented for the whole sample period. The IRF for real GDP is small and not significantly different from zero for more than a year. Then, it exhibits a u-shaped pattern, and it declines significantly for several periods in the second year after a shock to new orders. The IRF for RTB increases modestly for more than a year after a shock to new orders, and it is not significantly different from zero. Then, it declines sharply but briefly, and it is not significantly different from zero.

Overall, the IRF reported for new orders for the sub-sample period 1969:3 to 1989:4 is similar to the one presented for the whole sample period. However, the IRFs reported for real GDP and RTB are quite different. Furthermore, all the IRFs reported for the sub-sample period 1973:2 to 1999:2 are similar to the ones presented for the whole sample period.

4.10 Summary and Conclusions

This chapter provides evidence on the implications of using the Choleski decomposition for estimating the macroeconomic effects of exogenous shocks to government purchases. As in the previous chapters of the dissertation, it focuses on two

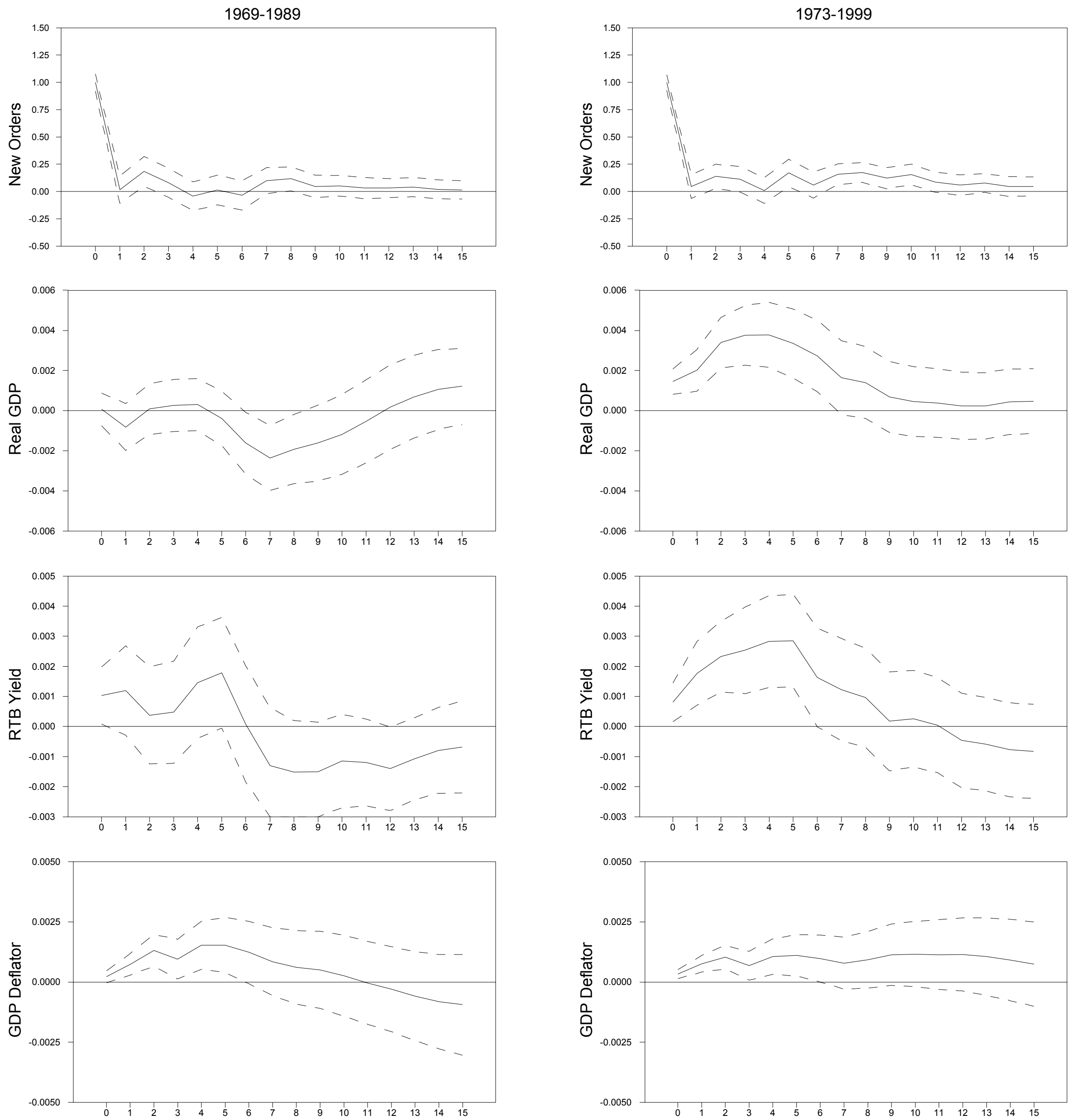


Figure 4.28: Point Estimates from Alternative Sample Periods for Model with New Orders of Defense Products
Confidence Intervals from Alternative Sample Periods

VAR systems in the spirit of Edelberg, Eichenbaum and Fisher (1999). In addition, it examines the benchmark model presented by Fatas and Mihov (2000).

Fatas and Mihov (2000) estimate a VAR system in the spirit of Edelberg, Eichenbaum, and Fisher (1999). However, they use a sample period different from the one presented by Edelberg, Eichenbaum, and Fisher (1999), and the values of the data for government receipts and transfer payments they use are incorrect. Therefore, the benchmark model presented by Fatas and Mihov (2000) is re-estimated using the correct values for government receipts and transfer payments over two different sample periods.

The IRFs for RTB and the GDP deflator reported for both sample periods are inconsistent with the theoretical two-sector neoclassical models presented by Ramey and Shapiro (1997) and Edelberg, Eichenbaum, and Fisher (1999) as well as the more traditional IS-LM and one-sector neoclassical models.

To compare the implications of using the narrative approaches presented in the previous chapters of the dissertation and the Choleski decomposition for estimating the effects of exogenous shocks to defense purchases, a benchmark model and an alternative model are estimated. They are identical to the ones estimated in the previous chapters, except that they do not include a dummy variable for exogenous shocks to defense purchases.

Then, IRFs that present the effects of a unit shock to defense purchases on defense purchases, real GDP, RTB, and the GDP deflator are computed. The IRFs reported for the benchmark model imply that defense purchases increase very persistently in response to a shock to defense purchases, output rises temporarily, and interest rates and the price level decline persistently. The IRFs reported for the alternative model are similar in pattern to the ones computed for the benchmark model; however, they are slightly different quantitatively.

Like the IRFs for RTB and the GDP deflator reported for Fatas and Mihov's model, the ones computed for the benchmark and alternative models are inconsistent with the theoretical two-sector neoclassical models presented by Ramey and Shapiro (1997) and Edelberg, Eichenbaum, and Fisher (1999) as well as the more traditional IS-LM and one-sector neoclassical models.

Since the robustness of the evidence reported using the Choleski decomposition to identify exogenous shocks to defense purchases has been questioned, this chapter examines the sensitivity of the results computed for the benchmark model to adding time trends and changing the lag length used. It is shown that the results reported for the benchmark model are not sensitive to adding time trends and to changing the lag length used, except for defense purchases.

To investigate the sensitivity of the results computed for the alternative model to perturbations in the list of variables used, eighteen endogenous and exogenous variables are added, in turn, to the alternative model, and the IRFs computed for the extended models and the alternative model are compared. It is shown that the results reported for the alternative model are sensitive to adding the Romers' monetary policy dummy, Hamilton's oil price dummy, the Ramey-Shapiro dummy variables, and to a lesser extent fiscal variables. However, they are not sensitive to adding sectoral variables except for employment in the durables manufacturing sector, and they are not sensitive to adding the monetary base, LTR, and the PPI for crude fuel.

The sensitivity of the results computed using the Choleski decomposition to perturbations in the sample period used is examined when the alternative model is estimated over four different sub-sample periods identical to the ones selected in the previous chapters of the dissertation. As for the narrative approaches, the IRFs reported for the four sub-samples periods using the Choleski decomposition imply that the results reported for the alternative model, in particular defense purchases, are sensitive to perturbations in the sample period used.

Edelberg, Eichenbaum and Fisher (1999) argue that the shocks to government purchases identified using the Choleski decomposition may not be unanticipated, and hence exogenous. Therefore, a VAR system identical to the alternative model, except that new orders of defense products is substituted for defense purchases, is estimated. Then, the IRFs that present the effects of a shock to new orders of defense products on new orders of defense products, real total GDP, RTB, and the GDP deflator are computed.

The IRFs reported for a shock to new orders of defense products are very different from the ones presented for a shock to defense purchases when the alternative model is estimated. They imply that output, interest rates, and the price level increase significantly for one and a half years in response to a positive shock to government purchases.

Unlike the IRFs presented for a shock to defense purchases when the alternative model is estimated, the ones reported for the model with new orders of defense products are consistent with a traditional IS-LM model. Therefore, it is concluded that new orders of defense products are a better proxy for government purchases than defense purchases.

To investigate the sensitivity of the results computed for the model with new orders of defense products to perturbations in the list of variables, the same methodology used to examine the robustness of the results reported for defense purchases are used. It is shown that the results reported for the model with new orders of defense products are not very sensitive to adding the variables selected, except the residential investment and consumption of durables and the Ramey-Shapiro dummy variable.

Finally, to investigate the sensitivity of the results computed for the model with new orders of defense products to perturbations in the sample period, this model is estimated for two different sub-sample periods. It is shown that the results reported for the model with new orders of defense products are fairly sensitive to altering the sample period.

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CHAPTER 5. LONG-RUN RESTRICTIONS

5.1 Introduction

As was mentioned in the introduction of the dissertation, although long-run (LR) restrictions have been commonly used in the VAR literature to investigate the macroeconomic effects of exogenous monetary policy shocks (Shapiro and Watson (1988), Blanchard and Quah (1989), Ahmed and al (1993), Faust and Leeper (1997), Fackler and McMillin (1998), Keating (1999), McMillin (2001)), it is believed that they have not been used yet to examine the effects of exogenous fiscal policy shocks.

However, LR restrictions may be an appropriate identification scheme to identify exogenous fiscal policy shocks, in particular shocks to government purchases. The most attractive feature of LR restrictions is that they are generally less controversial than contemporaneous restrictions. For instance, Keating (1999) states, "This method is particularly attractive to economists who believe theory describes long-run equilibrium phenomena better than short-run dynamics" (Keating 1999, p. 1).

Like the other identification schemes used to identify exogenous monetary policy shocks, LR restrictions have been the subject of several criticisms, which may be relevant when LR restrictions are implemented to identify exogenous shocks to government purchases. First, Faust and Leeper (1997) argue that the impulse response functions (IRFs) computed using LR restrictions are likely to be biased. They argue that the structural shocks identified must be viewed as aggregations of underlying shocks; however, the conditions for valid shock aggregation are unlikely to be met in a small VAR system. In particular, it is unlikely that all the underlying shocks used to construct the structural shocks affect the economy in precisely the same way.

Second, Faust and Leeper (1997) argue, "… The long-run effect of shocks is imprecisely estimated in finite samples, and the long-run identification scheme transfers this imprecision to other parameters of the model" (Faust and Leeper 1997, pp. 1-2). Third, Fackler and McMillin (1998) note, "… It is only in the short- and medium-runs for which substantive implications can be asserted since long-run results are constrained by the identifying restrictions" (Fackler and McMillin (1998), p. 653).

This chapter of the dissertation examines the implications of using LR restrictions for estimating the effects of exogenous shocks to government purchases. To compare the implications of using LR restrictions versus the narrative approaches and the Choleski decomposition presented in the previous chapters, it focuses on the same benchmark and alternative models as the ones examined in the previous chapters.

It also investigates the robustness of the results computed for the benchmark and alternative models when LR restrictions are used to identify exogenous shocks to government purchases. As was done in the studies of the narrative approaches and Choleski decomposition presented in the previous chapters, the robustness of the results computed for the benchmark model to adding time trends and altering the lag length used is examined. Furthermore, the robustness of the results computed for the alternative model to perturbations in the list of variables and the sample period used is considered.

Finally, some of the IRFs reported when LR restrictions are used to identify shocks to defense purchases are inconsistent with the theoretical two-sector neoclassical models presented by Ramey and Shapiro (1997) and Edelberg, Eichenbaum, and Fisher (1999) as well as the more traditional IS-LM and one-sector neoclassical models. Therefore, as was done in the previous chapter, the implications of using new orders of

defense products as a proxy for defense purchases for estimating the effects of a shock to defense are examined.

The plan of the remainder of this chapter is as follows. Section 5.2 presents the results computed for the benchmark model and for models in which alternative measures of interest rates are substituted for the net three month interest rate on Treasury bills (RTB). Section 5.3 examines the sensitivity of the benchmark model to adding time trends and altering the lag length used. Section 5.4 presents the results computed for the alternative model.

Section 5.5 and 5.6 discuss the sensitivity of the alternative model to perturbations in the list of variables and in the sample period used, respectively. Section 5.7 examines the results computed when new orders of defense products are used as a proxy for defense purchases. Section 5.8 discusses the sensitivity of the model reported for the model with new orders of defense products to perturbations in the list of variables and the sample period. Section 5.9 provides a brief summary and conclusion.

5.2 Benchmark Model

This section presents the IRFs computed for benchmark model when LR restrictions are used to identify the shocks to defense purchases. For comparison's sake, the benchmark model is exactly identical to the one estimated in the study of the Choleski decomposition. As was mentioned before, it includes a constant and four lagged values of defense purchases, real GDP, RTB, and the GDP deflator in each equation. The logarithmic values of the variables are used except for RTB.

The point estimates of the IRFs reported for the benchmark model as well as the other VAR systems examined in this chapter are computed following the methodology presented by McMillin (2001), who uses LR restrictions as well as contemporaneous restrictions to investigate the macroeconomic effects of monetary policy shocks. The variables are differenced prior to estimation. Then, a Choleski decomposition of the long-run relations among the variables in the systems is used to identify the exogenous shocks to defense purchases.

Keating (1999) shows that neutrality restrictions can be imposed within a VAR system, and hence structural shocks can be identified, using a Choleski decomposition of the long-run relations among the variables from a VAR estimated in first differences, provided that the long-run ordering is consistent with the underlying economic structure.

Since the variables are differenced prior to estimation, the benchmark model is estimated from 1948:2 to 1999:2 and data from 1947:2 to 1947:1 are used as pre-sample data. To compare the implications of using the identification schemes presented in the previous chapters of the dissertation and LR restrictions for estimating the effects of a shock to defense purchases, the effects of a shock to defense purchases on the levels of the variables are reported. Therefore, the point estimates of the IRFs computed using LR restrictions at any horizon are the cumulative sums of the point estimates of the IRFs computed for the differenced variables up to and including this point.

In the Choleski decomposition of the long-run relations among the residuals of the variables in the benchmark model, real GDP is ordered first, defense purchases is ordered second, the GDP deflator is ordered third, and RTB is ordered last. A key assumption made in selecting this ordering is that defense purchases have no effect on the level of output in the long run, which implies that the defense purchases should be ordered after real GDP. It is consistent with the predictions from a sticky-wage/price aggregate

demand-aggregate supply-type model. Furthermore, Keating (2000) shows that it is consistent with data from the post-World War II era.

Keating (2000) carries out a series of experiments to determine if demand shocks, including shocks to government purchases, are neutral in the long run. He argues that the evidence reported is consistent with the fact that demand shocks do not have a long run effect on the level of output, and concludes, "… The empirical results for postwar economies are consistent with the textbook aggregate supply and demand structure" (Keating 2000, p. 14).

Another key assumption is that shocks to the price level and RTB do not have a long-run effect on defense purchases, which implies that the price level and RTB are ordered after defense purchases. It is consistent with many studies published in the foreign policy and defense policy literature in which it is argued that decisions with regard to defense spending are independent from economic developments (Garnett (1987), Rearden (1984), Shilling (1962)).

For instance, Garnett (1987) argues, "… Defense expenditure is determined not by economic constraint, but by political decisions-decisions that reflect the values and priorities of the electorate and the government" (Garnett 1987, p. 10). Similarly, Schilling (1962) emphasizes that defense policy choices "… Can be made in only one place: the political arena" (Shilling 1962, p. 15). Furthermore, he argues that "… The major limit on the size of the defense budget is not how much the economy can 'stand' but how much the people can be persuaded to support" (Schilling 1962, p. 234).

The shocks to defense purchases identified using LR restrictions for the sample period from 1948:2 to 1999:2 are presented in Figure 5.1. The vertical lines mark the onsets of the exogenous increases and retrenchments in defense purchases identified in the third chapter of the dissertation using a narrative approach. Like the shocks identified using the Choleski decomposition, the shocks identified using LR restrictions are dramatically larger during the Korean War military build-up than any other period in the post-World War II era. The largest shock identified, which occurred in 1951:1, is more than twice as large as any other shocks taking place afterward.

As is done in the study of the Choleski decomposition presented in the previous chapter, the benchmark model is estimated, and the IRFs for defense purchases, real total GDP, RTB, and the GDP deflator that present the effects of a unit shock to defense purchases are computed. In Figure 5.2, the solid lines display the point estimates of the IRFs. The dashed lines display the lower and upper bounds of one standard error confidence intervals computed using a Monte Carlo integration procedure.

The IRF for defense purchases increases sharply for a year, and then it remains stable. It is highly significant at all horizons. The pattern of the IRF for defense purchases implies that the shocks to defense purchases identified have a temporary effect on the growth rate of defense purchases, and a permanent effect on their level. This is consistent with the point estimates of the IRF computed for defense purchases when the benchmark model is estimated in first differences, which indicate that the growth rate of defense purchases increases temporarily after a shock to defense purchases.

The IRF for real GDP is positive for one and a half years after a shock to defense purchases, and then it is negative. However, it is small and never significantly different from zero. The IRF for RTB is negative at all horizons, and it is marginally significant the quarter after a shock to defense purchases. The IRF for the GDP deflator is positive

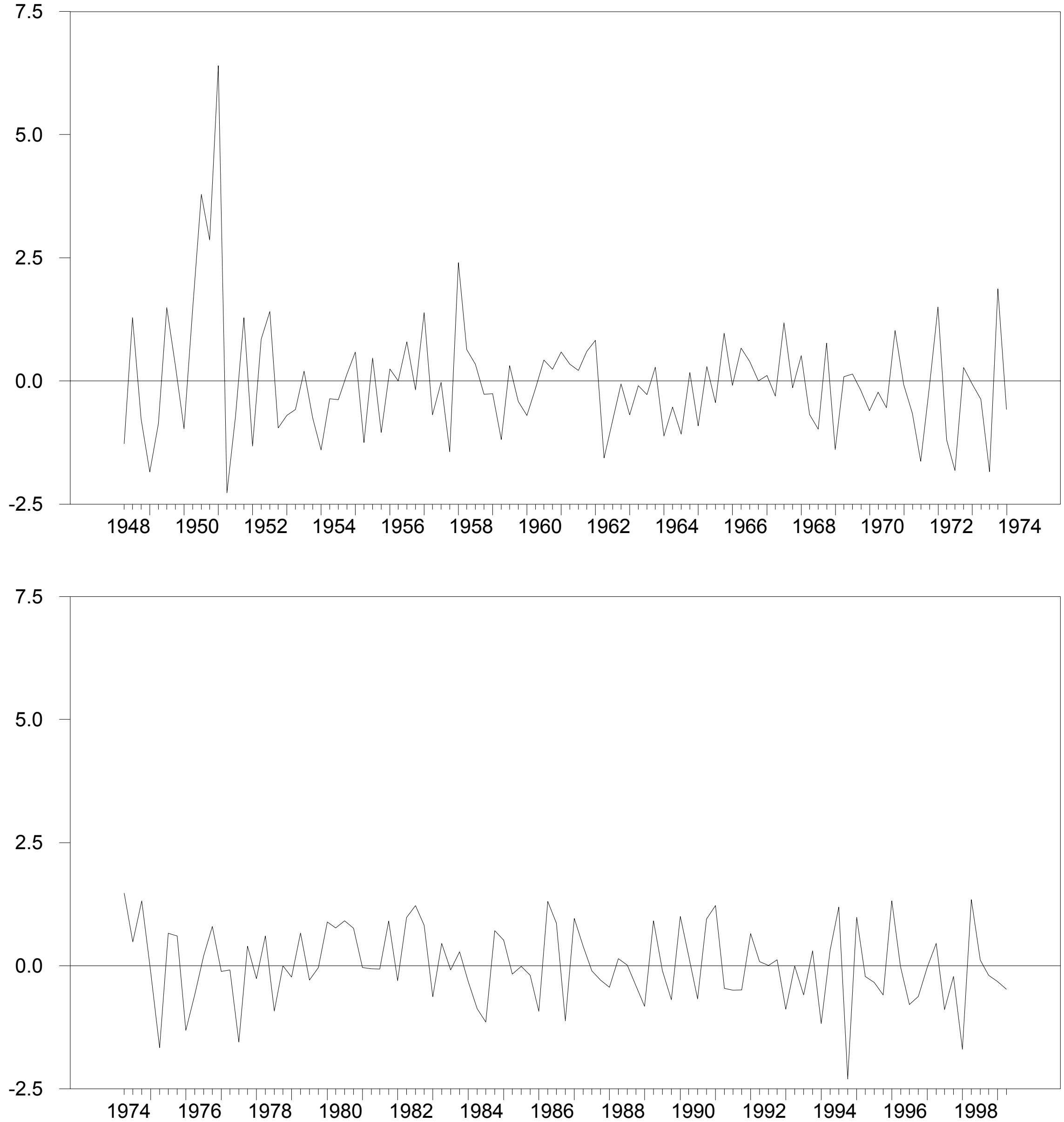

Figure 5.1: Shocks to Defense Purchases
Sample Period: 1948:2-1999:2

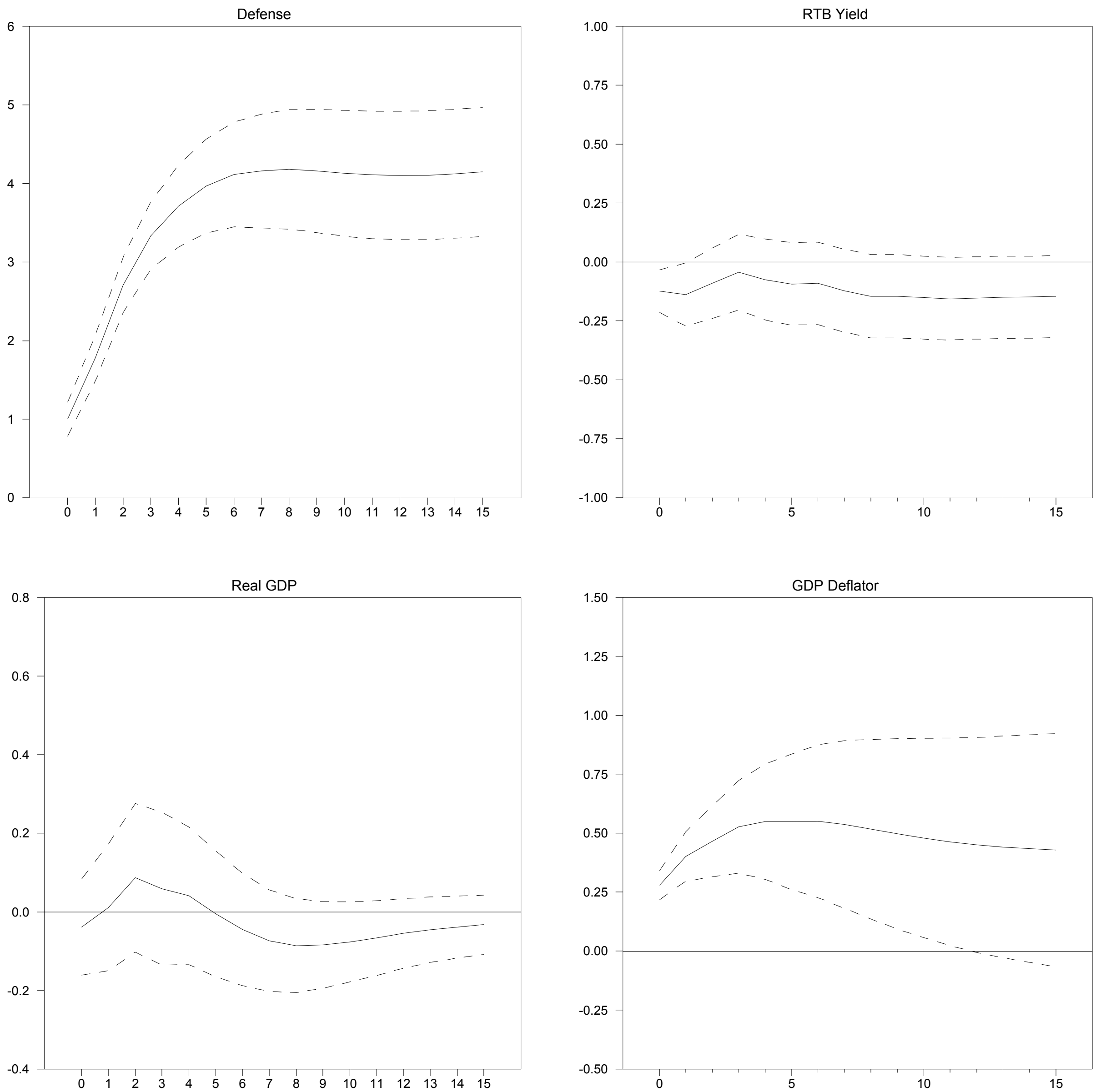

Figure 5.2: Point Estimates from Benchmark Model
Sample Period: 1948:2-1999:2

and persistent. It increases significantly for almost three years after a shock to defense purchases.

Like the IRF for RTB reported for the benchmark model using the Choleski decomposition, the one computed using LR restrictions is problematic. The IRF for RTB is inconsistent with the theoretical two-sector neoclassical models presented by Ramey and Shapiro (1997) and Edelberg, Eichenbaum, and Fisher (1999) as well as the more traditional IS-LM and one-sector neoclassical models.

Moreover, although a shock to defense purchases has a large and very persistent effect on defense purchases, the IRF computed for real GDP is not significantly different from zero at any horizon. However, unlike the IRF for the GDP deflator reported for the benchmark model using the Choleski decomposition, the one computed using LR restrictions is consistent with the theoretical two-sector neoclassical models presented by Ramey and Shapiro (1997) and Edelberg, Eichenbaum, and Fisher (1999) as well as the more traditional IS-LM and one-sector neoclassical models.

Given the IRF reported for RTB when the benchmark model is estimated, it is of interest to examine the sensitivity of the results computed for the benchmark model to alternatively substituting real RTB and the nominal ten-year Treasury rate (LTR) for RTB. In Figure 5.3, the solid lines display the point estimates of the IRFs for defense purchases, real GDP, the GDP deflator and the alternative measures of interest rates substituted for RTB computed for a unit shock to defense purchases. The dashed lines display the lower and upper bounds of one-standard deviation confidence intervals.

The patterns and amplitudes of the IRFs for defense purchases, real GDP, and the GDP deflator computed when real RTB or LTR is substituted for RTB are very similar to the ones reported for the benchmark model. The pattern of the IRF for real RTB is very different from the one reported for RTB. The IRF for real RTB drops significantly in the period of a shock to defense purchases, and then it steadily returns toward its original value. Overall, it is negative and significant for more than a year. The IRF for LTR is positive at all horizons; however, it is small and not significantly different from zero at any horizon.

In conclusion, the IRFs reported for defense purchases, real GDP, and the GDP deflator are not affected when real RTB or LTR is substituted for RTB in the benchmark model. Furthermore, like the IRF reported for RTB, the IRF computed for real RTB is inconsistent with the theoretical two-sector neoclassical models presented by Ramey and Shapiro (1997) and Edelberg, Eichenbaum, and Fisher (1999) as well as the more traditional IS-LM and one-sector neoclassical models. The IRF for LTR is not significantly different from zero at any horizon.

5.3 Alternative Time Trends and Lag Lengths

The benchmark model estimated in the previous section is exactly identical to the one presented in the previous chapter of the dissertation. Therefore, the statistical evidence on the selection of an appropriate time trend and an adequate lag length for the VAR system under study in the previous chapter applies to the system estimated in the previous section.

According to the Akaike Information Criterion (AIC) values reported in the previous chapter, it is best to add a “Perron-type” trend to each equation in the benchmark model. The Schwartz Bayesian Criterion (SBC) values reported imply that it is best not to add a time trend. Finally, the likelihood ratio tests carried out imply that it

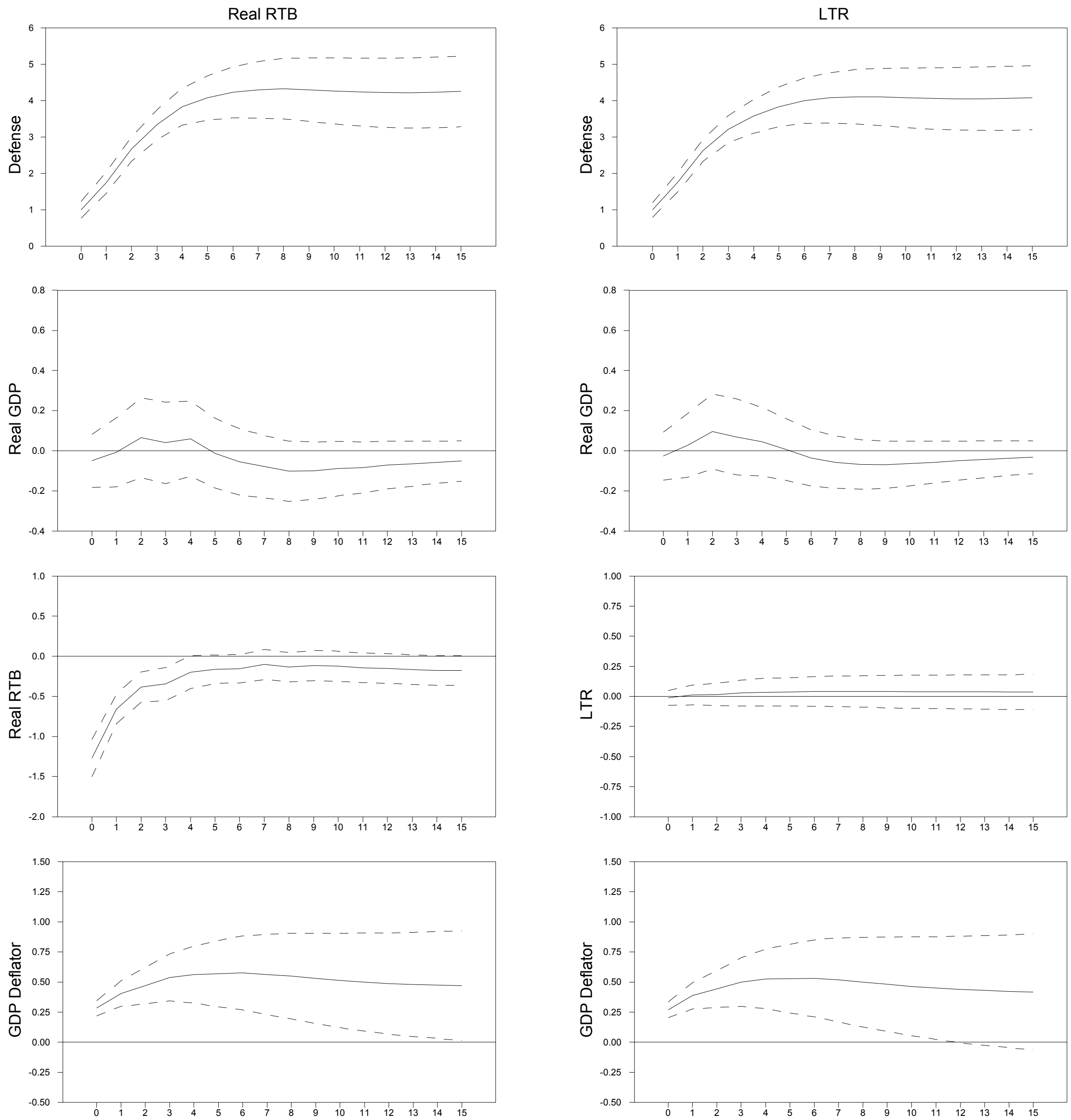

Figure 5.3: Point Estimates from Models With Alternative Measures of Interest Rates
Sample Period: 1948:2-1999:2

is preferable to include a “Perron-type” trend or linear and quadratic trends than no trend or a linear trend only.

Furthermore, according to the AIC values and the likelihood ratio tests reported in the previous chapter, it is better to include six lagged values of the endogenous variables in each equation of the benchmark model. The SBC values reported imply that it is best to include two lagged values of the variables.

5.3.1 Time Trend

To examine the sensitivity of the results reported for the benchmark model to adding time trends, VAR systems are estimated in which linear and quadratic trends and a “Perron-type” trend are added to each equation of the benchmark model.[1] If the results reported for the benchmark model are not sensitive to adding time trends, the IRFs computed for the systems in which linear and quadratic trends or a “Perron-type” trend are included ought to lie within the corresponding confidence intervals reported for the benchmark model.

In Figure 5.4, the solid lines display the point estimates of the IRFs for defense purchases, real GDP, RTB, and the GDP deflator computed for a unit shock to defense purchases when the models with linear and quadratic trends or a “Perron-type” trend are estimated. The dashed lines display the confidence intervals computed for the benchmark model. When the model with linear and quadratic trends is estimated, all the IRFs reported lie within the corresponding confidence intervals from the benchmark model at all horizons. Furthermore, their patterns are similar to the ones reported for the benchmark model.

When the model with a “Perron-type” trend is estimated, the IRF for defense purchases increases much more gradually than the one presented for the benchmark model, and it lies well below the confidence interval from the benchmark model at all horizons. The IRF for real GDP lies within or on the confidence interval from the benchmark model at all horizons; however, its pattern is very different from the one reported for the benchmark model.

Except for the first quarter after a shock to defense purchases, the IRF for RTB lies within or on the confidence interval from the benchmark model at all horizons; however, its pattern is different from the one reported for the benchmark model at long horizons. The IRF for the GDP deflator lies below the corresponding confidence interval from the benchmark model at all horizons.

Overall, the IRFs reported in this sub-section yield mixed evidence on the sensitivity of the results reported for the benchmark model to adding a time trend. The IRFs reported for the benchmark model are not significantly affected when linear and quadratic trends are added. In contrast, they are significantly affected when a “Perron-type” trend is added. Furthermore, whether linear and quadratic trends or a “Perron-type” trend are added, the IRF reported for RTB remains troublesome.

5.3.2 Lag Length

To examine the sensitivity of the results reported for the benchmark model to altering the lag length used, VAR systems identical to the benchmark model, except that they include two or six lagged values of the variables, are estimated. If the results reported for the benchmark model are not sensitive to the lag length used, the IRFs

[1] The “Perron-type” time trend as well as the other time trends included in this chapter are discussed in detail in the first chapter of the dissertation.

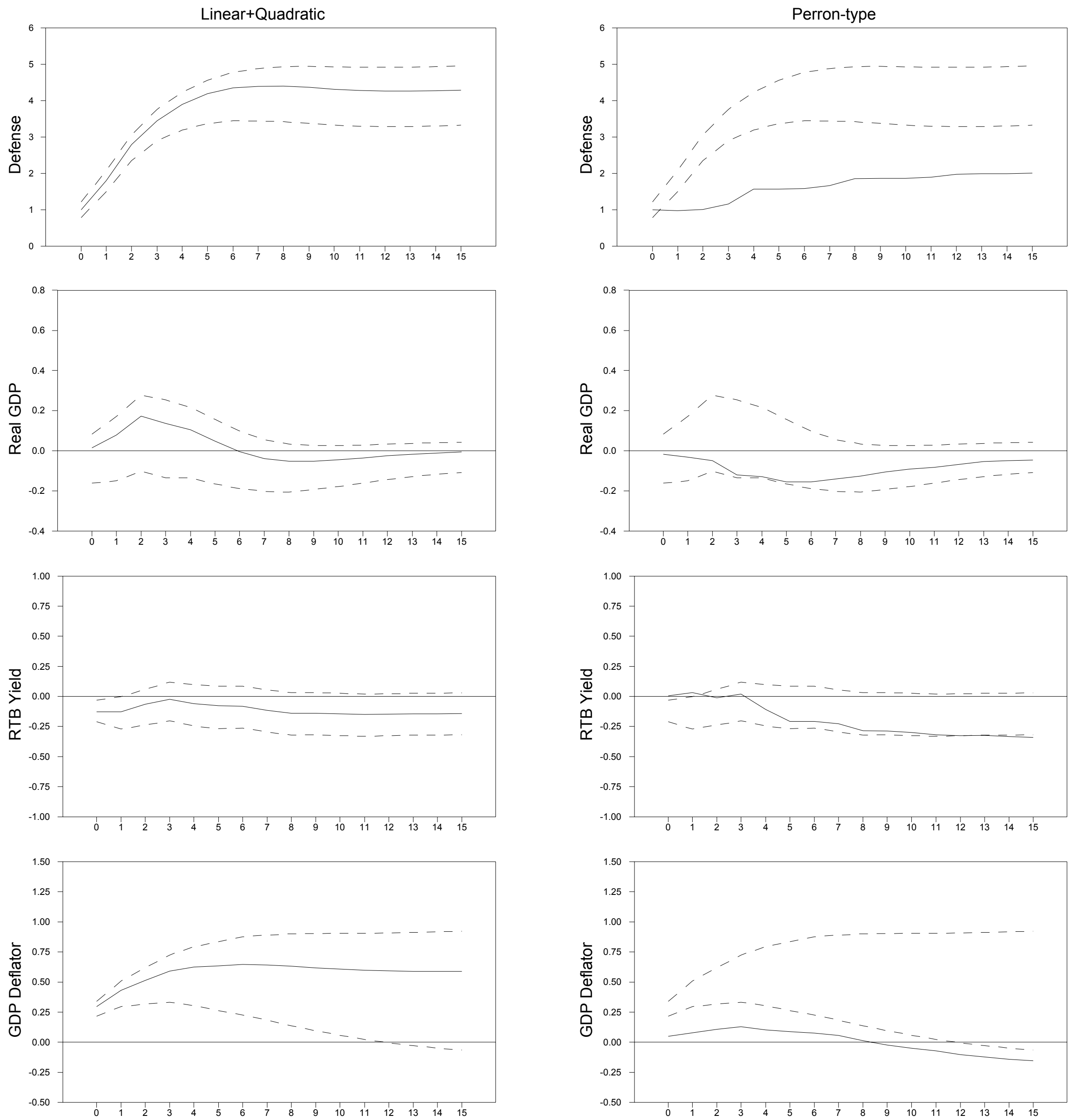

Figure 5.4: Point Estimates from Models with Alternative Time Trends
Confidence Intervals from Benchmark Model

computed for the systems with two or six lagged values of the variables ought to lie within the corresponding confidence intervals from the benchmark model.

In Figure 5.5, the solid lines display the point estimates of the IRFs for defense purchases, real GDP, RTB, and the GDP deflator computed for a unit shock to defense purchases when the systems with two or six lags of the variables are estimated. The dashed lines display the confidence intervals computed for the benchmark model. All the IRFs computed for the models with two and six lags lie within the corresponding confidence intervals from the benchmark model at all horizons. Furthermore, except for the IRF for real GDP computed for the model with six lags, the patterns of the IRFs reported for the models with two and six lags are similar to the ones presented for the benchmark model.

Overall, all the IRFs computed for the models with two or six lagged values of the variables lie within the corresponding confidence intervals from the benchmark model at all horizons. Furthermore, all but one of the IRFs computed for the models with two or six lagged values of the variables exhibit patterns similar to the ones reported for the benchmark model. Therefore, it is concluded that the results reported for the benchmark model are not sensitive to altering the lag length used.

5.4 Alternative Model

As was mentioned in the previous chapter, the specification of the equations selected for the benchmark model, which is the one used by Edelberg, Eichenbaum, and Fisher (1999), is not the best for the VAR system under study. According to the AIC criterion, it is best to estimate an alternative model that includes six lagged values of the endogenous variables and a "Perron-type" trend.

Therefore, this section presents the IRFs for defense purchases, real GDP, RTB, and the GDP deflator computed for a unit shock to defense purchases when the alternative model is estimated over the sample period from 1948:4 to 1999:2. In the first column of Figure 5.6, the solid lines display the point estimates of the IRFs and the dashed lines display the lower and upper bounds of one-standard deviation confidence intervals computed using a Monte Carlo integration procedure.

Except for real GDP, the IRFs reported for the benchmark and alternative models appear relatively similar. The main difference between the two models is found in the response of the real GDP. Whereas the IRF reported for the benchmark model is temporarily positive after a shock to defense purchases, the one computed for the alternative model remains negative. Furthermore, the IRF for the GDP deflator computed for the alternative model rises significantly for only one and a half years, compared to three years for the benchmark model.

To further compare the results computed for the benchmark and alternative models, the IRFs for defense purchases, real GDP, RTB, and the GDP deflator reported for the benchmark model are plotted against the confidence intervals from the alternative model, which is the preferred model. If the IRFs computed for the benchmark model are not significantly different from the ones reported for the alternative model, they ought to lie within the corresponding confidence intervals from the alternative model.

In the second column of Figure 5.6, the solid lines display the point estimates of the IRFs reported for the benchmark model and the dashed lines display the confidence intervals computed for the alternative model. The IRF for defense purchases lies very slightly above the upper bound of the confidence interval from the alternative model for

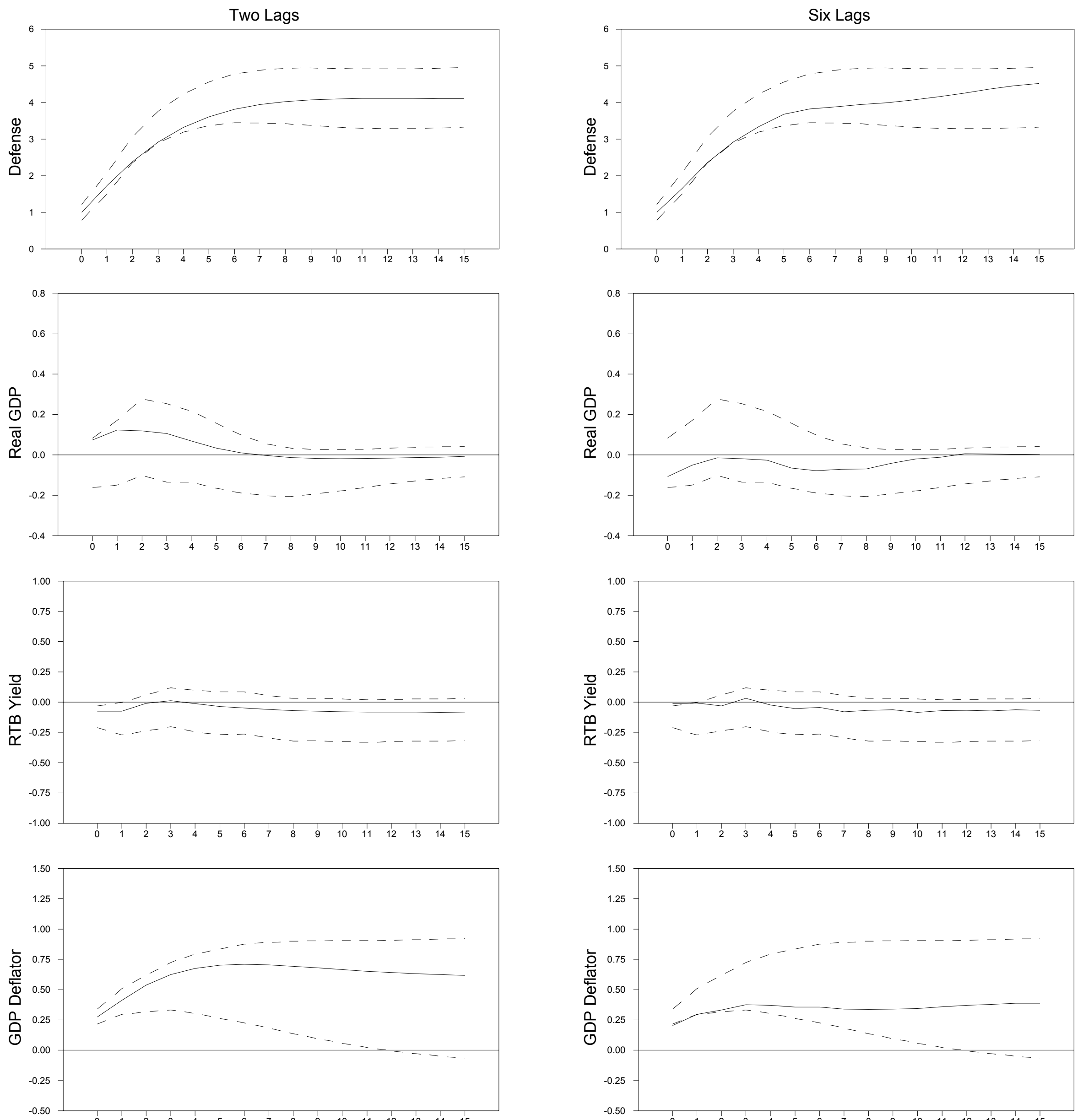

Figure 5.5: Point Estimates from Models with Alternative Lag lengths
Confidence Intervals from Benchmark Model

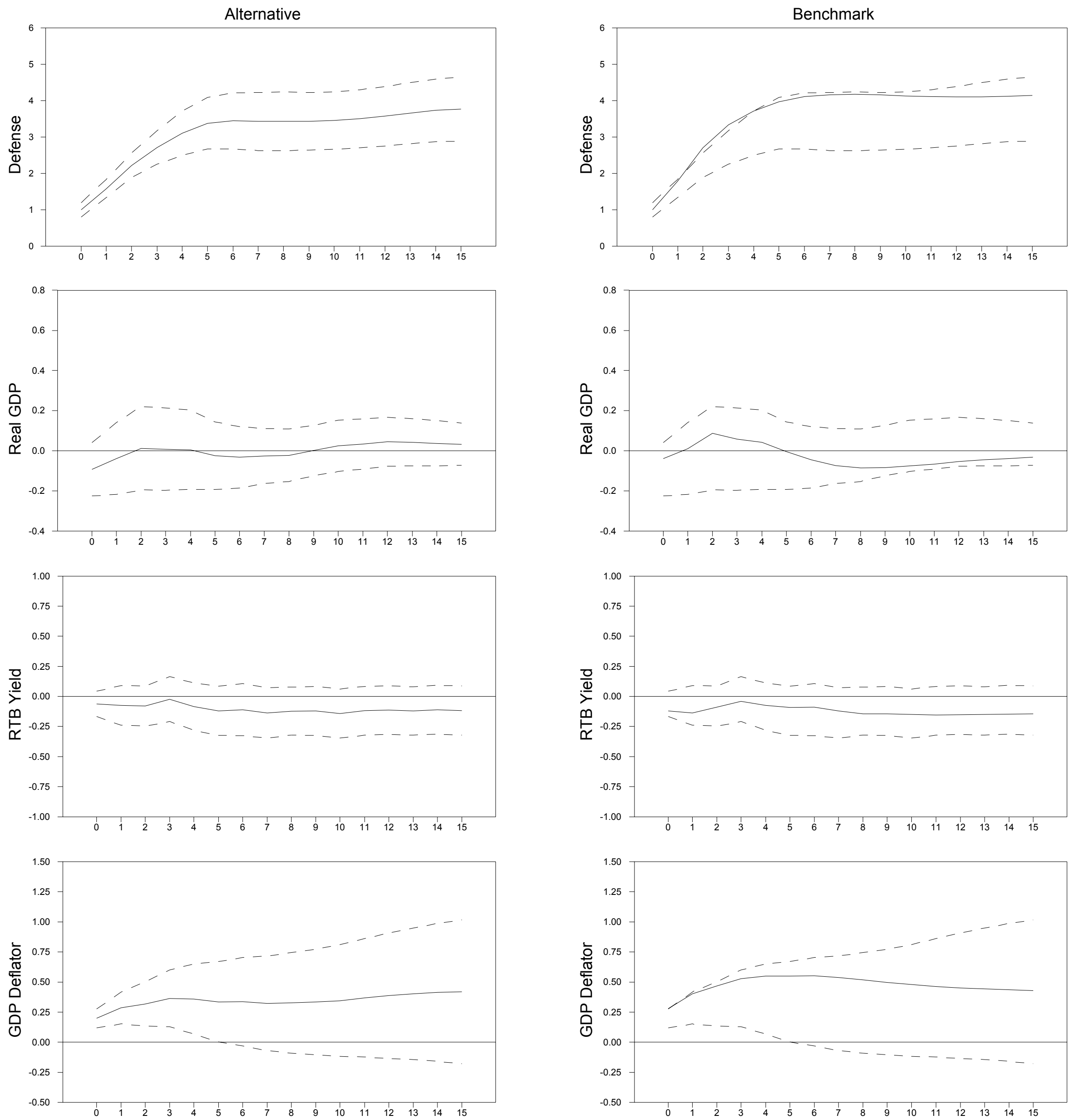

Figure 5.6: Point Estimates from Alternative Model and Benchmark Model
Confidence Interval from Alternative Model

several quarters, and it remains close to the upper bound of the confidence interval for more than two years. The IRFs for real GDP, RTB, and the GDP deflator lie within the corresponding confidence intervals from the alternative model at all horizons.

In conclusion, except for real GDP, the patterns of the IRFs presented for the alternative model are similar to the ones reported for the benchmark model. Except for defense purchases, the amplitudes of the IRFs presented for the alternative model are not significantly different from the ones reported for the benchmark model. The IRF for defense purchases is marginally and temporarily smaller than the one reported for the benchmark model.

Furthermore, as for the benchmark model, the IRF for RTB computed for the alternative model is inconsistent with the theoretical two-sector neoclassical models presented by Ramey and Shapiro (1997) and Edelberg, Eichenbaum, and Fisher (1999) as well as the more traditional IS-LM and one-sector neoclassical models. In addition, the IRF for real GDP is not significantly different from zero at any horizon.

5.5 Extended Models

This section investigates the sensitivity of the results reported for defense purchases, real GDP, RTB, and the GDP deflator to adding an endogenous variable or an exogenous dummy variable to the alternative model. Eighteen variables are alternatively considered. They are the ones used in the study of the Choleski decomposition presented in the previous chapter of the dissertation.

To examine the sensitivity of the results reported for the alternative model to adding any of the variables under consideration, the methodology used is the same as the one presented in the previous chapters. First, an extended version of the alternative model is estimated that includes defense purchases, real GDP, RTB, the GDP deflator, and the variable under consideration. Six lagged values of the variable under consideration are included if it is endogenous. The contemporaneous and six lagged values are included if it is an exogenous dummy variable.

Then, the IRFs for defense purchases, real GDP, RTB, and the GDP deflator are computed for a unit shock to defense purchases, and plotted against the corresponding confidence intervals reported for the alternative model. If the results reported for the alternative model are not sensitive to perturbations in the list of variables used, the IRFs computed for the extended model ought to lie within the corresponding confidence intervals from the alternative model.

First, the effects of the shocks to defense purchases in models that alternatively include additional fiscal variables are examined. Then, the effects of the shocks in models that alternatively include consumption, investment, and labor market variables are investigated. Next, the effects of the shocks in models that alternatively include the Romers' monetary policy dummy variable, the monetary base, a measure of long-term interest rates, Hamilton's oil price dummy variable, the PPI for crude fuel, and the Ramey-Shapiro dummy variable are presented.

5.5.1 Fiscal Variables

This sub-section presents evidence on the effects of shocks to defense purchases in models that alternatively include non-defense purchases, real federal government receipts, and the real federal government deficit. The logarithmic values of the additional fiscal variables are used except for the deficit, which takes negative values. To construct the measures of real federal government receipts and the real federal government deficit,

the current values of these variables in billions of dollars are deflated by the CPI. Non-defense purchases are in billions of chained (1992) dollars.[2]

For the models with an additional fiscal variable, real GDP is ordered first in the long-run Choleski decomposition used to identify the shocks to defense purchases, defense purchases are ordered second, the additional fiscal variables are ordered third, the GDP deflator is ordered fourth, and RTB is ordered last. This ordering implies that shocks to the additional fiscal variables under study may not a have long-run effect on defense purchases.

The critical assumption made in identifying the shocks to defense purchases within the fiscal models is that decisions regarding defense purchases in the long run come before other fiscal decisions. While this assumption is generally consistent with many studies in the foreign and defense policy literature, it is noted that shocks to the additional fiscal variables under consideration, in particular the real federal government deficit, may have some effects on defense purchases in the long run.[3]

However, a long-run Choleski decomposition of the residuals from the fiscal models does not permit to account for potential interactions among fiscal variables in the long run. Therefore, the exercises presented above for the fiscal variables were replicated when for real GDP is ordered first in the long-run Choleski decomposition used to identify the shocks to defense purchases, the additional fiscal variables are ordered second, defense purchases are ordered third, the GDP deflator is ordered fourth, and RTB is ordered last. The results computed for the alternative ordering are similar to the ones presented hereafter.

In Figure 5.7, the point estimates of the IRFs for defense purchases, real GDP, RTB, and the GDP deflator computed when the additional fiscal variables are added, in turn, to the alternative model are plotted against the corresponding confidence intervals from the alternative model. The solid lines display the point estimates of the IRFs and the dashed lines display the confidence intervals.

When non-defense purchases, real federal government receipts or the real federal government deficit are added to the alternative model, all the IRFs reported lie within or on the corresponding confidence intervals from the alternative model at all horizons. Furthermore, the patterns of the IRFs reported are similar to the ones presented for the alternative model. Therefore, it is concluded that the results reported for the alternative model are not sensitive to adding fiscal variables.

5.5.2 Sectoral Variables

This sub-section presents evidence on the effects of shocks to defense purchases in models that alternatively include components of consumption and investment. Following Edelberg, Eichenbaum, and Fisher (1999), consumption and investment are broken down into three components: consumption of non-durables and services, residential investment plus consumption of durables, and non-residential investment.

It also presents evidence on the effects of shocks to defense purchases in models that alternatively include measures of employment, real wages, and real compensation.

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[2] The different extended models estimated in this section and the variables included in these extended models are identical to the ones presented in the previous chapters of the dissertation. They are more thoroughly discussed in the second chapter of the dissertation.

[3] The historical accounts discussed in the second chapter of the dissertation suggest that the impact of high military expenditures on the deficit was a concern toward the end of the Korean War, the Kennedy, and Carter-Reagan military build-ups.

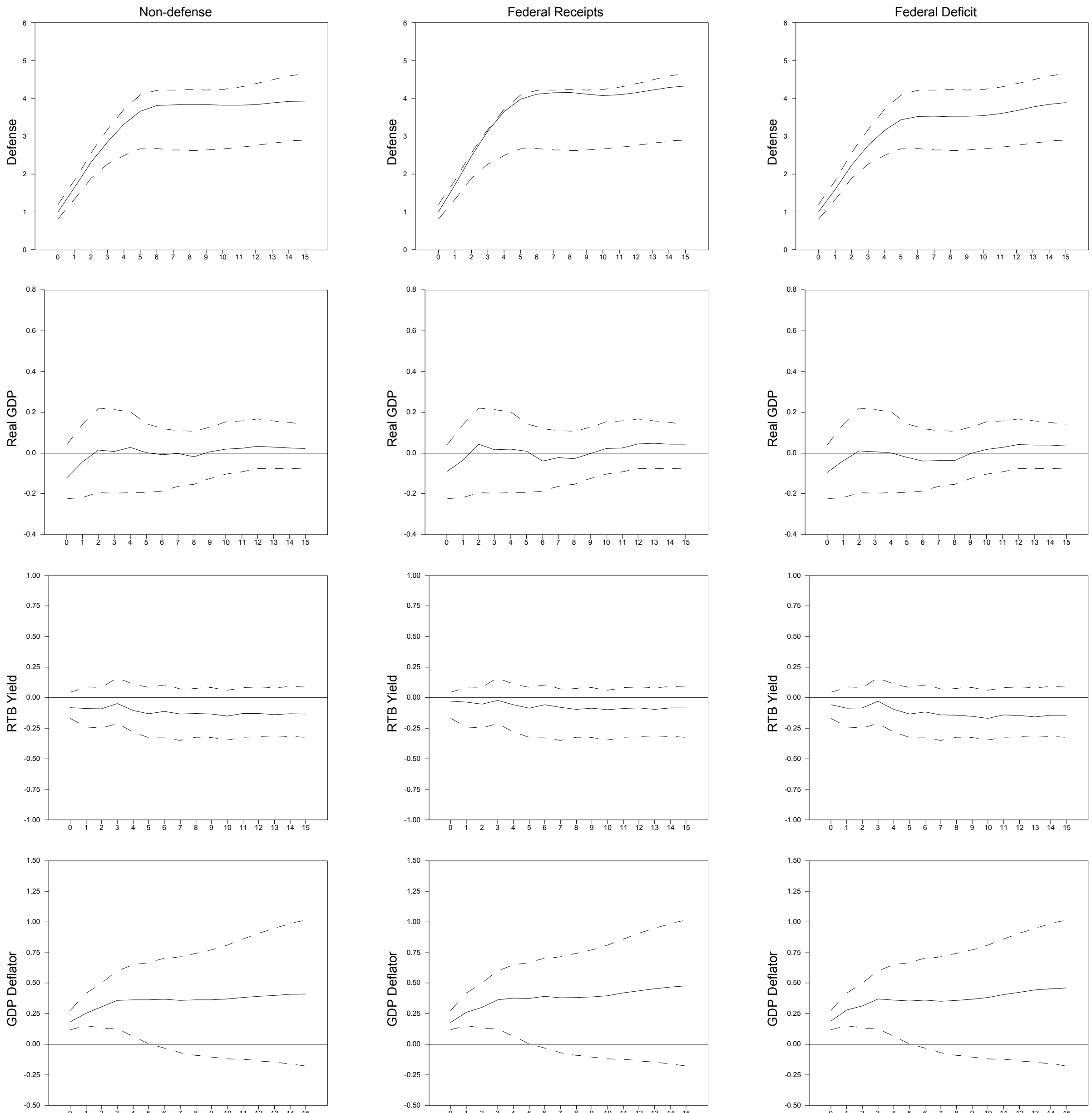

Figure 5.7: Point Estimates from Models with a Fiscal Variable
Confidence Interval from Alternative Model

First, employment in the private sector, employment in the non-durables manufacturing sector, and employment in the durables manufacturing sector are examined. Then, real wages in private industry, real compensation in the manufacturing sector, and real compensation in the business sector are considered.

The logarithmic values of the measures of consumption, investment, employment, real wages and real compensation are included in the models estimated. To construct the measures of real compensation and real wages, the nominal values of these variables are deflated by the CPI. The other additional sectoral variables examined hereafter are in billions of chained (1992) dollars.

The measures of consumption and investment are ordered third in the long-run Choleski decomposition used to identify the shocks to defense purchases. It is ordered after real GDP and defense purchases but before the GDP deflator and RTB. The key assumption is that shocks to consumption and investment may not have long run effects on the levels of output and defense; however, they may have long-run effects on the price level and interest rates.

The ordering presented above is consistent with the results from a simple aggregate supply-aggregate demand model in which aggregate demand shocks have a temporary effect on the level of output, but may have a permanent effect on the levels of interest rates and price. However, shocks to private investment, in particular non-residential investment, may in fact have some effects on the level of output in the long run since they may influence the stock of capital in the economy.

A long-run Choleski decomposition of the residuals from the models with a measure of investment does not permit one to account for potential interactions between investment and output in the long run. Therefore, the IRFs for the model with non-residential investment are also computed when non-residential investment is ordered first in the long-run Choleski decomposition used to identify the shocks to defense purchases, real GDP is ordered second, defense purchases are ordered third, the GDP deflator is ordered fourth, and RTB is ordered last. The results computed for the alternative ordering are similar to the ones presented hereafter.

Like the measures of consumption and investment, the different measures of employment, real wages, and real compensation added to the alternative model are ordered third in the long-run Choleski decomposition used to identify the shocks to defense purchases. It is assumed that shocks to employment, real wages, and real compensation may not have a long run effect on the level of output and defense; however, they may have long-run effects on the price level and interest rates.

In Figure 5.8, the point estimates of the IRFs computed for defense purchases, real GDP, RTB, and the GDP deflator when the consumption and investment variables listed above are added, in turn, to the alternative model are plotted against the corresponding confidence intervals from the alternative model. The solid lines display the point estimates of the IRFs and the dashed lines display the confidence intervals.

In Figure 5.9, the point estimates of the IRFs for defense purchases, real GDP, RTB, and the GDP deflator computed when employment in private industry, employment in the non-durables manufacturing sector, and employment in the durables manufacturing sector are added, in turn, to the alternative model are plotted against the corresponding confidence intervals from the alternative model. The solid lines display the point estimates of the IRFs and the dashed lines display the confidence intervals

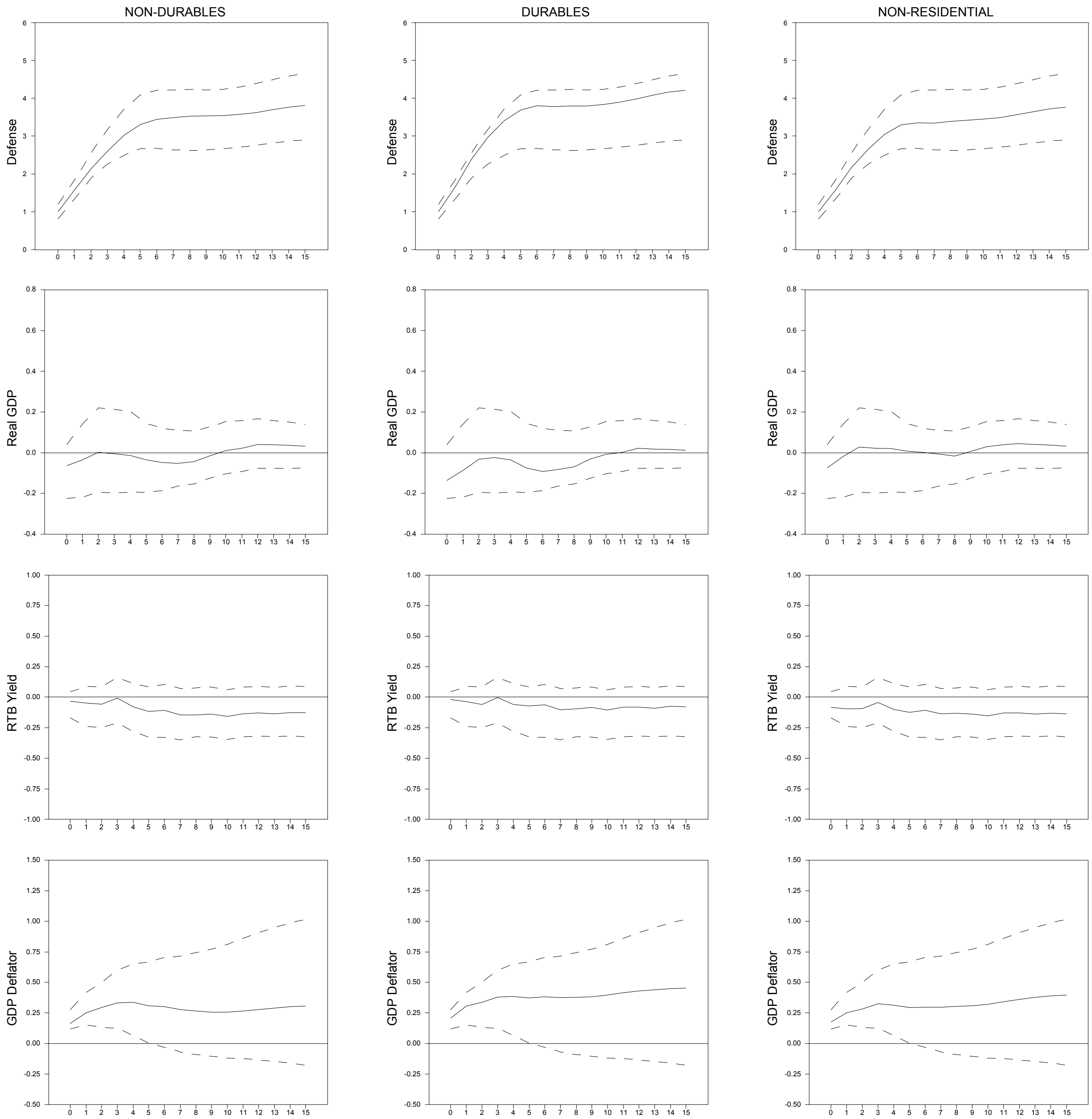

Figure 5.8: Point Estimates from Models with a Consumption or Investment Variable
Confidence Intervals from Alternative Model

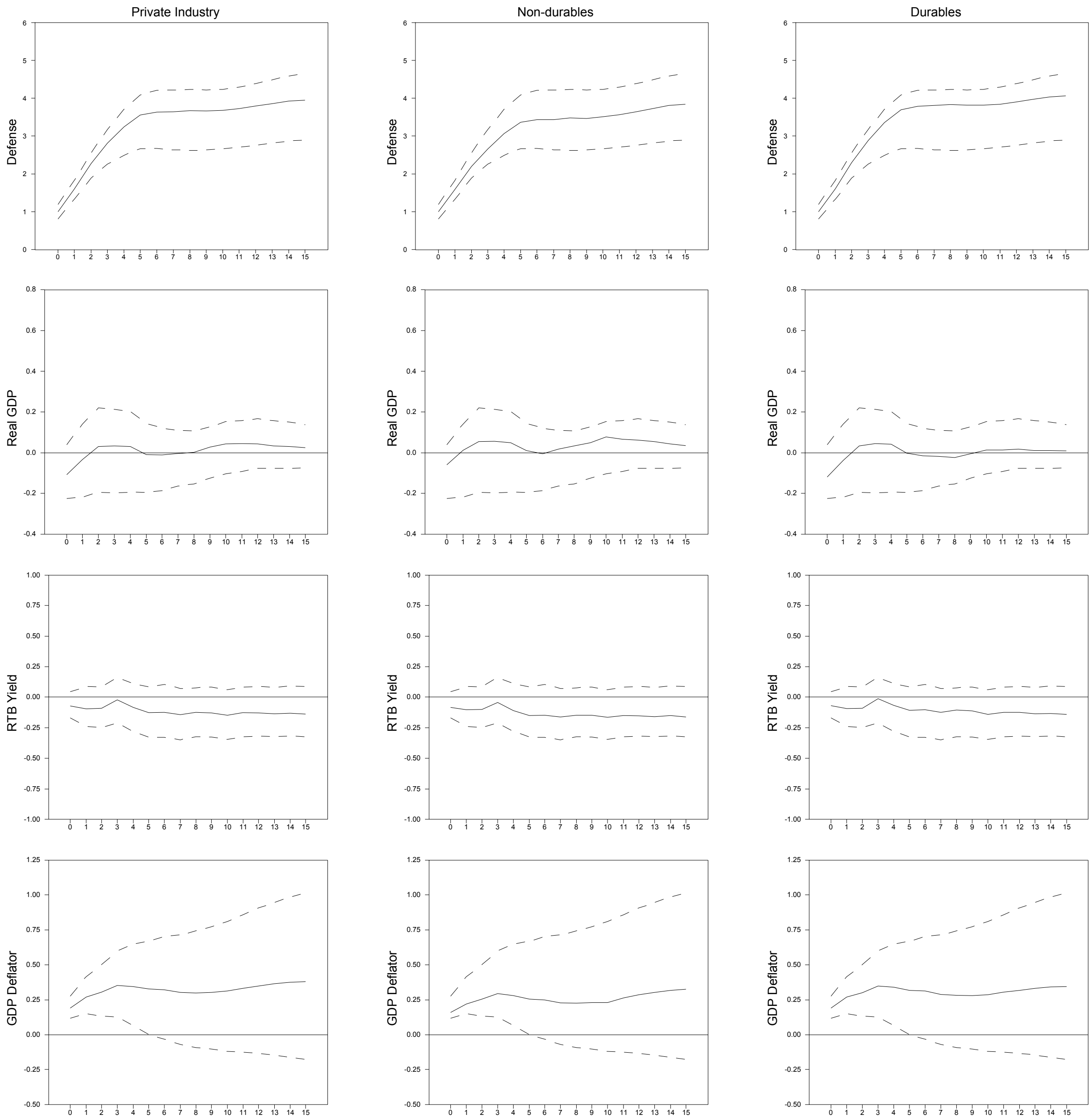

Figure 5.9: Point Estimates from Models with an Employment Variable
Confidence Intervals from Alternative Model

In Figure 5.10, the point estimates of the IRFs for defense purchases, real GDP, RTB and the GDP deflator computed when real wages in private industry, real compensation in the manufacturing sector, and real compensation in the business sector are added, in turn, to the alternative model are plotted against the corresponding confidence intervals from the alternative model. The solid lines display the point estimates of the IRFs and the dashed lines display the confidence intervals.

Since the series for compensation in the manufacturing sector is not available before 1949:1, the model with real compensation in the manufacturing sector is estimated from 1950:4 to 1999:2, and the IRFs reported for this model are plotted against the confidence intervals computed for the same sample period.

When measures of consumption and investment, or measures of employment, or measures of real wages and real compensation are added, in turn, to the alternative model, all the IRFs reported lie within or on the corresponding confidence intervals from the alternative model at all horizons. Furthermore, the patterns of the IRFs reported are similar to the ones presented for the alternative model. Therefore, it is concluded that the results reported for the alternative model are not sensitive to adding sectoral variables.

5.5.3 Additional Macroeconomic Variables

This sub-section presents evidence on the effects of shocks to defense purchases in models that include the Romers' monetary policy dummy variable, the monetary base, and LTR. It also investigates the effects of shocks to defense purchases in models that include Hamilton's oil price dummy variable, the PPI for crude fuel, and the Ramey-Shapiro dummy variable.

For the model with the monetary base, this variable is ordered third in the long-run Choleski decomposition used to identify the shocks to defense purchases. It is ordered after real GDP and defense purchases but before the GDP deflator and RTB. Shocks to the monetary base are assumed not to have long-run effects on real GDP and defense purchases; however, they may have a permanent effect on the levels of interest rates and price.[4]

For the model with LTR, this variable is ordered last in the long-run Choleski decomposition used to identify the shocks to defense purchases. The other variables follow the same ordering as in the alternative model. Shocks to LTR are assumed not to have long-run effects on the other variables in the system estimated; however, shocks to the other variables in the system, in particular RTB, may have a long-run effect on LTR.

In Figure 5.11, the point estimates of the IRFs for defense purchases, real GDP, RTB, and the GDP deflator computed when the monetary variables and LTR are added, in turn, to the alternative model are plotted against the corresponding confidence intervals from the alternative model. The solid lines display the point estimates of the IRFs and the dashed lines display the confidence intervals.

When the Romers' monetary policy dummy variable is added to the alternative model, the IRF computed for defense purchases increases much more gradually than the one reported for the alternative model. It lies below the lower bound of the confidence interval from the alternative model at all horizons. The IRFs for real GDP and RTB lie

[4] Since the traditional IS-LM model predicts that monetary shocks have only temporary effects on the price level and interest rates, the monetary base may be ordered after the GDP deflator and RTB in the long-run Choleski decomposition used to identify shocks to defense purchases. It does not affect the results reported for the model with the monetary base.

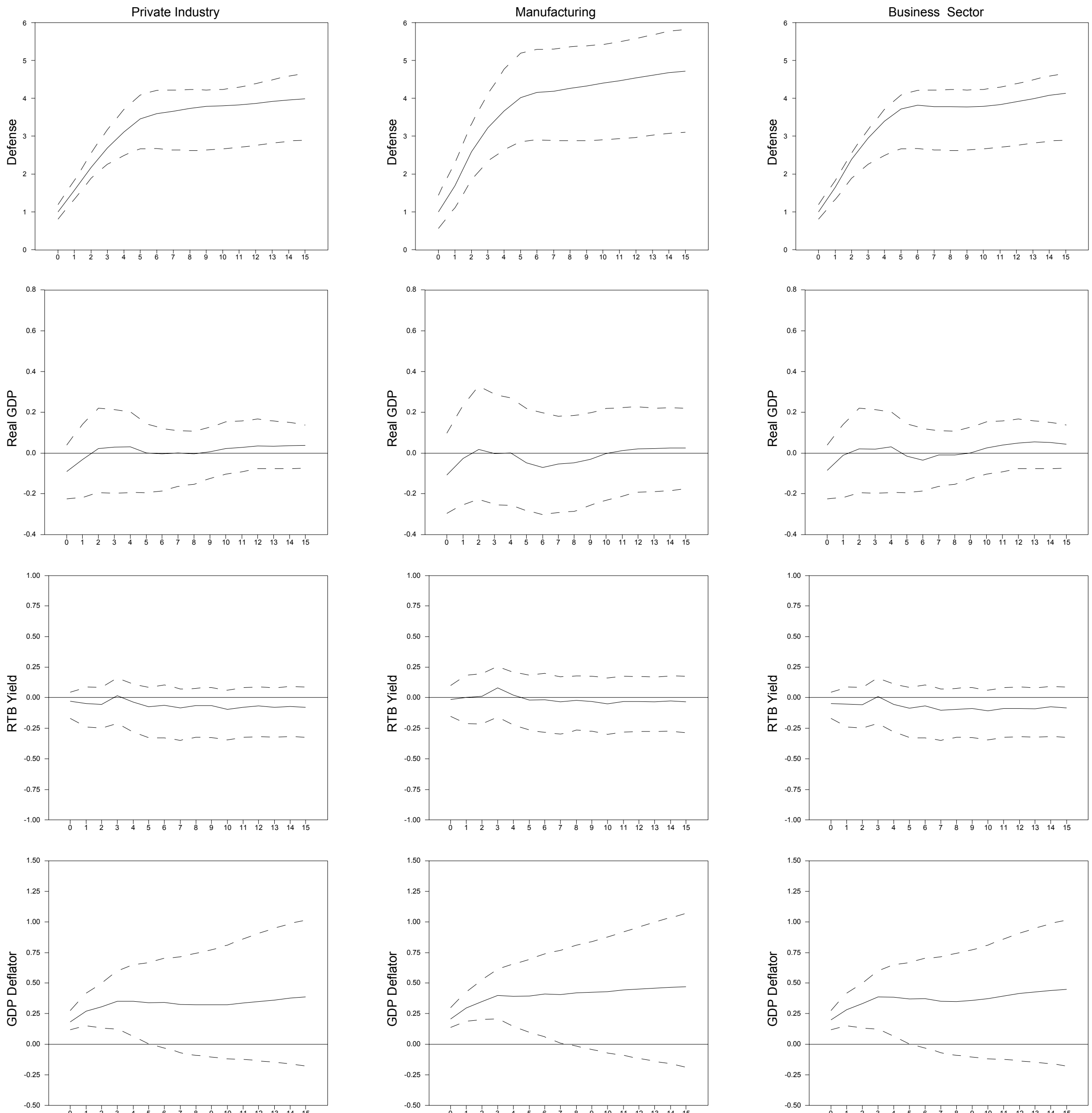

Figure 5.10: Point Estimates from Models with a Measure of Real Wages or Real Compensation
Confidence Intervals from Alternative Model

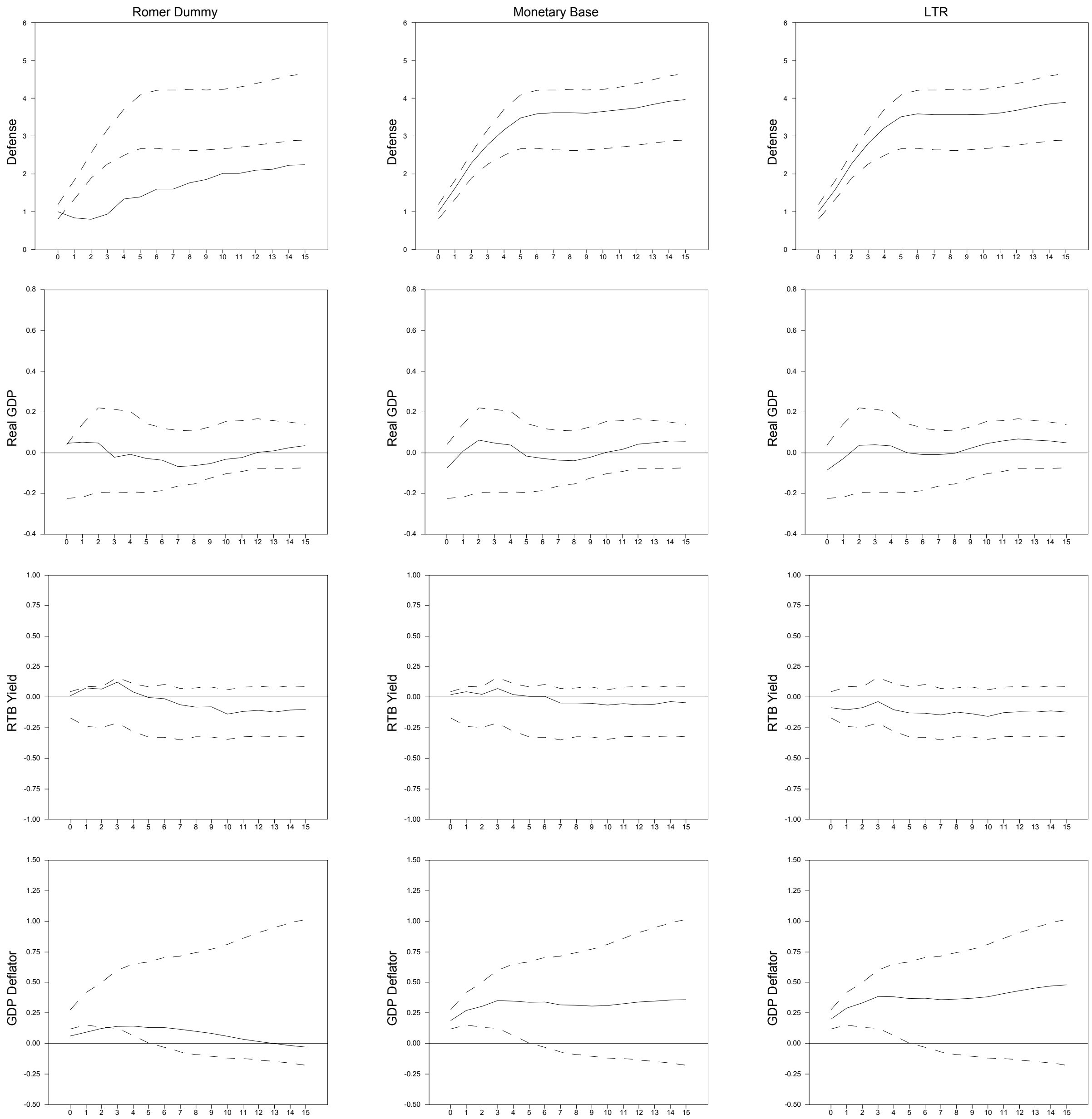

Figure 5.11: Point Estimates from Models with an Additional Macroeconomic Variable
Confidence Intervals from Alternative Model

within the corresponding confidence intervals from the alternative model at all horizons. The IRF for the GDP deflator is small at all horizons, and it lies slightly below the lower bound of the confidence interval from the alternative model for more than two quarters after a shock to defense purchases.

When the monetary base or LTR is added to the alternative model, all the IRFs reported lie within the corresponding confidence intervals from the alternative model at all horizons. Furthermore, the patterns of the IRFs reported are similar to the ones presented for the alternative model.

In Figure 5.12, the point estimates of the IRFs computed when Hamilton's oil price dummy variable, the PPI for crude fuel, and the Ramey-Shapiro dummy variable are added, in turn, to the alternative model are plotted against the corresponding confidence intervals from the alternative model. The solid lines display the point estimates of the IRFs and the dashed lines display the confidence intervals.

When Hamilton's oil price dummy variable is added to the alternative model, the IRF computed for defense purchases increases much more gradually than the one reported for the alternative model, and it lies below the lower bound of the confidence interval from the alternative model at all horizons. The IRF for real GDP lies within the confidence interval from the alternative model at all horizons.

The IRF for RTB reported for the model with Hamilton's oil price dummy variable is positive at all horizons, and it lies above the upper bound of the confidence interval from the alternative model at all horizons. The IRF for the GDP deflator is small, and it lies slightly below the lower bound of the confidence interval from the alternative model for two quarters after a shock to defense purchases.

When the PPI for crude fuel is added to the alternative model, all the IRFs computed lies within the corresponding confidence intervals from the alternative model at all horizons. Furthermore, the patterns of the IRFs reported are similar to the ones presented for the alternative model.

When the Ramey-Shapiro dummy variable is added to the alternative model, the IRF computed for defense purchases increases much more gradually than the one reported for the alternative model, and it lies below the lower bound of the confidence interval from the alternative model at all horizons. The IRFs computed for real GDP and RTB lie within or on the corresponding confidence intervals from the alternative model at all horizons. The IRF for the GDP deflator is small, and it lies slightly below the lower bound of the confidence interval from the alternative model for more than a year after a shock to defense purchases.

Overall, The results computed when the monetary base, LTR, and the PPI for crude fuel are added, in turn, to the alternative model imply that the IRFs reported for the alternative model are not sensitive to adding these variables. However, the results computed when the dummy variables are added, in turn, to the alternative model imply that the IRFs reported for the alternative model, in particular for defense purchases, are sensitive to adding the dummy variables.

When the dummy variables are added, in turn, to the alternative model, the IRFs reported for defense purchases are much smaller than the one reported for the alternative model, and the IRFs for the GDP deflator are initially smaller than the one reported for the alternative model. Furthermore, when Hamilton's oil price dummy variable is added

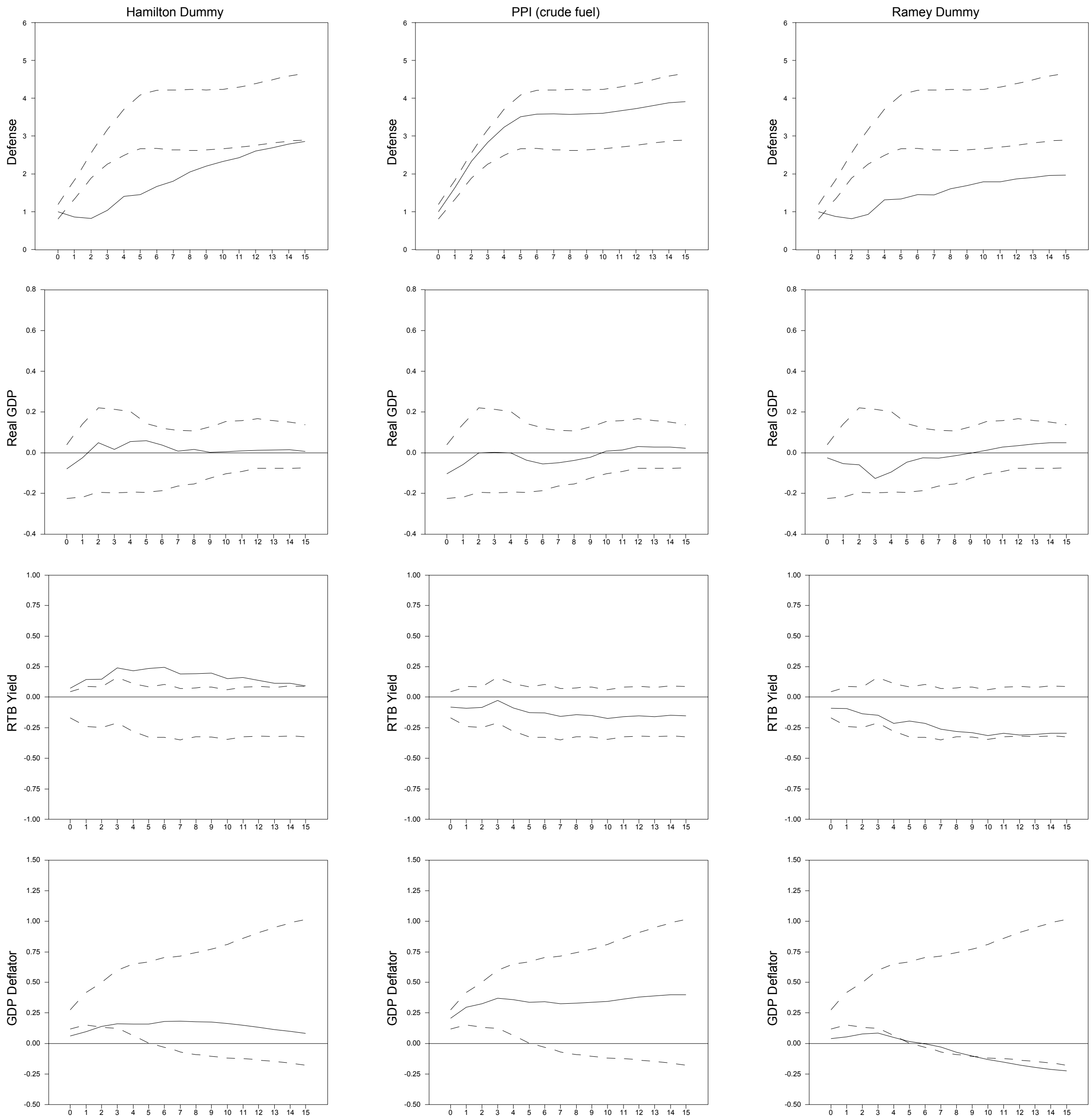

Figure 5.12: Point Estimates from Models with an Additional Macroeconomic Variable
Confidence Intervals from Alternative Model

to the alternative model, the IRF for RTB is larger than the one reported for the alternative model.

5.5.4 Responses of Fiscal and Monetary Variables

As was done for the narrative approaches and the Choleski decomposition, it is of interest to determine whether the shocks identified using LR restrictions coincide not only with increases in defense purchases but also changes in other dimensions of fiscal policy or changes in monetary policy. Therefore, this sub-section presents the effects of a shock to defense purchases on some of the fiscal and monetary variables added, in turn, to the alternative model in the previous sub-section.

It is of interest to present the effects of a unit shock to new orders on additional fiscal variables and the monetary base. In Figure 5.13, the solid lines display the point estimates of the IRFs computed for non-defense purchases, real federal government receipts, the real federal government deficit, and the monetary base when the extended models that include these variables are estimated. The dashed lines display the lower and upper bounds of one-standard deviation confidence intervals. The IRFs for the additional fiscal variables are very different from the ones reported when a narrative approach or the Choleski decomposition is used to identify exogenous shocks to defense purchases.

The IRF for non-defense purchases decreases significantly in the period of a shock to defense purchases, and then it gradually returns toward its original level. The decline in non-defense purchases is persistent, it is significant for almost three years after a shock. The IRF for real federal government receipts increases significantly in the period of a shock to defense purchases, and then it remains stable. It is positive and significant at all horizons.

The IRF for the real federal government deficit declines steadily for one and a half years after a shock to defense purchases, and then it remains stable. It is significant at all horizons after a delay of a year, which means that the federal government deficit deteriorates significantly and persistently in response to a shock to defense purchases. This result may be consistent with the IRFs reported for the other fiscal variables examined. Together with the IRF for government deficit, the IRFs for government purchases and government receipts imply that the government has to finance large increases in defense purchases through deficits in spite of the rise in government receipts and the decline in non-defense purchases.

The IRF for the monetary base is very different from the one reported when the Choleski decomposition is used to identify shocks to defense purchases. It increases persistently; however, it is relatively small and not significantly different from zero at any horizon. It implies that shocks to defense purchases do not coincide with significant changes in monetary policy.

5.6 Alternative Sample Periods

This section examines the sensitivity of the results reported for defense purchases, real GDP, RTB, and the GDP deflator to perturbations in the sample period used to estimate the alternative model. The methodology implemented is the same as the one presented for the narrative approaches and Choleski decomposition in the previous chapters of the dissertation.

First, the alternative model is estimated over four sub-sample periods. The early and late sub-sample periods span from 1948:4 to 1973:1 and 1960:1 to 1999:2,

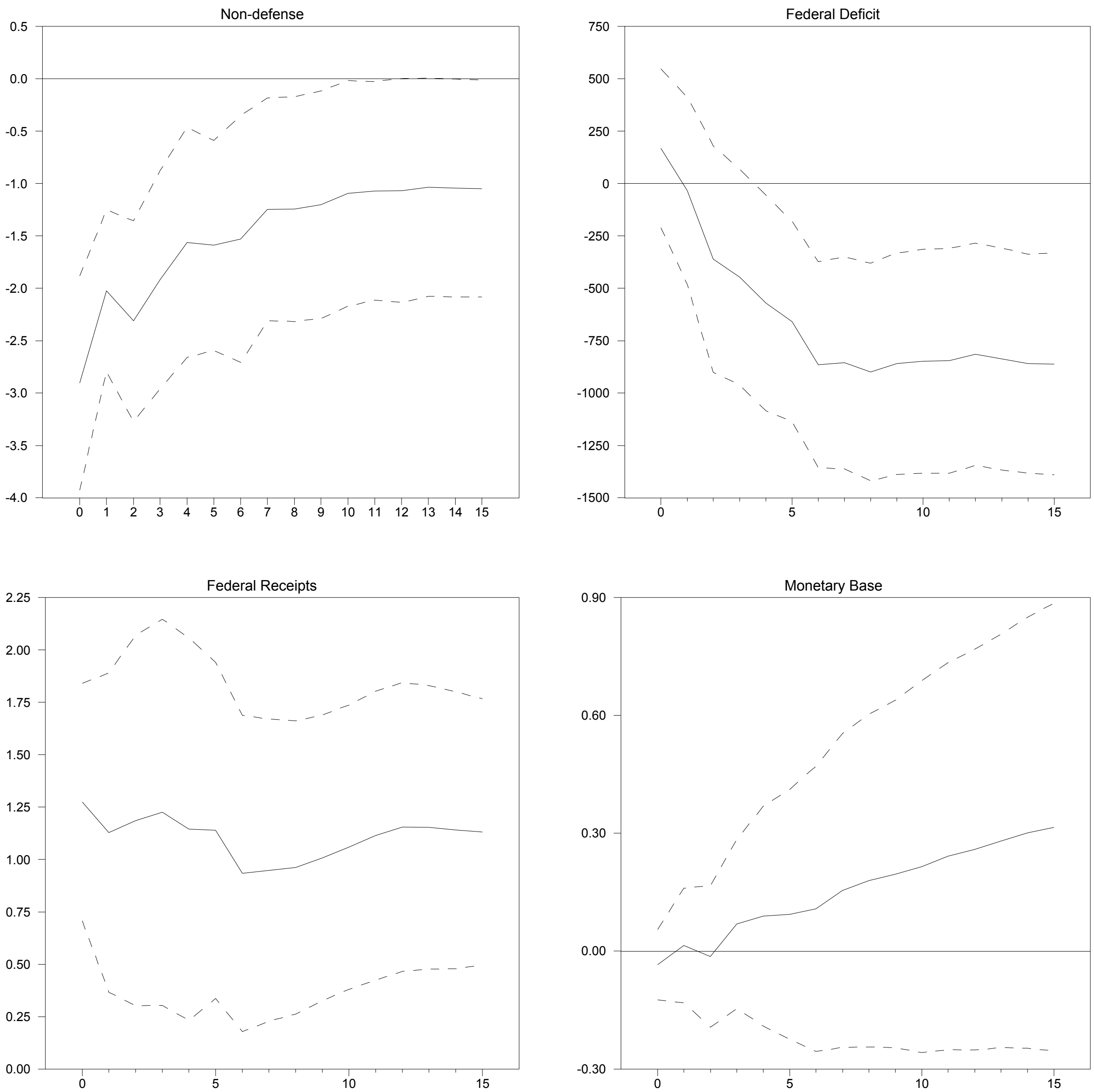

Figure 5.13: Point Estimates of the IRFs for Fiscal and Monetary Variables
Sample Period: 1948:4-1999:2

respectively. The next sub-sample periods selected span from 1950:1 to 1999:2 and from 1948:4 to 1989:4, which corresponds to the Cold War era.

Then, the point estimates of the IRFs for defense purchases, real GDP, RTB, and the GDP deflator are computed for a unit shock to defense purchases for each sub-sample period, and they are plotted along with the corresponding confidence intervals reported for the whole sample period. If the results computed for the alternative model are not sensitive to perturbations in the sample period used, the IRFs reported for the different sub-sample periods ought to lie within the corresponding confidence intervals from the whole sample period.

In the first and second columns of Figure 5.14, the solid lines display the point estimates of the IRFs for defense purchases, real GDP, RTB, and the GDP deflator computed when the alternative model is estimated over the early and late sub-sample periods, respectively. The dashed lines display the confidence intervals reported for the whole sample period.

When the alternative model is estimated over the early sub-sample period, the IRF computed for defense purchases increases more sharply in the first year after a shock to defense purchases than the one reported for the whole sample period. After the initial shock to defense purchases, it lies above the upper bound of the confidence interval reported for the whole sample period at all horizons.

The IRFs computed for real GDP, RTB, and the GDP deflator computed for the early sub-sample period lie within the corresponding confidence intervals reported for the whole sample period at all horizons. However, the pattern of the IRF for real GDP is initially different from the one reported for the whole sample period. In the first two years after a shock to defense purchases, it is positive and exhibits a hump-shaped pattern.

When the alternative model is estimated over the late sub-sample period, the IRF computed for defense purchases increases more gradually than the one reported for the whole sample period. After the initial shock to defense purchases, it lies below the lower bound of the corresponding confidence interval from the whole sample at all horizons.

The IRFs computed for real GDP and RTB lie within the corresponding confidence intervals reported for the whole sample period at all horizons, and their patterns are similar to the ones reported for the whole sample period. The IRF computed for the GDP deflator is small, and it lies slightly below the lower bound of the confidence interval reported for the whole sample period for two quarters after a shock to defense purchases, and then it lies within the confidence interval.

In the third and fourth columns of Figure 5.14, the solid lines display the point estimates of the IRFs for defense purchases, real GDP, RTB, and the GDP deflator computed when the alternative model is estimated over the sub-sample period from 1950:1 to 1999:2 and the Cold War era, respectively. The dashed lines display the confidence intervals reported for the whole sample period. All the IRFs reported for the sub-sample period from 1950:1 to 1999:2 and the Cold War era lie within or on the corresponding confidence intervals reported for the whole sample period at all horizons. Furthermore, their patterns are similar to the ones reported for the whole sample.

Overall, when the alternative model is estimated over the early sub-sample period, the IRF computed for defense purchases is significantly larger than the one reported for the whole sample period at all horizons. However, the IRFs for real GDP and the GDP

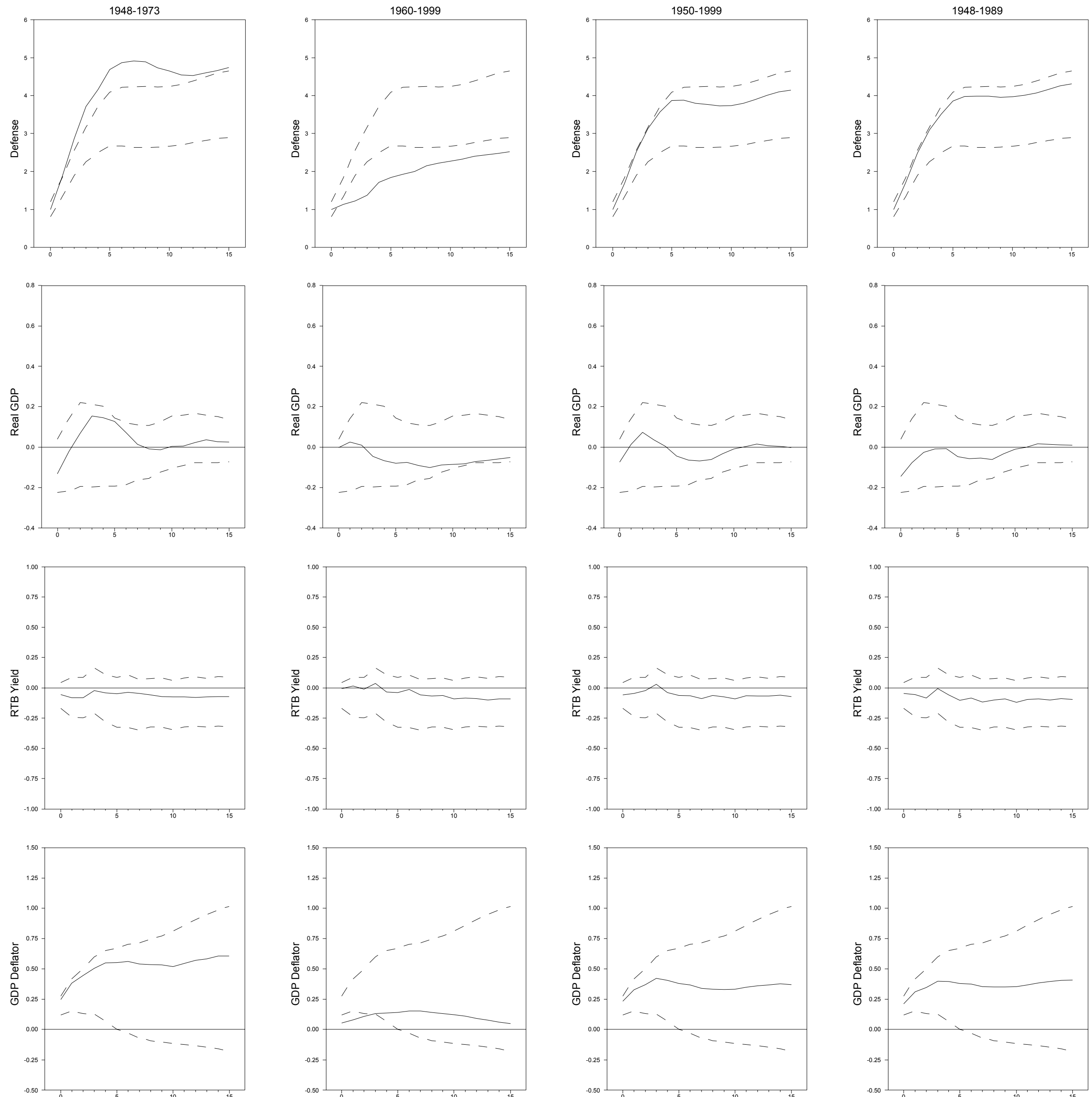

Figure 5.14: Point Estimates from Alternative Sample Periods
Confidence Intervals from the Whole Sample Period

deflator are not significantly different from the ones reported for the whole sample period at any horizon.

When the alternative model is estimated over the late sub-sample period, the IRF computed for defense purchases is significantly smaller than the one reported for the whole sample period at all horizons. The IRF for the GDP deflator is slightly smaller than the one reported for the whole sample period in the first year after a shock to defense purchases. The IRFs for real GDP and RTB are not significantly different from the ones reported for the whole sample period at any horizon.

Therefore, based on the results presented above, it is concluded that the IRF for defense purchases computed for the alternative model is sensitive to perturbations in the sample period used. However, it is concluded that the IRFs for real GDP and RTB are not sensitive to perturbations in the sample period used, and the IRF for the GDP deflator is only marginally sensitive to perturbations in the sample period used.

When the alternative model is estimated over the sub-sample period from 1950:1 to 1999:2 and the Cold War era, none of the IRFs computed are significantly different from the corresponding IRFs reported for the whole sample period at any horizon. Therefore, it is concluded that the IRFs computed for the alternative model are not sensitive to small perturbations in the sample period used.

To further examine the sensitivity of the results reported for the alternative model to perturbations in the sample period, Figure 5.15 presents the point estimates and confidence intervals of the IRFs computed for a unit shock to defense purchases when the alternative model is estimated over the early and late sub-sample periods. The solid lines display the point estimates of the IRFs for defense purchases, real GDP, RTB, and the GDP deflator. The dashed lines display the lower and upper bounds of one-standard deviation confidence intervals for the two sub-sample periods, not the whole sample period.

As was mentioned before, when the alternative model is estimated over the early sub-sample period, the IRF computed for defense purchases increases more sharply than the one reported for the whole sample period. Furthermore, the maximum effect of a shock on defense purchases computed for the early sub-sample period is somewhat larger than for the whole sample period.

The IRF for real GDP computed for the early sub-sample period exhibits a hump-shaped pattern. It is positive for almost two years; however, it is not significantly different from zero at any horizon. The IRF for RTB is negative at all horizons, but it is never significantly different from zero. The IRF for the GDP deflator rises more persistently than the one reported for whole sample period. It is significant at all horizons, compared to less than one and a half years for the one reported for the whole sample period.

When the alternative model is estimated over the late sub-sample period, the pattern of the IRF computed for defense purchases is very different from the one reported for the whole sample period. It increases more gradually and is smaller than the IRF reported for the whole sample. After a delay of two quarters, the IRF for real GDP is slightly negative; however, it is never close to being significant. The IRFs for RTB and the GDP deflator are small and never significantly different from zero.

Overall, like the IRFs reported when the alternative model is estimated over the whole sample period, the ones computed when it is estimated over the early and late sub-

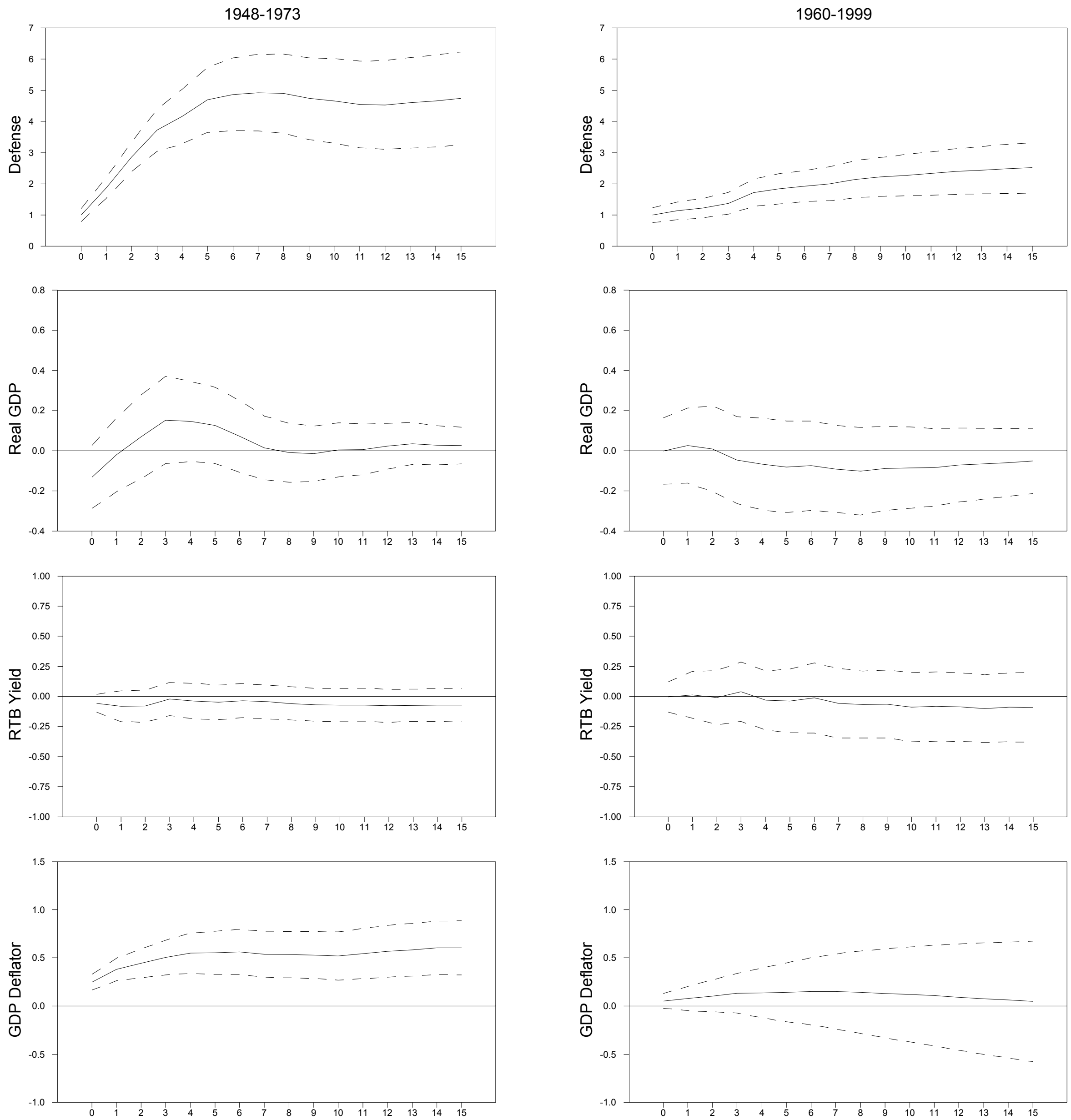

Figure 5.15: Point Estimates from Alternative Sample Periods
Confidence Intervals from Alternative Sample Periods

samples are problematic. The IRF for defense purchases reported for the early sub-sample period is larger than the one presented for the whole sample period; however, the IRF for real GDP is not significantly different from zero at any horizon, and the IRF for RTB is negative at all horizons, although not significantly.

The IRF for defense purchases reported for the late sub-sample period increases much more gradually, and is smaller, than the one presented for the whole sample period. Furthermore, the IRF for the GDP deflator reported for the late sub-sample period is not significantly different from zero at any horizon, and the IRFs for real GDP and RTB are negative at most horizons, although not significantly.

5.7 New Orders of Defense Products

The IRFs for RTB and to a lesser extent the IRFs for real GDP reported for the VAR systems estimated in this chapter are inconsistent with the theoretical two-sector neoclassical models presented by Ramey and Shapiro (1997) and Edelberg, Eichenbaum, and Fisher (1999) as well as the more traditional IS-LM and one-sector neoclassical models. Therefore, it is of interest to examine the effects of substituting new orders of defense products for defense purchases in the alternative model.

As was mentioned in the previous chapter of the dissertation, new orders of defense products are a monthly series from a set of 256 data series commonly known as the US Business Cycle Indicators (BCI) series that are used for tracking and predicting U.S business activity. Quarterly data are constructed by adding the monthly data within each quarter from the sample period 1968:2 to 1999:2. Furthermore, since the data for new orders of defense products are originally in billions of current dollars, they are deflated by the GDP deflator.[5]

Although the values of new orders of defense products are small in comparison to those of defense purchases, new orders of defense products may be a better policy variable than defense purchases for several reasons discussed in the previous chapter. In particular, Ramey and Shapiro (1997) argue that changes in defense spending tend to be concentrated in a few industries that manufacture defense products. For simplicity's sake, new orders of defense products are hereafter referred to as new orders.

To estimate the macroeconomic effects of the exogenous shocks to new orders identified using LR restrictions, a VAR system identical to the alternative model, except that new orders are substituted for defense purchases, is estimated for the sample period 1969:4 to 1999:2. Data from 1968:2 to 1969:3 are used as pre-sample data. Then, the IRFs that present the effects of a unit shock to new orders on new orders, real GDP, RTB, and the GDP deflator are computed following the same procedure as the one used earlier for the alternative model.

In the long-run Choleski decomposition used to identify the shocks to new orders, real GDP is ordered first, new orders is ordered second, the GDP deflator is ordered third, and RTB is ordered last. As was done for defense purchases in the alternative model, new orders are constrained not to have an effect on real GDP in the long run. In Figure 5.16, the solid line displays the shocks to new orders identified using LR restrictions when the model with new orders is estimated from 1969:4 to 1999:2. The shocks identified do not exhibit any particular pattern, and no shock appears particularly larger than others.

[5] The results computed when new orders of defense purchases are deflated by the CPI are similar to the ones reported hereafter.

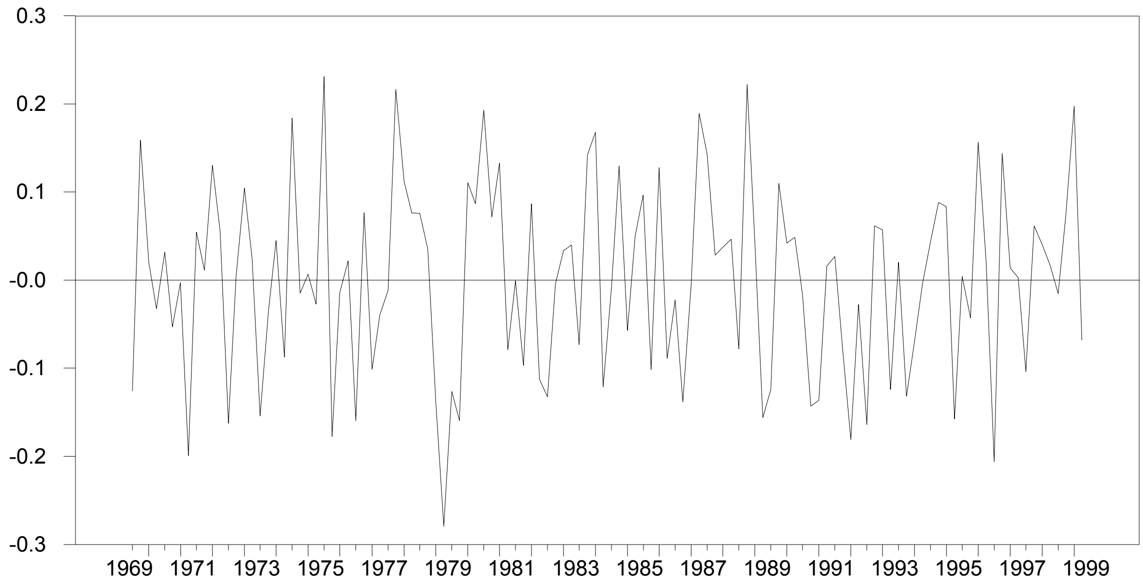

Figure 5.16: Shocks to New Orders of Defense Products
Sample Period: 1969:4-1999:2

To examine the relations between the series for defense purchases and new orders, the cross-correlation coefficients of the series for the shocks to defense purchases and the contemporaneous and lagged series for shocks to new orders identified using LR restrictions are computed. All the cross-correlation coefficients are less than 0.2, which implies that the shocks to defense purchases and new orders are weakly correlated.

In the first column of Figure 5.17, the solid lines display the point estimates of the IRFs computed for a unit shock to new orders. The dashed lines display the lower and upper bounds of one standard error confidence intervals computed using a Monte Carlo integration procedure. The IRF for new orders decreases sharply in the period of a shock; however, it remains above its initial level and it is significantly positive at all horizons. This result implies that the growth rate of new orders declines quickly after a shock to new orders. However, it remains positive, and the level of new orders is permanently higher after a shock.

The IRF for real GDP exhibits a hump-shaped pattern in the first two years after a shock to new orders. However, it is small and not significantly different from zero at any horizon. After a delay of three quarters, the IRF for RTB increases persistently, and it is significant for more than a year. The IRF for the GDP deflator increases persistently after a shock to new orders, and it is significant except in the quarters of a shock.

The IRFs reported for a shock to new orders imply that output is not affected by a positive shock to government purchases; however, interest rates and the price level increase significantly and persistently. Unlike The IRF for the GDP deflator computed for a shock to defense purchases, the one reported for a shock to new orders is consistent with a traditional IS-LM model. However, the IRFs for real GDP and RTB reported for a shock to new orders are not totally consistent with a traditional IS-LM model. The IRF for real GDP is never significantly different from zero, and the IRF for RTB does not increase immediately after a shock to new orders.

The sample period used to estimate the models with new orders and defense purchases are different. To compare the implications of using new orders and defense purchases as policy variables, the alternative model is estimated over the sample period 1969:4 to 1999:2, and the IRFs that present the effects of a unit shock to defense purchases on defense purchases, real GDP, RTB, and the GDP deflator are computed. In the second column of Figure 5.17, the solid lines display the point estimates of the IRFs computed for the alternative model. The dashed lines display the lower and upper bounds of the corresponding one standard error confidence intervals.

As was reported for a shock to new orders, the IRF for real GDP computed for a shock to defense purchases over the sample period 1969:4 to 1999:2 is not significantly different from zero at any horizon. The IRF for RTB is not significantly different from zero at any horizon either. Therefore, it is concluded that the shocks to new orders of defense products identified using LR restrictions are better measures of exogenous shocks to defense spending than shocks to defense purchases, even though the IRF for real GDP is never significantly different from zero.

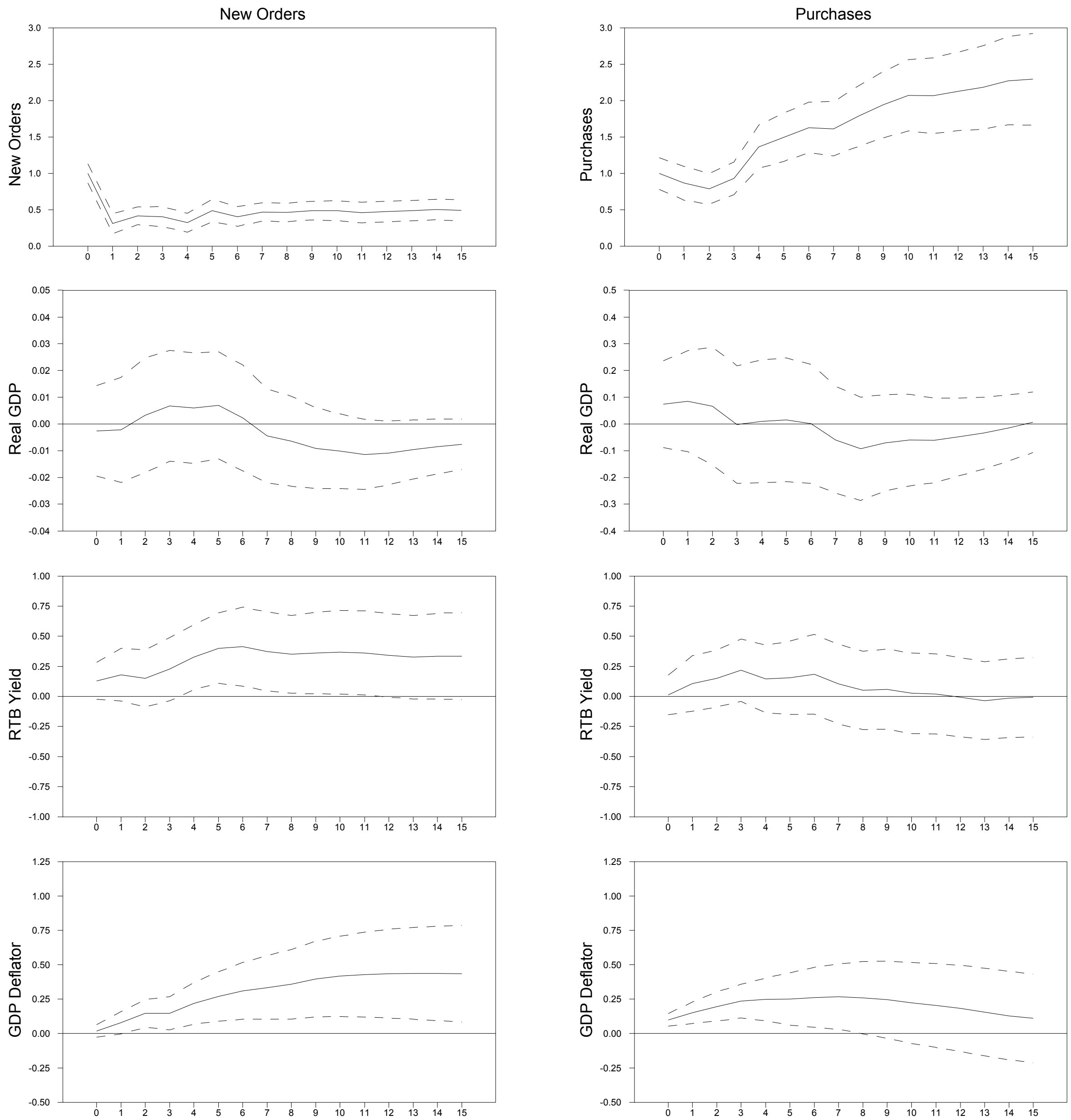

Figure 5.17: Point Estimates from Models with New Orders of Defense Products and Defense Purchases
Sample Period: 1969:4-1999:2

5.8 Robustness of the Results Reported For the Model with New Orders of Defense Products

This section investigates the sensitivity of the results reported for the model with new orders to perturbations in the list of variables used following the same procedure as the one used earlier for the alternative model. Furthermore, it presents the IRFs computed for additional fiscal variables and the monetary base.

To investigate the sensitivity of the results reported for the model with new orders to perturbations in the list of variables, the same endogenous variables and exogenous dummy variables as the ones used earlier for the alternative model are added, in turn, to the model with new orders. Then, the IRFs that present the effects of a unit shock to new orders on new orders, real GDP, RTB, and the GDP deflator are computed. If the results reported for the model with new orders are not sensitive to perturbations in the list of variables used, the IRFs computed for the extended models ought to lie within the corresponding confidence intervals from the model with new orders.

This section also examines the sensitivity of the results reported for the model with new orders to perturbations in the sample period used. The model with new orders is estimated over two sub-sample periods, and the IRFs for new orders, real GDP, RTB, and the GDP deflator are computed for a unit shock to new orders. If the results reported for the model with new orders are not sensitive to perturbations in the sample period used, the IRFs computed for the sub-sample periods ought to lie within the corresponding confidence intervals from the whole sample period.

As was done in the previous chapter of the dissertation, the model with new orders is estimated for a first sub-sample period that spans 1969:4 to 1989:4 and a second one that spans 1973:2 to 1999:2. The former excludes the data from the post-Cold War era, which represent one-third of the data from the whole sample period. The latter begins with the oil crisis of 1973-1974, which may have affected the structural relations among the variables in the model estimated.

5.8.1 Extended Models

In Figure 5.18 to Figure 5.23, the solid lines display the point estimates of the IRFs for new orders, real GDP, RTB, and the GDP deflator computed for a shock to new orders when the endogenous variables and exogenous dummy variables are added, in turn, to the model with new orders. The dashed lines display the corresponding confidence intervals from the model with new orders.

Figure 5.18 presents the effects of the shocks in models that alternatively include the following additional fiscal variables: non-defense purchases, real federal government receipts, and the real federal government deficit. Figure 5.19 presents the effects of the shocks in models that alternatively include the following consumption and investment variables: consumption of non-durables and services, residential investment plus consumption of durables, and non-residential investment.

Figures 5.20 and 5.21 present the effects of the shocks in models that alternatively include labor market variables. The variables examined in Figure 5.20 are employment in private industry, employment in the non-durables manufacturing sector, and employment in the durables manufacturing sector. The variables examined in Figure 5.21 are real wages in private industry, real compensation in the manufacturing sector, and real compensation in the business sector.

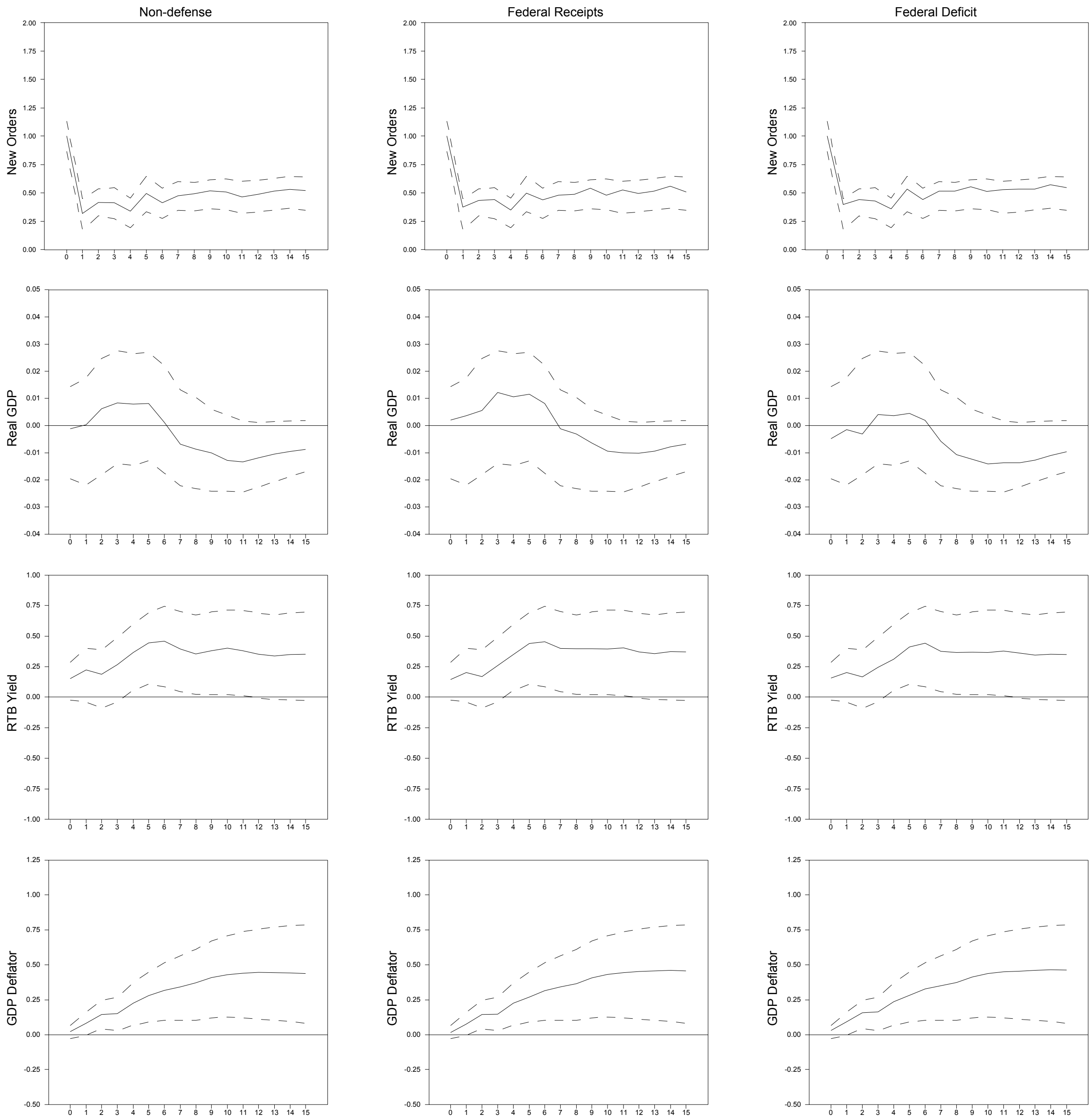

Figure 5.18: Point Estimates from Models with New Orders of Defense Products and a Fiscal Variable
Confidence Intervals from Models with New Orders of Defense Products

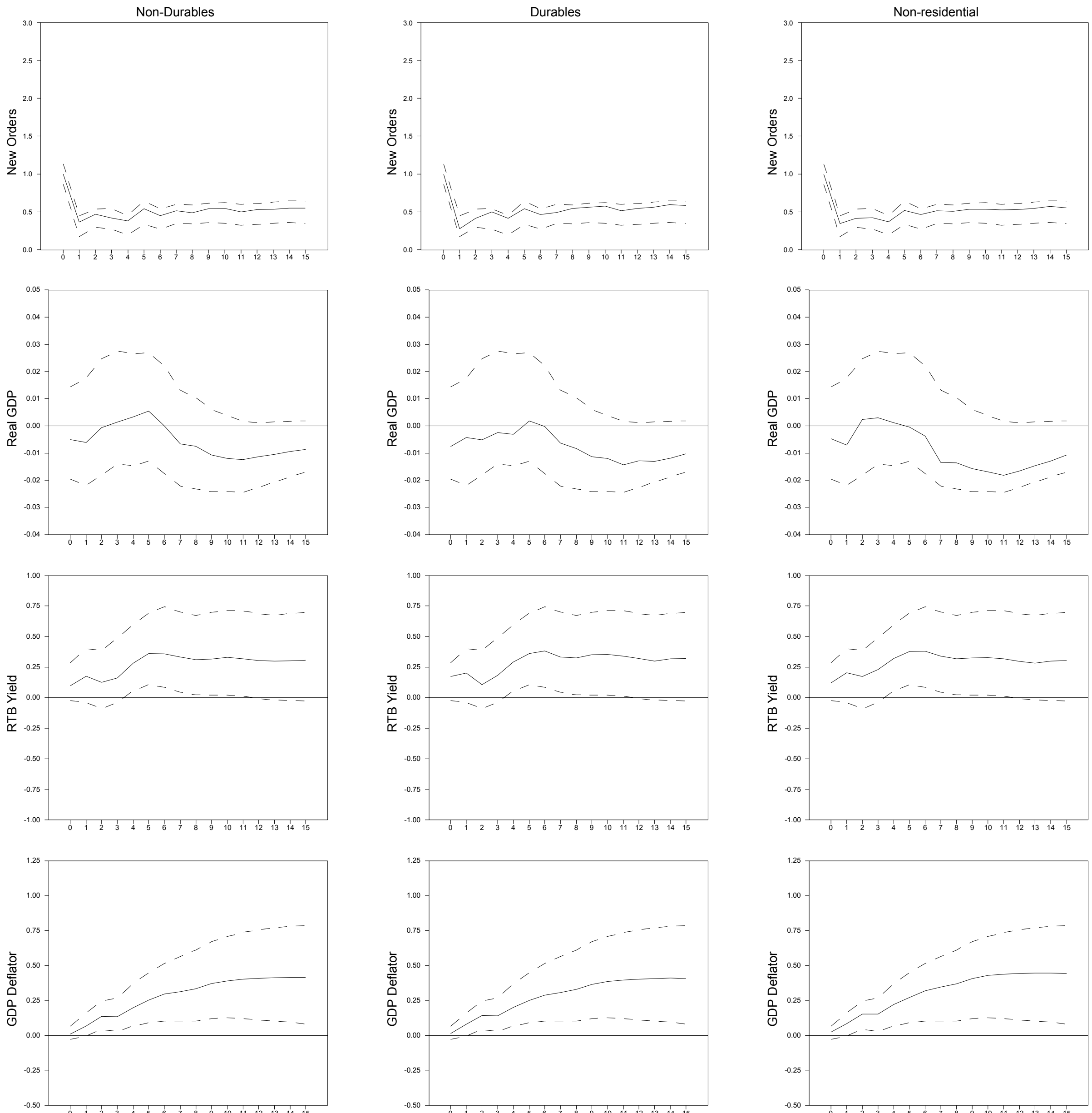

Figure 5.19: Point Estimates from Models with New Orders of Defense Products and a Consumption or Investment Variable
Confidence Intervals from Models with New Orders of Defense Products

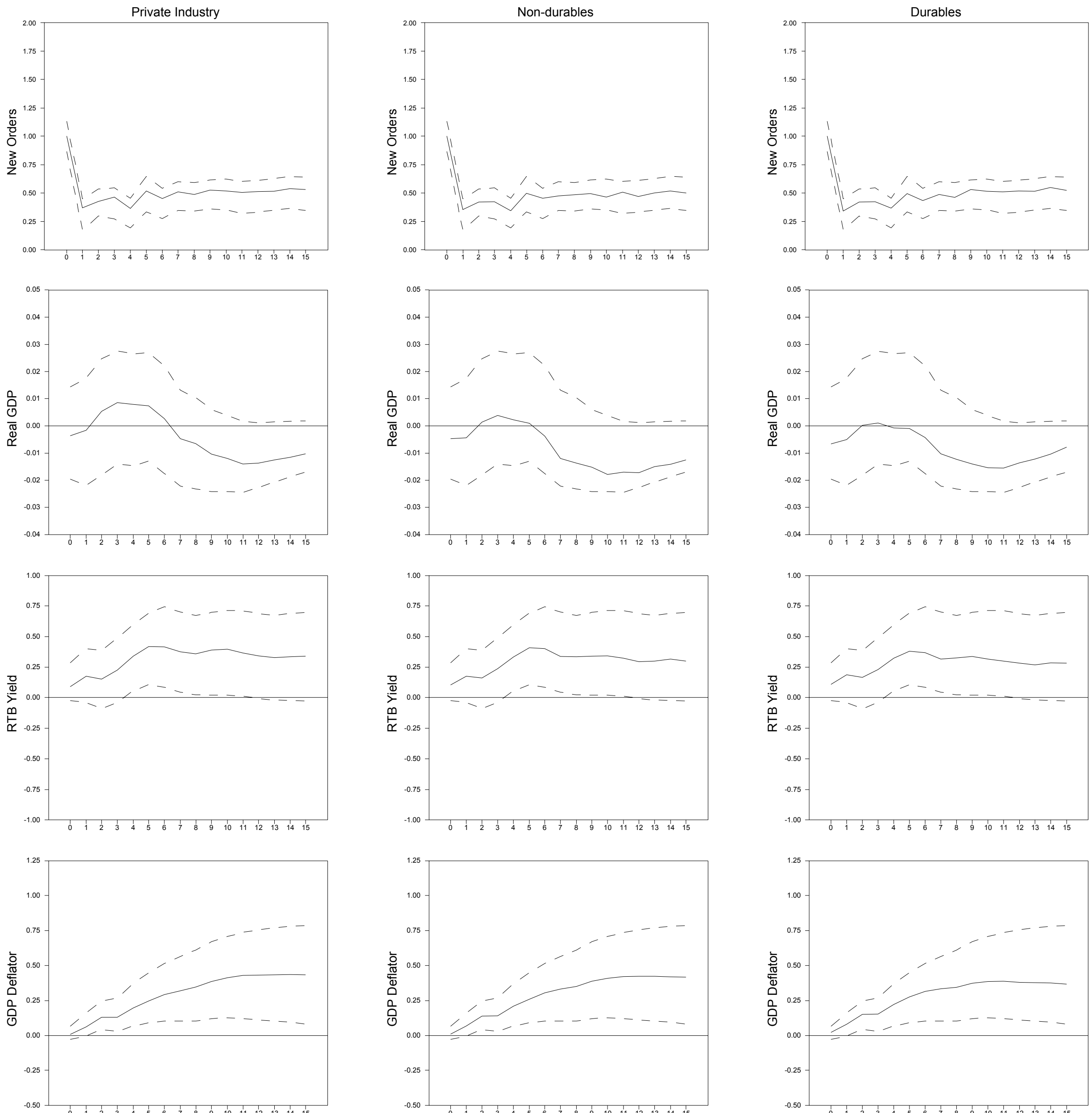

Figure 5.20: Point Estimates from Models with New Orders of Defense Products and an Employment Variable
Confidence Intervals from Models with New Orders of Defense Products

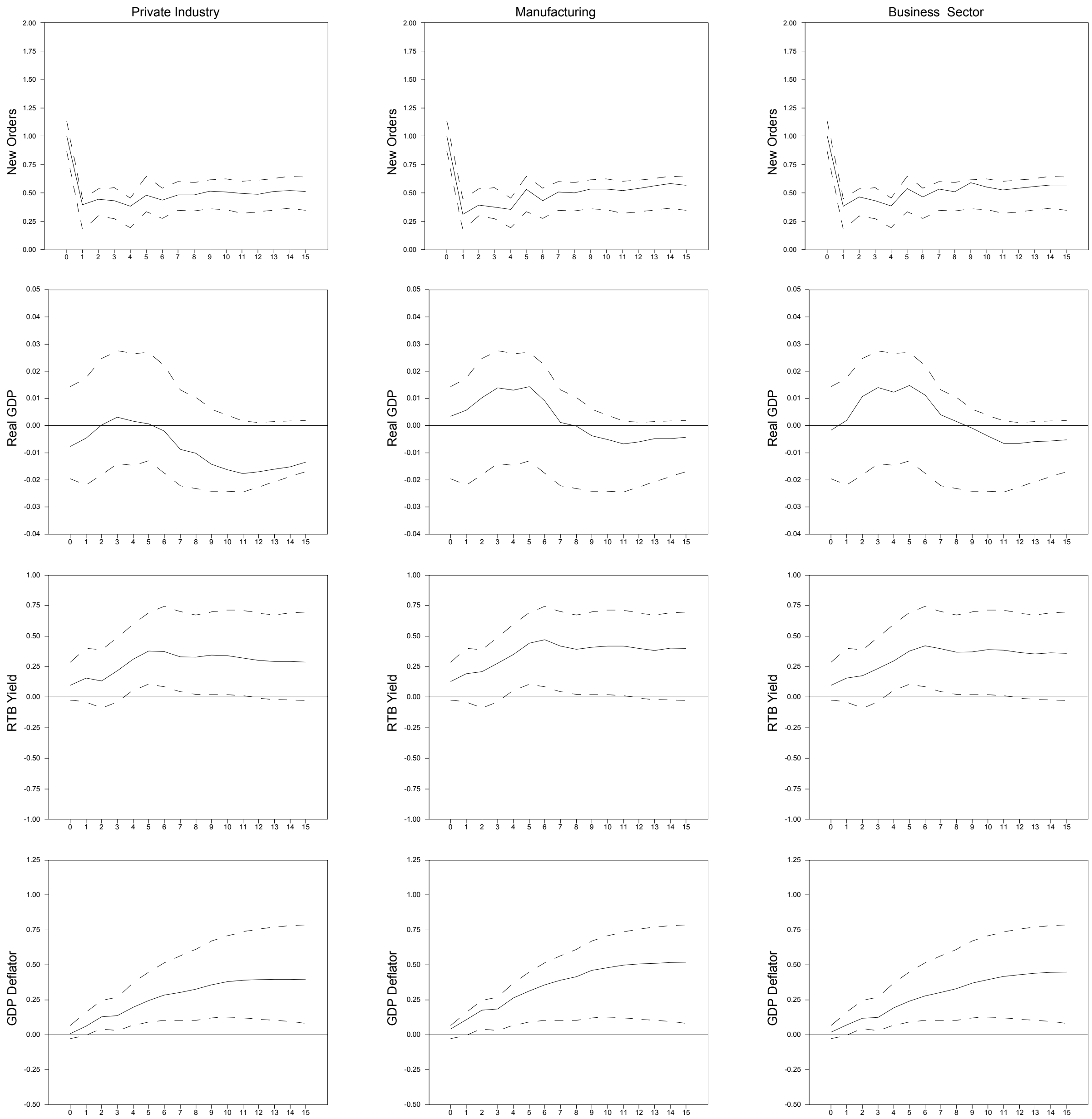

Figure 5.21: Point Estimates from Models with New Orders of Defense Products and a Measure of Real Wages or Real Compensation
Confidence Intervals from Models with New Orders of Defense Products

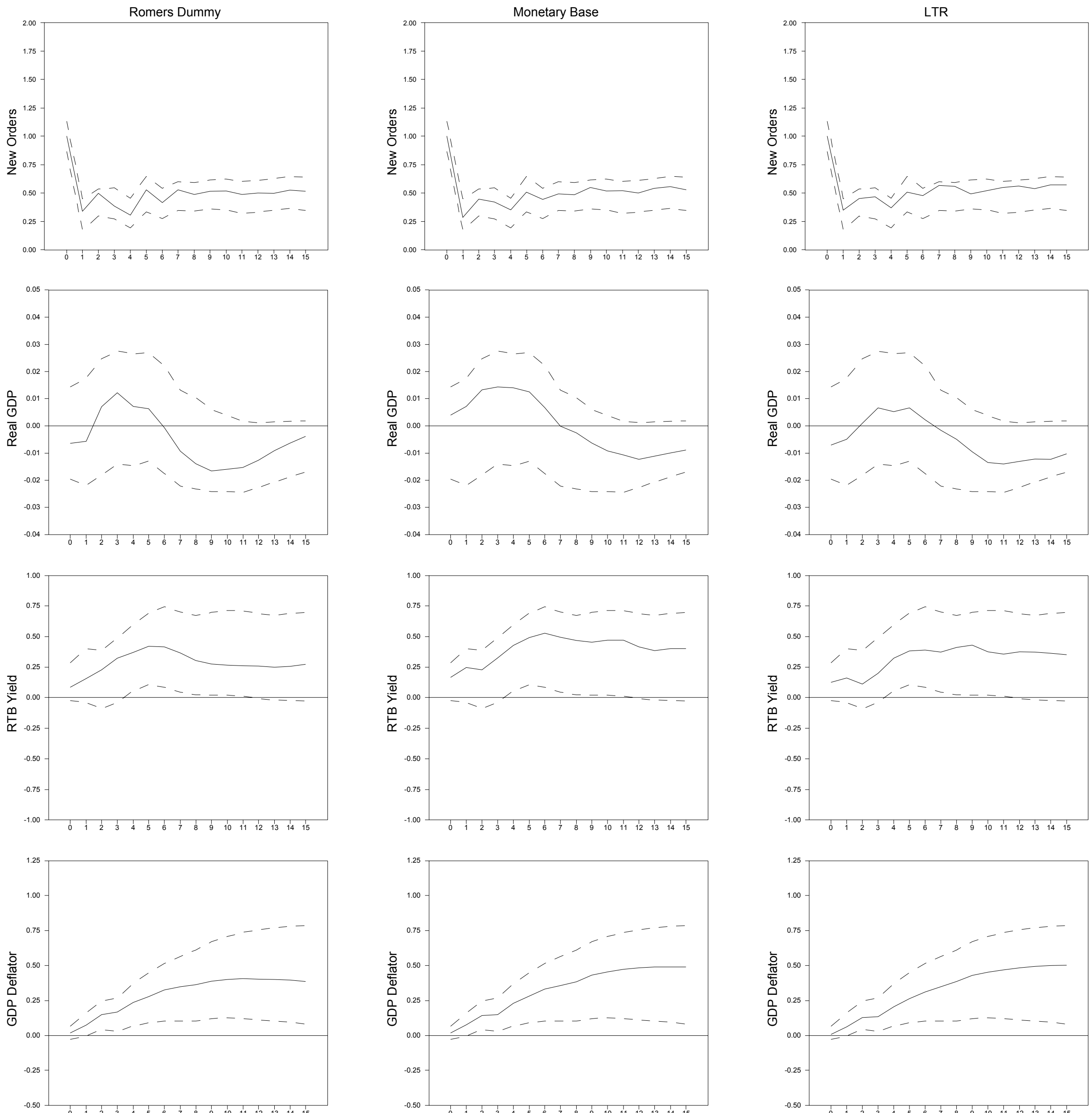

Figure 5.22: Point Estimates from Models with New Orders of Defense Products and an Additional Macroeconomic Variable
Confidence Intervals from Models with New Orders of Defense Products

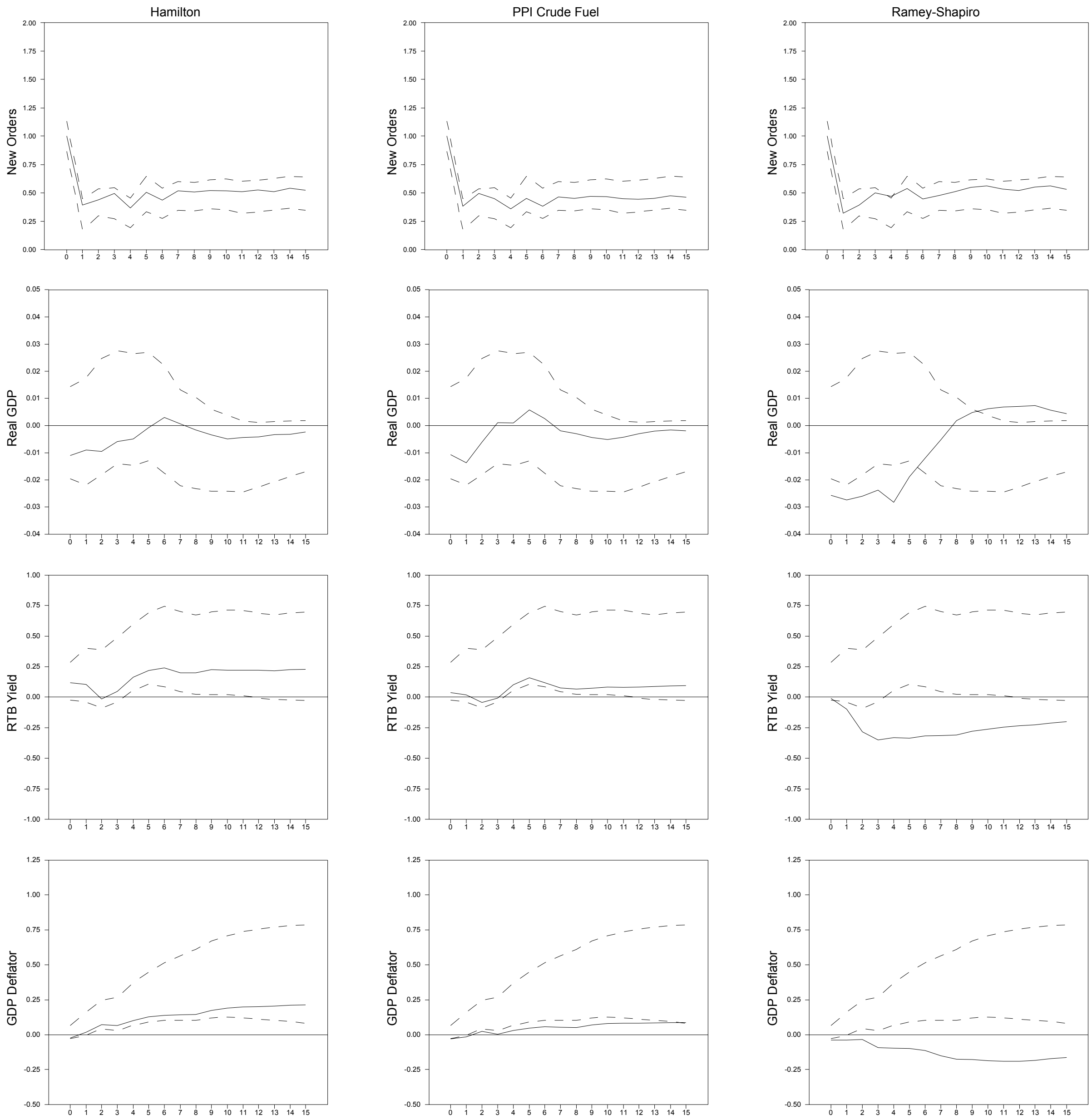

Figure 5.23: Point Estimates from Models with New Orders of Defense Products and an Additional Macroeconomic Variable
Confidence Intervals from Models with New Orders of Defense Products

Figures 5.22 and 5.23 present the effects of the shocks in models that alternatively include additional macroeconomic variables. The variables examined in Figure 5.22 are the Romers' monetary policy dummy variable, the monetary base, and the constant maturity ten-year Treasury bond yield (LTR). The variables examined in Figure 5.23 are Hamilton's oil price dummy variable, the PPI for crude fuel, and the Ramey-Shapiro dummy variable.

Except for the PPI for crude fuel and the Ramey-Shapiro dummy variable, all the IRFs reported for the extended models lie well within the corresponding confidence intervals from the model with new orders at all horizons. Furthermore, the patterns of the IRFs reported are generally similar to the ones presented for the model with new orders.

When the PPI for crude fuel is added to the model with new orders, the IRF computed for the GDP deflator lies slightly below the lower bound of the confidence interval from the model with new orders at all horizons. However, the IRFs for new orders, real GDP, and RTB lie within the corresponding confidence intervals.

When the Ramey-Shapiro dummy variable is added to the model with new orders, the IRF reported for new orders lies within the confidence interval from the model with new orders at all horizons. However, the IRFs reported for real GDP and the GDP deflator differ significantly and persistently from the ones presented for the model with new orders. The IRF for real GDP lies below the lower bound of the confidence interval from the model with new orders for more than a year. Then, it lies within the confidence interval for several periods, and finally it lies above the upper bound of the confidence interval. The IRFs for RTB and the GDP deflator lie below the lower bound of the corresponding confidence intervals from the model with new orders at all horizons.

Overall, the IRFs computed when eighteen different variables are added, in turn, to the model with new orders indicate that the results reported for the model with new orders are not sensitive to adding an endogenous variable or an exogenous dummy variable, except for the Ramey-Shapiro dummy variable and to a lesser extent the PPI for crude fuel.

As was mentioned in the previous chapter, Ramey and Shapiro (1997) identify only one exogenous shock to defense purchases during the sample period 1969:4 to 1999:2. It corresponds to the Carter-Reagan episode that is dated as beginning in 1980:1. However, Hamilton (1985) also identifies a major exogenous increase in oil price the quarter the onset of the Carter-Reagan episode.

Therefore, the sensitivity of the results reported for the model with the Ramey-Shapiro dummy variable may reflect not only the effects of the increase in defense purchases identified by Ramey and Shapiro (1997) but also the effects of the increase in oil price identified by Hamilton (1985). In fact, the results reported above indicate that the IRFs computed for the model with new orders are sensitive to adding a measure of oil price, although not as much as the Ramey-Shapiro dummy variable.

As was done for the alternative model, it is of interest to present the effects of a unit shock to new orders on additional fiscal variables and the monetary base. In Figure 5.24, the solid lines display the point estimates of the IRFs computed for non-defense purchases, real federal government receipts, the real federal government deficit, and the monetary base are added, in turn, to the model with new orders. The dashed lines display the lower and upper bounds of one-standard deviation confidence intervals.

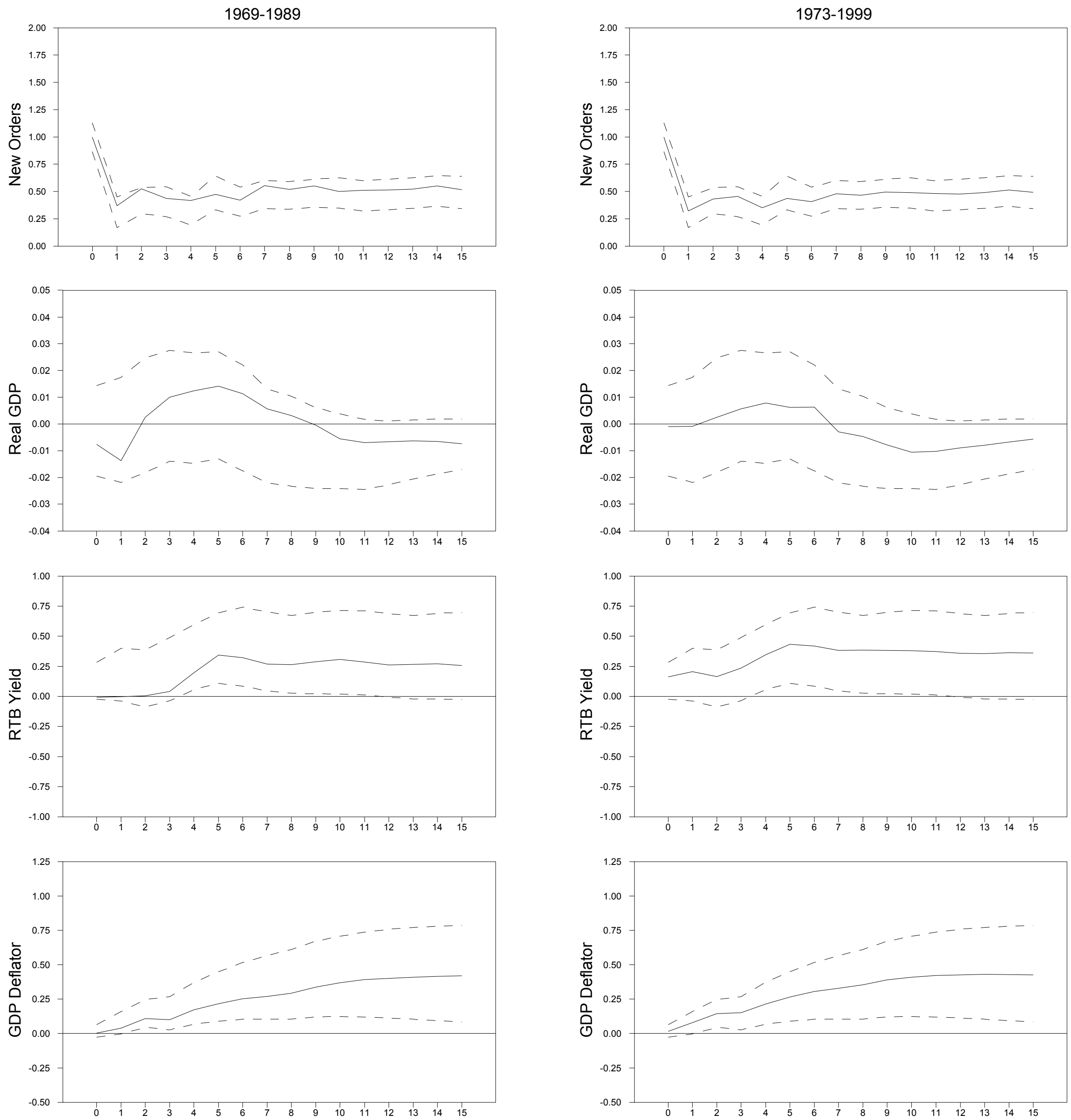

Figure 5.24: Point Estimates of the IRFs for Fiscal and Monetary Variables
Models with New Orders of Defense Products

The patterns of the IRFs reported for the additional fiscal variables and the monetary base are very different from the ones presented in the previous chapter of the dissertation using a Choleski decomposition. The IRF for non-defense purchases is alternatively positive and negative for two years, and then it remains negative. It is negative and very marginally significant for less than a quarter at the end of the first year after a shock to new orders.

The IRF for real federal government is positive at all horizons; however, it is only marginally significant for two quarters in the first year after a shock to new orders. After a delay of a quarter, the IRF for the real federal government deficit is positive; however, it is small and never close to being significantly different from zero. Therefore, it is concluded that the shocks to new orders do not coincide with significant changes in non-defense purchases, real federal government receipts, and the real federal government deficit.

The IRF for the monetary base is positive for more than a year after a shock to new orders, and then it declines quickly and persistently. However, it is never close to being significant. Therefore, it is concluded that the shocks to new orders do not appear to coincide with changes in monetary policy.

5.8.2 Alternative Sample Periods

As was mentioned before, to examine the sensitivity of the results reported for the model with new orders to perturbations in the sample period used, the model with new orders is estimated over the sub-sample periods 1969:4 to 1989:4 and 1973:2 to 1999:2. Then, the IRFs for new orders, real GDP, RTB, and the GDP deflator computed for a unit shock to new orders are plotted against for the corresponding confidence intervals reported for the whole sample period.

In the first and second columns of Figure 5.25, the solid lines display the point estimates of the IRFs for new orders, real GDP, RTB, and the GDP deflator computed when the model with new orders is estimated over the sub-sample periods 1969:4 to 1989:4 and 1973:2 to 1999:2, respectively. The dashed lines display the confidence intervals reported for the whole sample period.

When the model with new orders is estimated over the sub-sample periods 1969:4 to 1989:4 and 1973:2 to 1999:2, all the IRFs reported lie within the corresponding confidence intervals from the whole sample period at all horizons. Furthermore, their patterns are generally similar to the ones reported for the alternative model. Therefore, it is concluded that the IRFs computed for the model with new orders are not sensitive to perturbations in the sample period used.

Figure 5.26 presents the point estimates and confidence intervals of the IRFs computed for a unit shock to new orders when the model with new orders is estimated over the sub-sample periods 1969:4 to 1989:4 and 1973:2 to 1999:2. The solid lines display the point estimates of the IRFs for new orders, real GDP, RTB, and the GDP deflator. The dashed lines display the lower and upper bounds of one-standard deviation confidence intervals from these sample periods, not the full sample period.

The patterns and magnitudes of the IRFs reported for the sub-sample periods 1969:4 to 1989:4 and 1973:2 to 1999:2 are similar to the ones presented for the whole sample period. However, not only the IRF for real GDP but also the IRFs for RTB and the GDP deflator reported for the sub-sample period 1969:4 to 1989:4 are not significantly different from zero at any horizon.

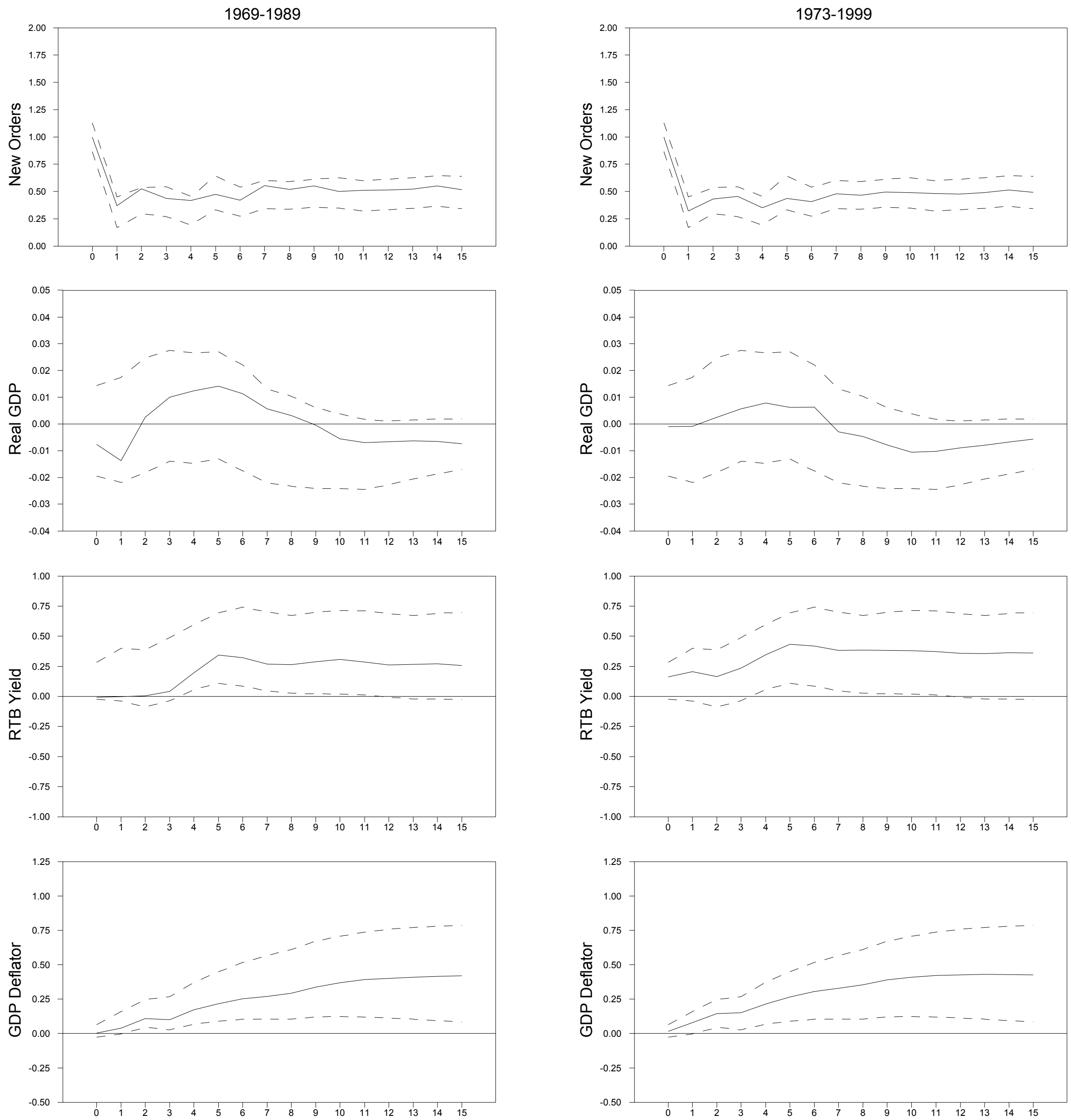

Figure 5.25: Point Estimates from Alternative Sample Periods for Model with New Orders of Defense Products

Confidence Intervals from the Whole Sample Period

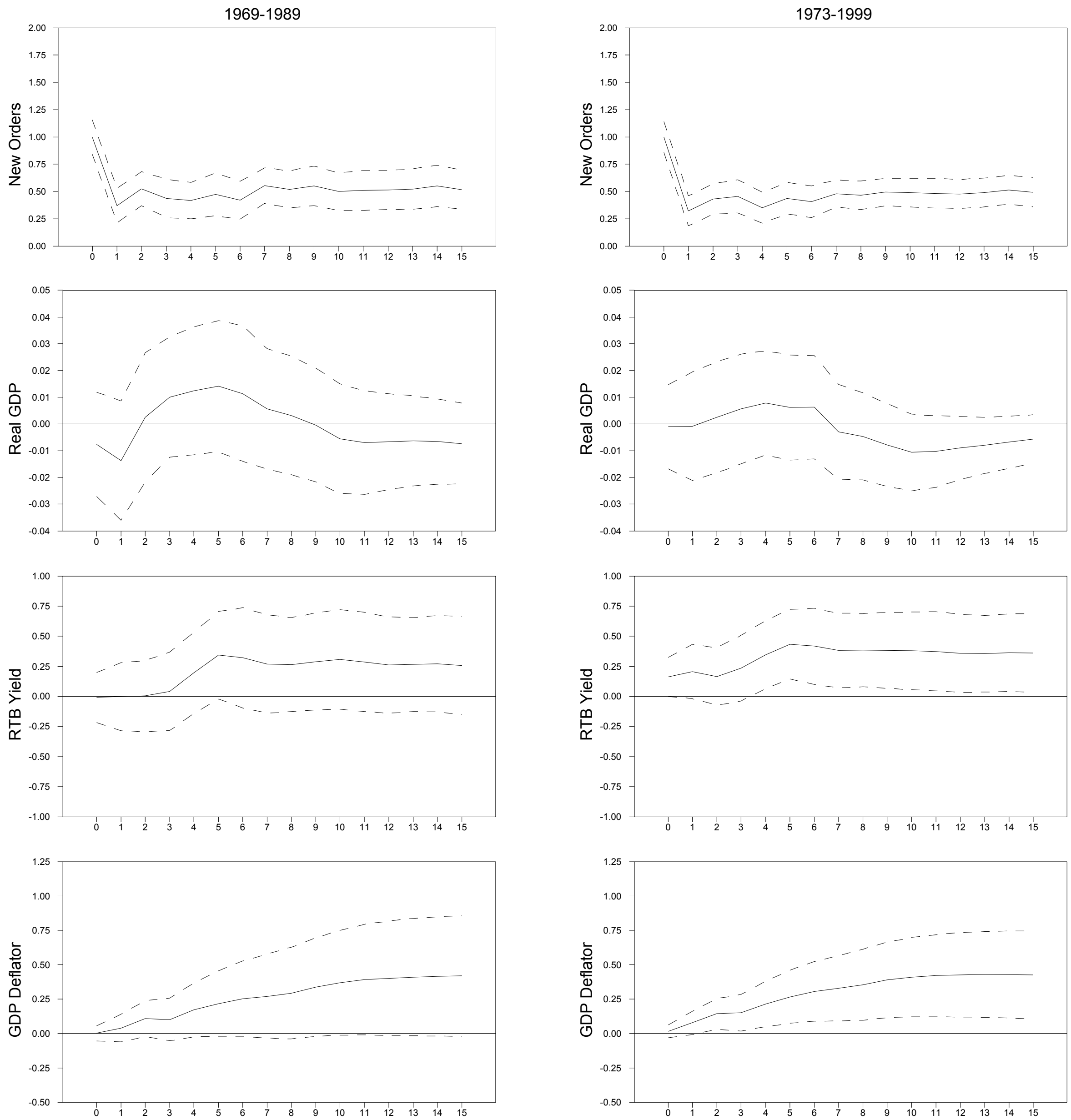

Figure 5.26: Point Estimates from Alternative Sample Periods for Model with New Orders of Defense Products

Confidence Intervals from Alternative Sample Periods

5.9 Summary and Conclusions

This chapter of the dissertation examines the implications of using LR restrictions for estimating the effects of exogenous shocks to defense purchases. It focuses on a benchmark model and an alternative mode that are identical to the ones estimated in the previous chapter to investigate the implications of using the Choleski decomposition.

First, the IRFs that present the effects of a unit shock to defense purchases on defense purchases, real GDP, RTB, and the GDP deflator are computed when the benchmark and alternative models are estimated. Like the results reported using the Choleski decomposition, the results computed using LR restrictions are not consistent with the theoretical two-sector neoclassical models presented by Ramey and Shapiro (1997) and Edelberg, Eichenbaum, and Fisher (1999) as well as the more traditional IS-LM and one-sector neoclassical models.

The IRFs for defense purchases and the GDP deflator reported for the benchmark and alternative models increase very persistently in response to a shock to defense purchases. The IRFs for real GDP are not significantly different from zero at any horizon. The IRF for RTB computed for the benchmark model is negative at all horizons, and it is briefly significant. The IRF for RTB computed for the alternative model is negative at all horizons, but it is never significant.

As was done in the previous chapter, the sensitivity of the results computed for the benchmark model to adding time trends and changing the lag length used is examined. It is shown that the results reported for the benchmark model are sensitive to adding a “Perron-type” time trend; however, they are not sensitive to changing the lag length used.

To investigate the sensitivity of the results computed for the alternative model to perturbations in the list of variables used, eighteen endogenous and exogenous variables are added, in turn, to the alternative model, and the IRFs computed for the extended models and the alternative model are compared. It is shown that the IRFs reported for the alternative model, in particular for defense purchases, are sensitive to adding the exogenous dummy variables under examination. However, they are not sensitive to adding the endogenous variables

To examine the sensitivity of the results computed for the alternative model to perturbations in the sample period used, the alternative model is estimated over four different sub-sample periods, including an early sub-sample period that spans 1948:4 to 1973:1 and a late sub-sample period that spans 1973:2 to 1999:2. As for the narrative approaches and the Choleski decomposition, the IRFs reported using LR restrictions imply that the results computed for the alternative model, in particular for defense purchases, are sensitive to perturbations in the sample period used. Furthermore, like the IRFs reported when the alternative model is estimated over the whole sample period, the ones computed when it is estimated over the early and late sub-sample periods are problematic.

As was done in the previous chapter, a VAR system identical to the alternative model, except that new orders is substituted for defense purchases, is estimated. Then, the IRFs that present the effects of a shock to new orders on new orders, real GDP, RTB, and the GDP deflator are computed.

The patterns of the IRFs for real GDP, RTB, and the GDP deflator reported for a shock to new orders are relatively similar to the ones presented for a shock to defense

purchases when the alternative model is estimated. The main difference between the results reported for the model with new orders and the alternative model is found in the response of RTB, which is significant for the model with new orders, but not for the alternative model.

Furthermore, the IRFs reported for the model with new orders are not totally consistent with the theoretical two-sector neoclassical models presented by Ramey and Shapiro (1997) and Edelberg, Eichenbaum, and Fisher (1999) as well as the more traditional IS-LM and one-sector neoclassical models. Therefore, it is concluded that when LR restrictions are used to identify shocks to defense spending, new orders do not appear to be a much better policy variable than defense purchases.

To investigate the sensitivity of the results computed for the model with new orders to perturbations in the list of variables, the same methodology used to examine the robustness of the results reported for the alternative model is used. It is shown that the results reported for the model with new orders are not sensitive to adding the variables selected, except the PPI for crude fuel and the Ramey-Shapiro dummy variable.

Finally, to investigate the sensitivity of the results computed for the model with new orders of defense products to perturbations in the sample period, this model is estimated for two different sub-sample periods. It is shown that the results reported for the model with new orders are not sensitive to altering the sample period used.

5.10 References

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CHAPTER 6. SUMMARY AND CONCLUSIONS

6.1 Summary

In 1997, Ramey and Shapiro published an influential study in which they applied a narrative approach in the spirit of Hamilton (1983) and Romer and Romer (1989, 1994) to identify three exogenous increases in defense purchases in the post-World War II era. The exogenous increases in defense purchases, which are commonly referred to as the Ramey-Shapiro episodes, correspond to the Korean War, the Vietnam War, and the Carter-Reagan military build-ups.

Ramey and Shapiro (1997) use the shocks they identify to construct a dummy variable that has the value one at the onsets of the increases in defense purchases, and zero otherwise. Then, they include the dummy variable as an exogenous variable in a series of univariate equations, and compute impulse response functions (IRFs) that present the effects of an average Ramey-Shapiro episode.

Defense purchases have long been used as a proxy for government purchases in empirical studies of the macroeconomic effects of government purchases because they are widely believed to be exogenous with respect to macroeconomic variables (Barro (1981), Kormendi (1983)). This is consistent with many studies published in the foreign policy and defense policy literature (Garnett (1987), Rearden (1984), Shilling (1962)).

Eichenbaum and Fisher (1998) and Edelberg, Eichenbaum and Fisher (1999) include the Ramey-Shapiro dummy variable as an exogenous variable in a series of vector autoregression (VAR) systems. Following Ramey and Shapiro (1997), they compute IRFs that present the macroeconomic effects of an average Ramey-Shapiro episode.

The evidence presented by Edelberg, Eichenbaum and Fisher (1999) has been a point of reference within a small but influential literature in which VAR systems are used to estimate the macroeconomic effects of exogenous shocks to government purchases. In particular, Fatas and Mihov (2000), who use a Choleski decomposition to identify exogenous shocks to government purchases, estimate VAR systems in the spirit of Edelberg, Eichenbaum, and Fisher (1999).

As was discussed in the introduction of the dissertation, the effects of shocks to government purchases estimated using the narrative approach of Ramey and Shapiro (1997) and contemporaneous restrictions differ greatly. As Perotti (2000) argues, "… Despite some methodological advances, there is absolutely no consensus on even the basic effects of fiscal policy on the macroeconomy" (Perotti, 2000, p. 1).

Since the VAR systems estimated in the studies recently published differ in terms of the method of identifying the exogenous policy shocks, the variables in the models estimated, and the sample period over which the models are estimated, the source of the different results across studies is not clear. The dissertation provides evidence on the implications of using four different methods of identifying exogenous shocks to defense purchases within a common VAR system estimated over a specific sample period.

The narrative approach of Ramey and Shapiro (1997) is examined in the second chapter of the dissertation. A more comprehensive narrative approach that tries to isolate exogenous reductions in defense expenditures as well as exogenous increases in defense expenditures is examined in the following chapter. Finally, two statistically-based methods of identifying defense spending shocks, a Choleski decomposition and a long-run restrictions, are examined in the last two chapters.

The benchmark models estimated in each chapter of the dissertation includes a constant and four lagged values of defense purchases, real GDP, a short-term interest rate, and the GDP deflator that are entered as endogenous variables. In addition, the contemporaneous value and four lagged values of a dummy variable are entered as exogenous variables when the narrative approaches are used to identify the policy shocks. The logarithmic values of the variables are used except for interest rates.

The benchmark models estimated in the dissertation are identical to the benchmark model presented by Edelberg, Eichenbaum, and Fisher (1999), except that the GDP deflator is substituted for the producer price index (PPI) for crude fuel in the benchmark models estimated in the dissertation. Based on the Akaike Information Criterion (AIC), the specification of the equations selected for the benchmark models does not appear to be the best for the VAR systems under study; therefore, alternative models are also estimated.

The alternative models include a constant and six lagged values of defense purchases, real GDP, the net three month interest rate on Treasury bills (RTB), and the GDP deflator as well as a “Perron-type” time trend. In addition, the contemporaneous value and six lagged values of a dummy variable are included when the narrative approaches are used to identify the policy shocks.

The benchmark and alternative models are estimated over the sample periods from 1948:1 to 1999:2 and from 1948:3 to 1999:2, respectively.[1] To examine the implications of using the different methods of identifying exogenous shocks to defense purchases under study, the IRFs that present the effects of exogenous shocks to defense purchases on defense purchases, real GDP, RTB, and the GDP deflator are computed over a horizon of sixteen quarters.

When the narrative approach of Ramey and Shapiro (1997) is used to identify exogenous shocks to defense purchases, the IRFs that present the effects of a unit shock to the Ramey-Shapiro dummy variable are computed. The Ramey-Shapiro dummy variable has the value one at the onsets of the Ramey-Shapiro episodes, and zero otherwise. The episodes are dated as beginning in 1950:3, 1965:1, and 1980:1, respectively.

When a more comprehensive narrative approach than Ramey and Shapiro (1997) is used to identify exogenous shocks to defense purchases, the IRFs that present the effects of a unit shock to a defense purchases (DP) dummy variable are computed. The DP dummy variable has the value one at the dates of the onsets of the military build-ups identified in the second chapter of the dissertation, minus one at the dates of the military retrenchments, and zero otherwise

The date of the onset of the Korean War build-up is the same as the one selected by Ramey and Shapiro (1997); however, the dates of the onsets of the Vietnam War and Carter-Reagan build-ups are different. They are dated as beginning in 1965:3 and 1979:4, respectively. The onsets of the military retrenchments that are identified using the more comprehensive narrative are dated as beginning in 1952:4, 1969:3, and 1989:4, respectively.

[1] When long-run restrictions are used to identify exogenous shocks, the variables are differenced before estimation. In this case, the benchmark model and alternative models are estimated for 1948:2 to 1999:2 and 1948:4 to 1999:2, respectively.

When the Choleski decomposition is used to identify exogenous shocks to defense purchases, economic theory is used to impose a recursive contemporaneous causal structure among the variables in the VAR systems estimated. Then, the IRFs that present the effects of a unit shock to defense purchases are computed. When long-run restrictions are used to identify exogenous shocks to defense purchases, economic theory is used to impose a recursive long-run causal structure among the variables in the VAR systems estimated.

When the narrative approach of Ramey and Shapiro (1997) is used to identify exogenous shocks to defense purchases, the IRFs reported for the benchmark model imply that defense purchases increase very persistently following an exogenous increase in government purchases, output rises temporarily, the price level rises persistently, and interest rates initially fall and then they rise significantly.

When the more comprehensive narrative approach is used to identify exogenous shocks to defense purchases, the IRFs reported for the benchmark model imply that defense purchases increase very persistently following an exogenous increase in government purchases, output rises temporarily, and interest rates and the price level rise persistently. The main difference with the results reported for the narrative approach of Ramey and Shapiro (1997) is that interest rates do not decrease initially.

When the Choleski decomposition is used to identify exogenous shocks to defense purchases, the IRFs reported for the benchmark model imply that defense purchases increase very persistently following an exogenous increase in government purchases, output rises temporarily, and interest rates and the price level decline persistently. When long-run restrictions are used to identify exogenous shocks to defense purchases, the IRFs reported imply that defense purchases and the GDP deflator increase very persistently; however, real GDP and RTB are not significantly affected.

For all the methods of identifying the exogenous policy shocks under examination, the IRFs reported for the alternative models estimated are similar in pattern to the ones reported for the benchmark models. However, they are quantitatively different, in particular for the narrative approach of Ramey and Shapiro (1997).

As was mentioned in the first chapter of the dissertation, there is an abundant literature in which theoretical models of the effects of shocks to government purchases on the economy are analyzed. Generally, the predictions of the theoretical models differ if the shocks to government purchases are temporary or permanent. Furthermore, they differ if the economy is closed or open.

With regard to the effects of a temporary shock to government purchases within a closed economy, the traditional IS-LM and one-sector neoclassical theoretical models as well as the two-sector theoretical models of Ramey and Shapiro (1997) and Edelberg, Eichenbaum, and Fisher (1999) predict that output, the price level, and interest rates rise temporarily in response to an increase in government purchases. However, according to the two-sector models of Edelberg, Eichenbaum, and Fisher (1999), interest rates briefly fall before they rise.

The IRFs reported for the narrative approach of Ramey and Shapiro (1997) are consistent with the theoretical two-sector neoclassical models of Ramey and Shapiro (1997) and Edelberg, Eichenbaum, and Fisher (1999). The IRFs reported for the more comprehensive narrative approach are consistent with the traditional IS-LM model,

except that the IRF for RTB does not increase immediately after a shock to defense purchases.

The IRFs for RTB and the GDP deflator reported for the Choleski decomposition are not consistent with the theoretical two-sector neoclassical models of Ramey and Shapiro (1997) and Edelberg, Eichenbaum, and Fisher (1999) as well as the more traditional IS-LM and one-sector neoclassical models. Furthermore, when the benchmark model used by Fatas and Mihov (2000) is estimated and shocks to government purchases are identified using the Choleski decomposition, the IRFs computed for real RTB and the GDP deflator are also problematic. Finally, the IRFs for real GDP and RTB reported using long-run restrictions are not consistent with the theoretical models mentioned above.

Ramey and Shapiro (1997) only identify three exogenous shocks to defense purchases. Furthermore, Edelberg, Eichenbaum, and Fisher (1999) argue that results reported using the Choleski decomposition appears to be sensitive to perturbations in the sample period used and the list of variables used. However, the amount of evidence available on the robustness of the results reported for the different methods of identifying exogenous shocks to defense purchases is limited.

Therefore, it is important to investigate the robustness of the results computed for the models estimated in the dissertation. For each method of identifying exogenous shocks to defense purchases under examination, the sensitivity of the results computed for defense purchases, real GDP, RTB, and the GDP deflator to adding time trends and changing the lag length in the benchmark model is investigated.

Then, the sensitivity of the results computed for defense purchases, real GDP, RTB, and the GDP deflator to adding, in turn, additional endogenous variables and exogenous dummy variables to the alternative model is examined. Finally, the sensitivity of the results computed for the alternative model to perturbations in the sample period is considered.

To examine the sensitivity of the results computed for the benchmark model to adding time trends, the IRFs for defense purchases, real GDP, RTB, and the GDP deflator are computed when linear and quadratic trends and a "Perron-type" time trend are added, in turn, to each equation of the benchmark model. To examine the sensitivity of the results computed for the benchmark model to perturbations in the lag length used, the IRFs for defense purchases, real GDP, RTB, and the GDP deflator are computed for models identical to the benchmark model, except that two and six lagged values of the variables are included in each equation of the benchmark model.

When the narrative approach of Ramey and Shapiro (1997) and the more comprehensive narrative approach are used to identify exogenous shocks to defense purchases, the results reported for the benchmark model are not sensitive to adding time trends. However, the results reported for defense purchases, real GDP, and RTB appear to be sensitive to changing the lag length used.

When the Choleski decomposition is used to identify exogenous shocks to defense purchases, the results reported for the benchmark model are not sensitive to adding time trends and to changing the lag length used, except for defense purchases. When long-run restrictions are used to identify exogenous shocks to defense purchases, the results reported for the benchmark model are sensitive to adding a "Perron-type" time trend; however, they are not sensitive to changing the lag length used.

To examine the sensitivity of the results computed for the alternative model to perturbations in the list of variables, the IRFs for defense purchases, real GDP, RTB, and the GDP deflator are computed for extended models in which six lagged values of additional endogenous variables and exogenous dummy variables are added, in turn, to each equation of the alternative model. For each method of identifying exogenous shocks to defense purchases under examination, seventeen additional variables are considered.

First, the effects of shocks to defense purchases are examined in models that alternatively include non-defense purchases, real federal government receipts, and the real federal government deficit. Then, the effects of shocks to defense purchases are investigated in models that alternatively include consumption of non-durables and services, consumption of durables plus residential investment, and non-residential investment.

Next, the effects of shocks to defense purchases are examined in models that alternatively include total private employment, employment in the non-durables manufacturing sector, employment in the durables manufacturing sector, real wages in private industry, real compensation in the manufacturing sector, and real compensation in the business sector.

Finally, the effects of shocks to defense purchases are presented in models that alternatively include the Romers' monetary policy dummy variable, the monetary base, Hamilton's oil price dummy variable, the PPI for crude fuel, and a measure of long-term interest rates are presented. Furthermore, when the Choleski decomposition and long-run restrictions are used to identify exogenous shocks to defense purchases, the effects of shocks to defense purchases are presented in models that include the Ramey-Shapiro dummy variable.

When the narrative approach of Ramey and Shapiro (1997) is used to identify exogenous shocks to defense purchases, the results reported for the alternative model appear to be robust to perturbations in the list of variables used, except for Hamilton's oil price dummy variable. When the more comprehensive narrative approach is used to identify exogenous shocks to defense purchases, the results reported for the alternative model appear to be robust to perturbations in the list of variables used, except for employment in the durables manufacturing sector.

When the Choleski decomposition is used to identify exogenous shocks to defense purchases, the results reported for the alternative model appear to be robust to perturbations in the list of variables used, except for Hamilton's oil price dummy, and to a lesser extent the additional fiscal variables.

When long-run restrictions are used to identify exogenous shocks to defense purchases, the results reported for the alternative model, in particular for defense purchases, are sensitive to adding the exogenous dummy variables under examination. However, they are not sensitive to adding the endogenous variables.

To examine the sensitivity of the results computed for the alternative model to perturbations in the sample period, the IRFs for defense purchases, real GDP, RTB, and the GDP deflator are computed when the alternative model is estimated over four different sub-sample periods. The first two sub-sample periods selected spans 1948:3 to 1973:1 and 1960:1 to 1999:2. They are referred to as the early-sub-sample period and the late sub-sample period, respectively. The next sub-sample periods selected span 1950:1 to 1999:2 and 1948:3 to 1989:4, which corresponds to the Cold War era.

When the alternative model is estimated for the early and late sub-sample periods, the IRFs reported for all the method of identifying exogenous shocks to defense purchases imply that the IRFs computed for the alternative model, in particular defense purchases, are sensitive to perturbations in the sample period used. When it is estimated for the sub-sample period 1950:1 to 1999:2 and the Cold War era, the IRFs computed for the alternative model do not appear to be sensitive to perturbations in the sample period used, except for the IRFs for the GDP deflator computed when the narrative approaches are used to identify exogenous shocks to defense purchases.

In conclusion, for all the methods of identifying exogenous shocks to defense purchases under examination, the results reported for the benchmark model are not very sensitive to adding time trends and changing the lag length used, except when long-run restrictions are used to identify exogenous shocks to defense purchases and a "Perron-type" time trend is added to the benchmark model.

As Edelberg, Eichenbaum, and Fisher (1999) claim, when the Choleski decomposition is used to identify exogenous shocks to defense purchases, the IRFs computed for the alternative model, in particular for defense purchases, appear to be sensitive to perturbations in the sample period used. However, the IRFs computed for all the methods of identifying exogenous shocks to defense purchases, including the narrative approach of Ramey and Shapiro (1997), appear to be sensitive to perturbations in the sample period used.

Finally, Edelberg, Eichenbaum, and Fisher (1999) argue that when the Choleski decomposition is used to identify exogenous shocks to government purchases, the results are sensitive to perturbations in the list of variables used. When the Choleski decomposition and the other methods under examination are used to identify exogenous shocks to defense purchases, the differences in the IRFs reported for the extended models and the alternative model are only minor, except for the model with Hamilton's oil price dummy variable.

In order to further investigate the implications of the methods of identifying exogenous shocks to defense purchases under examination, the dissertation also examines issues specific to each method. When the narrative approach of Ramey and Shapiro (1997) and the more comprehensive narrative approach are used to identify exogenous shocks to defense purchases, the implications of abandoning the assumption that the shocks to defense purchases are of equal intensity is examined. Furthermore, the exogeneity of the shocks included in the Ramey-Shapiro dummy and DP dummy variables is investigated.

To account for the differences in size among the shocks included in the Ramey-Shapiro dummy and the DP dummy variables, modified dummy variables are constructed whose values at the dates of the shocks to defense purchases vary according to the size of the changes in defense purchases that follow each shock identified. Then, the IRFs for defense purchases, real GDP, RTB, and the GDP deflator are computed for a unit shock to the modified Ramey-Shapiro dummy variable and the modified DP dummy variable when the alternative model is estimated.

Except for RTB, the patterns of the IRFs computed for shocks to the modified dummy variables are fairly similar to the ones reported when the shocks to defense purchases are of equal intensity; however, their magnitudes differ. The IRFs for RTB reported for shocks the modified Ramey-Shapiro dummy variable and the modified DP

dummy variable decline significantly in the first year after a shock, and then it is not significantly different from zero.

When the assumption that the shocks to defense purchases are of equal intensity is abandoned, the IRFs for RTB are inconsistent with the theoretical two-sector neoclassical models of Ramey and Shapiro (1997) and Edelberg, Eichenbaum, and Fisher (1999) as well as the more traditional IS-LM and one-sector neoclassical models. Furthermore, they imply that the results reported for shocks to the Ramey-Shapiro dummy or DP dummy variable are sensitive to allowing variation in the intensity of the episodes.

To examine the exogeneity of the shocks included in the Ramey-Shapiro dummy and the DP dummy variables, a methodology used by Leeper (1997) to study the exogeneity of the Romers' monetary policy dummy variable is implemented. First, a logit equation that includes macroeconomic variable is estimated for the Ramey-Shapiro dummy variable, and the conditional expectations for the Ramey-Shapiro episodes are computed.

The logit equation is very imprecisely estimated. Moreover, although it is widely accepted that the breakout of the Korean War was sudden and unexpected, the conditional expectation reported for the Korean War episode implies that this episode was predicted by recent developments in the U.S economy. Therefore, it is concluded that the logit equation does not appear to provide meaningful evidence on the exogeneity of the Ramey-Shapiro episodes. Similarly, a logit equation was estimated for the DP dummy variable that led to the same conclusion.

Second, linear systems are estimated in which the Ramey-Shapiro dummy and the DP dummy variables are entered, in turn, as endogenous variables along with the other variables included in the alternative model. Then, the IRFs for defense purchases, real GDP, RTB, and the GDP deflator are computed for a unit shock to the Ramey-Shapiro dummy and the DP dummy variables. Since they are similar to the corresponding IRFs computed for the alternative model, it is concluded that the results reported for the linear systems are consistent with the shocks identified using the narrative approaches being exogenous.

Finally, since the dates identified for the Vietnam War and Carter-Reagan episodes in the third chapter of the dissertation are slightly different from the ones selected by Ramey and Shapiro (1999), they are used to examine the sensitivity of the results computed for the benchmark and alternative models to small perturbations in the dates of the Ramey-Shapiro episodes.

Edelberg, Eichenbaum, and Fisher (1999) argue that the results they report using the Ramey-Shapiro dummy variable are robust to small perturbations in the dates of the Ramey-Shapiro episodes. However, when the alternative dates selected for the Vietnam War and Carter-Reagan shocks are used to construct a modified Ramey-Shapiro dummy variable, the IRFs reported for real GDP and RTB are significantly different from the ones computed when the dates selected by Ramey and Shapiro (1997) are used. Therefore, it is concluded that the results computed for the benchmark and alternative models are sensitive to small perturbations in the dates of the Vietnam War and Carter-Reagan episodes.

Since the anticipation, and hence exogeneity, of the shocks to fiscal policy identified using the Choleski decomposition are serious concerns, a VAR system identical to the alternative model, except that new orders of defense products is

substituted for defense purchases, is estimated. Then, the IRFs that present the effects of a unit shock to new orders of defense products on new orders of defense products, real total GDP, RTB, and the GDP deflator are computed.

New orders of defense products are a series from the US Business Cycle Indicators (BCI) series that are used for tracking and predicting U.S business activity. Since the data for new orders of defense products are available since 1968:1, the model with new orders of defense products is estimated over the sample period 1969:3 to 1999:2.

The evidence reported when new orders of defense products are used as a proxy for defense purchases is less likely to be subject to the criticisms against using the Choleski decomposition to identify exogenous shocks to defense purchases presented in the literature for several reasons. First, new orders of defense products contain information about future flows of defense purchases. Second, since new orders of defense products are recorded before defense purchases, shocks to new orders of defense products are more likely to be unanticipated than shocks to defense purchases. Finally, since new orders of defense products are recorded before production begins, shocks to new orders of defense products do not reflect shocks to the private sector.

As was done in earlier chapters, new orders of defense products are hereafter referred to as new orders. When the Choleski decomposition is used to identify exogenous shocks to new orders, the IRFs reported are very different from the ones presented when it is used to identify exogenous shocks to defense purchases. They imply that output, interest rates, and the price level increase significantly for one and a half years in response to a positive shock to government purchases.

The IRFs reported for the model with new orders are consistent with a traditional IS-LM model when accelerator effects are considered. Furthermore, the IRFs for real GDP, RTB, and the GDP deflator computed for the alternative model over the sample period 1969:3 to 1999:2 are problematic. Therefore, it is concluded that new orders are better proxy for government purchases than defense purchases.

To investigate the sensitivity of the results computed for the model with new orders to perturbations in the list of variables, the methodology used to examine the robustness of the results reported for defense purchases is used. It is concluded that the results reported for the model with new orders are not very sensitive to adding the variables selected, except for residential investment plus consumption of durables and the Ramey-Shapiro dummy variable.

To investigate the sensitivity of the results computed for the model with new orders to perturbations in the sample period, this model is estimated for two sub-sample periods that spans1969:3 to 1989:4 and 1973:2 to 1999:2, respectively. It is concluded that the IRFs for real GDP and RTB reported for the model with new orders are fairly sensitive to perturbations in the sample period used.

When long-run restrictions are used to identify exogenous shocks to defense purchases, a VAR system identical to the alternative model, except that new orders is substituted for defense purchases, is also estimated. Then, the IRFs that present the effects of a unit shock to new orders on new orders, real GDP, RTB, and the GDP deflator are computed.

The IRFs for real GDP, and the GDP deflator reported for a shock to new orders are relatively similar to the ones presented for a shock to defense purchases; however, the

IRF for RTB is different. They imply that defense purchases, RTB, and the GDP deflator increase persistently in response to a shock to new orders, and real GDP is not significantly affected.

The IRFs reported for the model with new orders are not totally consistent with the theoretical two-sector neoclassical models presented by Ramey and Shapiro (1997) and Edelberg, Eichenbaum, and Fisher (1999) as well as the more traditional IS-LM and one-sector neoclassical models. Furthermore, the IRFs for real GDP, RTB, and the GDP deflator computed for the alternative model over the sample period 1969:3 to 1999:2 are even more problematic than the ones computed for the model with new orders. Therefore, it is concluded that new orders are better proxy for government purchases than defense purchases, although they do not appear to be a much better policy variable than defense purchases.

Following the same methodology as the one used for the Choleski decomposition, it is concluded that the results reported for the model with new orders are not sensitive to adding an additional endogenous or exogenous variable, except for the PPI for crude fuel and the Ramey-Shapiro dummy variable. It is also concluded that the results reported for the model with new orders are not sensitive to altering the sample period used.

6.2 The Effects of Exogenous Shocks to Defense Purchases on Consumption, Investment, and Labor Market Variables

As was mentioned in the first chapter of the dissertation, the traditional IS-LM, one-sector neoclassical model, and the two-sector models of Ramey and Shapiro (1997) and Edelberg, Eichenbaum, and Fisher (1999) predict that employment rises and real wages fall in response to an increase in government purchases.

However, theoretical models generally differ on their predictions about the effects of a shock to government purchases on consumption and investment. The traditional IS-LM model predicts that private consumption rises temporarily in response to a temporary increase in government purchases. Since a rise in interest rates crowds out private investment, it also predicts that private investment declines temporarily. However, since an increase in the level of income raises private investment, the effect of a temporary increase in government purchases on private investment is uncertain when accelerator effects are considered.

Because of the wealth effect of a change in government purchases, the one-sector neoclassical model predicts that private consumption declines permanently in response to a temporary increase in government purchases. Furthermore, since employment rises permanently after an increase in government purchases, Perotti (2000) argues that gross investment should also be permanently larger to maintain the ratio of labor to capital in the economy constant in the long run. The two-sector model of Edelberg, Eichenbaum, and Fisher (1999) predicts that private consumption declines but non-residential investment rises in response to a temporary increase in government purchases.

This section examines the implications of different methods of identifying exogenous shocks to defense purchases for estimating the effects of these shocks on consumption, investment, and labor market variables. Specifically, the IRFs that present the effects of a shock to defense purchases on the consumption, investment, and labor market variables are computed when extended models identical to the ones used in the previous chapters of the dissertation are estimated.

The variables included in the systems estimated, the specification of the systems estimated, and the sample period used are held constant so that discrepancies in the IRFs computed using different identification schemes can be attributed to the identification schemes. The identification schemes examined include the narrative approach of Ramey and Shapiro (1997), and the more comprehensive narrative approach that tries to isolate exogenous reductions in defense expenditures as well as exogenous increases in defense expenditures, the Choleski decomposition, and long-run restrictions.

For each method of identifying exogenous shocks to defense purchases, the same models are estimated over the sample period from 1948:3 to 1999:2. Six lagged values of defense purchases, GDP, RTB, the GDP deflator, and a consumption, investment, or labor market variable under examination are entered as endogenous variables. A constant and a "Perron-type" time trend are also included in each equation of the models estimated. Furthermore, when a narrative approach is used to identify shocks to defense purchases, the relevant defense purchases dummy variable is entered as an exogenous variable.

It was shown in the third chapter of the dissertation that the inference reported using the narrative approach are sensitive to using alternative dates for the exogenous increases in defense purchases identified by Ramey and Shapiro (1997). Therefore, this section presents IRFs computed when the dates selected by Ramey and Shapiro (1997) as well as the alternative dates selected in the second chapter of the dissertation are used to construct the Ramey-Shapiro dummy variable. Furthermore, it presents IRFs computed when the dates selected in the second chapter of the dissertation are used to construct the DP dummy variable that includes exogenous increases and exogenous decreases in defense purchases.

It was shown in the fourth chapter of the dissertation that the results reported for a shock to defense purchases using the Choleski decomposition are inconsistent with the theoretical two-sector neoclassical models of Ramey and Shapiro (1997) and Edelberg, Eichenbaum, and Fisher (1999) as well as the more traditional IS-LM and one-sector neoclassical models. However, when new orders are used as a proxy for defense purchases, the results reported using the Choleski decomposition are consistent with the traditional IS-LM model.

Furthermore, it was shown in the fifth chapter of the dissertation that the results reported using long-run restrictions when new orders are used as a proxy for defense purchases appear to be better than the ones presented for the models with defense purchases. Therefore, this section presents IRFs computed when the Choleski decomposition and long-run restrictions are used to identify exogenous shocks to new orders as well as defense purchases. Due to data availability, the models with new orders are estimated over the sample periods 1969:3 to 1999:2.

Ramey and Shapiro (1997) identify only one shock to defense purchases since 1969:3 that corresponds to the Carter-Reagan episode. Furthermore, it was shown in the second chapter of the dissertation that the results reported using the Ramey-Shapiro dummy variable are very sensitive to excluding the Korean war episode from the sample period used. Therefore, it would be meaningless to compare the results reported using the Choleski decomposition and long-run restrictions to identify shocks to new orders over the sample period 1969:3 to 1999:2 and the results computed using the narrative approach of Ramey and Shapiro (1997) over the same sample period.

Therefore, the IRFs for the consumption, investment, and labor market variables reported for the models with new orders were not directly compared to the ones computed for the models estimated earlier for the sample period 1948:3 to 1999:2. However, it would be of interest to compare in a future study the IRFs computed for models with defense purchases and new orders over the same sample period using the Choleski decomposition and long-run restrictions.

The methodologies used to compute the IRFs reported in the previous chapters of the dissertation are used to compute the IRFs that present the effects of a unit shock to the different policy variables on consumption, investment, and labor market variables. Following Edelberg, Eichenbaum, and Fisher (1999), consumption and investment are broken down into three variables: consumption of non-durables and services, consumption of durables plus residential investment, and non-residential investment

In Figure 6.1, the solid lines display the point estimates of the IRFs for consumption of non-durables and services, consumption of durables plus residential investment, and non-residential investment computed for a unit shock to the Ramey-Shapiro dummy variable, the alternative Ramey-Shapiro dummy variable, and the DP dummy variable. The dashed lines display the lower and upper bounds of sixty-eight percent confidence intervals.[2] The patterns of the IRFs for consumption and investment reported in Figure 6.1 are similar to the ones presented by Edelberg, Eichenbaum, and Fisher (1999).

After a brief delay, the IRF for consumption of non-durables and services declines significantly for two quarters, and then it is no longer significantly different from zero. The IRF for consumption of durables plus residential investment rises significantly at the time of a shock to defense purchases, and it declines significantly in the period after a shock. Then, it is not significantly different from zero for a year, and finally it declines significantly and persistently. The IRF for non-residential investment rises significantly in the period of a Ramey-Shapiro episode, then it is not significant for several periods, and finally it rises significantly for almost two years.

The IRFs for consumption and investment reported for a shock to the Ramey-Shapiro dummy variable are consistent with the theoretical two-sector models of Ramey and Shapiro (1997) and Edelberg, Eichenbaum, and Fisher (1999) that imply that private consumption falls and non-residential investment rises in response to a shock to government purchases.

The pattern of the IRF for consumption of non-durables and services computed for a shock to the alternative Ramey-Shapiro dummy variable is different from the one reported for a shock to the Ramey-Shapiro dummy variable. It increases significantly in the period of a shock to defense purchases, and then it is not significantly different from zero for more than two years. Finally, it declines significantly, although marginally.

The IRF for consumption of durables plus residential investment initially declines more rapidly than the one reported for a shock to the Ramey-Shapiro dummy variable; however, it is not very different. The pattern of the IRF for non-residential investment is very different from the one reported for a shock to the Ramey-Shapiro dummy variable. It rises slightly but significantly in the period of a shock to defense purchases, then it is

[2] The lower and upper bounds of the confidence intervals represent the 80^{th} lowest and 420^{th} highest values across 500 impulse response coefficients computed using a bootstrap Monte Carlo procedure identical to the one presented by Edelberg, Eichenbaum, and Fisher (1999).

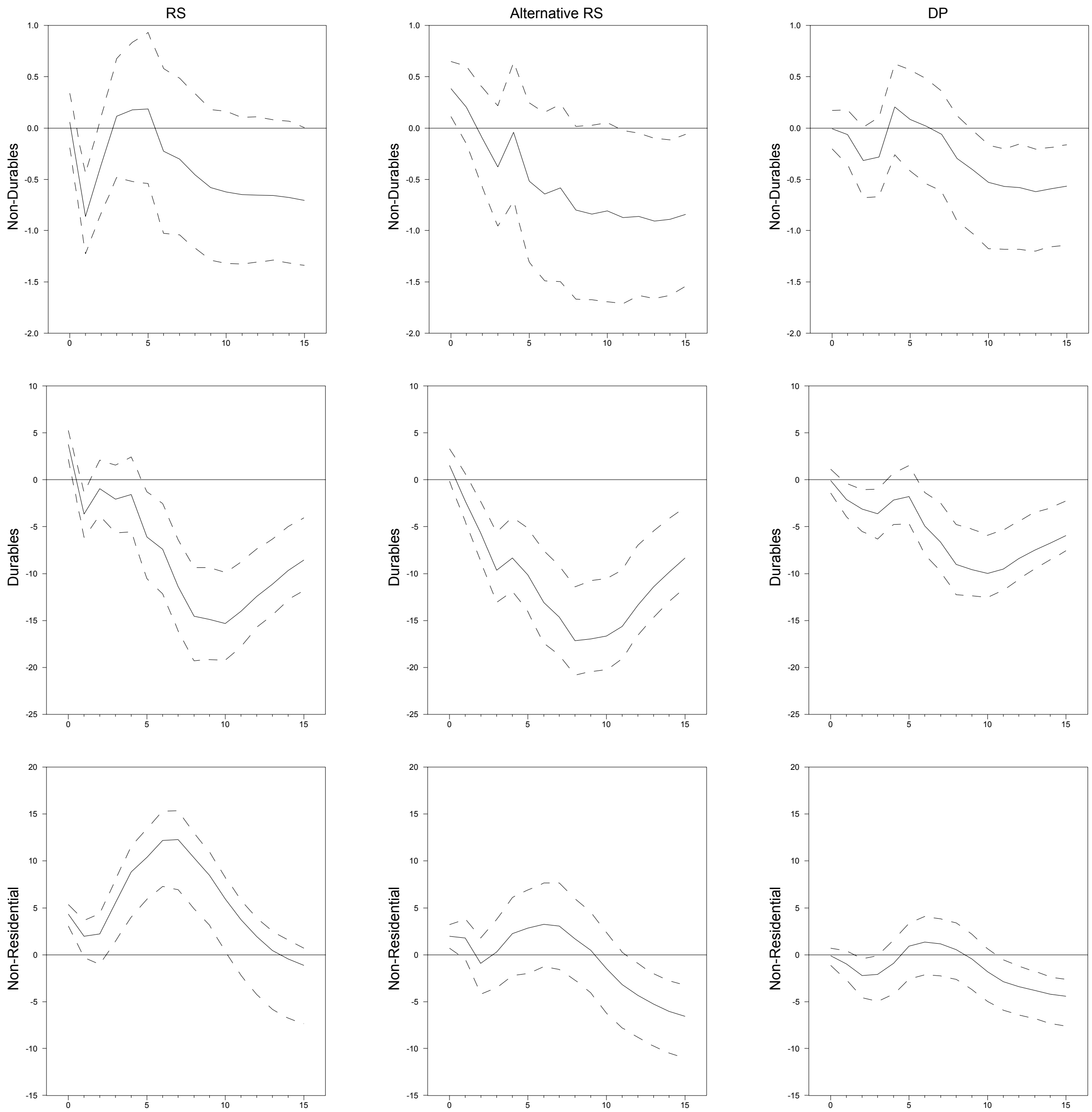

Figure 6.1: Point Estimates for Consumption and Investment Computed Using Narrative Approaches
Ramey-Shapiro Dummy (RS), Alternative Ramey-Shapiro Dummy, Defense Purchases Dummy (DP)

not significantly different from zero for almost three years, and finally it decreases significantly.

The IRFs for consumption and investment computed for a shock to the DP dummy variable are not very different from the ones reported for a shock to the alternative Ramey-Shapiro dummy variable. However, it is noted that the IRF for non-residential investment computed for a shock to the DP dummy variable declines for several quarters in the first year as well as in the fourth year after a shock to defense purchases.

The patterns of the IRFs for consumption of non-durables and services and consumption of durables plus residential investment computed for a unit shock to the alternative Ramey-Shapiro dummy and the DP dummy variables are consistent with the theoretical two-sector models and the empirical evidence presented by Ramey and Shapiro (1997) and Edelberg, Eichenbaum, and Fisher (1999).

However, the patterns of the IRFs for non-residential investment computed for a unit shock to the alternative Ramey-Shapiro dummy variable and the DP dummy variable are not consistent with the theoretical two-sector models of Ramey and Shapiro (1997) and Edelberg, Eichenbaum, and Fisher (1999) as well as the more traditional IS-LM and one-sector neoclassical models.

The discrepancies between the results for non-residential investment may reflect the sensitivity of the IRFs reported for shocks to the dummy variables to small perturbations in the dates of the Vietnam War and Carter-Reagan episodes. As was shown in the third chapter of the dissertation, the IRFs for RTB computed for IRFs reported for shocks to the Ramey-Shapiro dummy variable are sensitive to using alternative dates for the onsets of the Vietnam War and Carter-Reagan episodes.

In the first and second columns of Figure 6.2, the solid lines display the point estimates of the IRFs for consumption of non-durables and services, consumption of durables plus residential investment, and non-residential investment computed for a unit shock to defense purchases and new orders using the Choleski decomposition. The dashed lines display the lower and upper bounds of one-standard deviation confidence intervals computed using a Monte Carlo integration procedure.

The magnitudes of the IRFs for consumption and investment reported for a unit shock to defense purchases or new orders using the Choleski decomposition are much smaller than the ones presented above for a unit shock to the dummy variables. This also true when the other IRFs reported for employment, real wages, and real compensation are computed using the Choleski decomposition. Similarly, the IRFs reported using long-run restrictions are much smaller than the ones presented above for a unit shock to the dummy variables, although they are larger than the ones reported using the Choleski decomposition.

After a delay of more than a year, the IRF for consumption of non-durables and services computed for a shock to defense purchases using the Choleski decomposition exhibits a hump-shaped pattern. It increases significantly for a year. The IRF for consumption of durables plus residential investment is not significantly different from zero at any horizon. The IRF for non-residential investment is negative and significant at all horizons, except for a year when it is only marginally significant.

The IRF for consumption of non-durables and services computed for a shock to new orders using the Choleski decomposition increases sharply for a year after a shock,

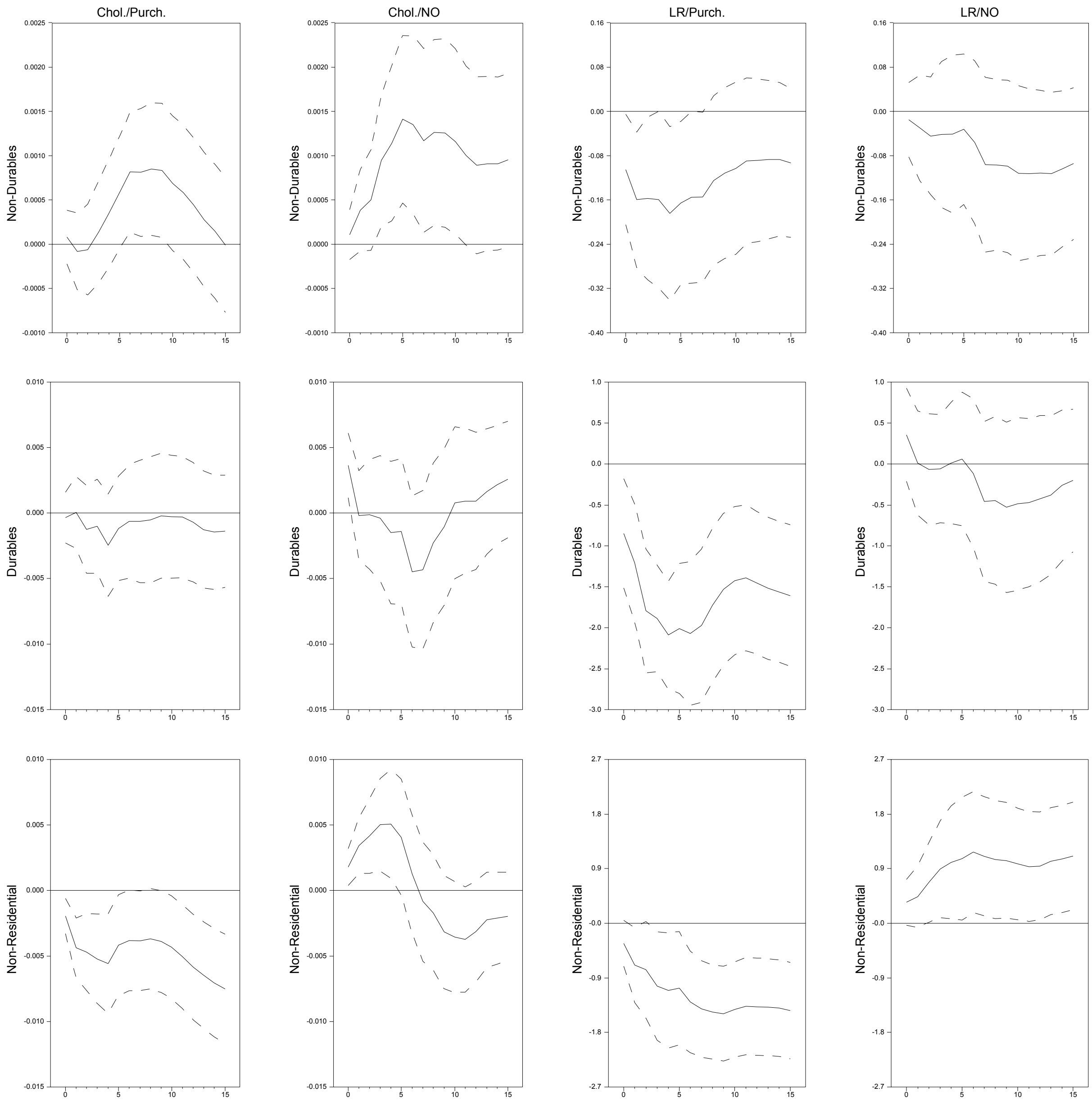

Figure 6.2: Point Estimates for Consumption and Investment from Choleski Decomposition (Chol.) and Long-Run Restrictions (LR)
Defense Purchases (Purch.) and New Orders of Defense Products (NO)

and then it stabilizes. After a delay of two quarters, it is significant for more than two years. The IRF for consumption of durables plus residential investment exhibits a u-shaped pattern. It increases significantly at the time of a shock to new orders, but it is not significantly different from zero at any horizon afterward. The IRF for non-residential exhibits a hump-shaped pattern, and it increases significantly for one and a half years after a shock to new orders.

Overall, the IRFs for consumption of non-durables and services, consumption of durables plus residential investment, and non-residential investment computed for a unit shock to defense purchases using the Choleski decomposition imply that consumption of non-durables and services increases temporarily in response to a shock to defense purchases, non-residential investment declines persistently, and consumption of durables plus residential investment does not change significantly.

These IRFs are inconsistent with the one-sector neoclassical model and the two-sector neoclassical models of Ramey and Shapiro (1997) and Edelberg, Eichenbaum, and Fisher (1999). However, they are consistent with a traditional IS-LM model in which an increase in government purchases crowds out private investment.

The IRFs for consumption of non-durables and services, consumption of durables plus residential investment, and non-residential investment computed for a unit shock to new orders using the Choleski decomposition imply that consumption of non-durables and services rises persistently in response to a shock to new orders, consumption of durables plus residential investment increases very briefly, and non-residential investment increases temporarily. They are inconsistent with the one-sector neoclassical model and the two-sector neoclassical models of Ramey and Shapiro (1997) and Edelberg, Eichenbaum, and Fisher (1999). However, they are consistent with an IS-LM model in which accelerator effects are considered.

In the third and fourth columns of Figure 6.2, the solid lines display the point estimates of the IRFs for consumption of non-durables and services, consumption of durables plus residential investment, and non-residential investment computed for a unit shock to defense purchases and new orders using long-run restrictions. The dashed lines display the lower and upper bounds of one-standard deviation confidence intervals computed using a Monte Carlo integration procedure.

The IRFs for consumption of non-durables and services, consumption of durables plus residential investment, and non-residential investment computed for a shock to defense purchases using long-run restrictions are negative at all horizons. The IRF for consumption of non-durables and services is significant for one and a half years. The IRFs for consumption of durables plus residential investment and non-residential investment are significant at all horizons.

The IRFs for consumption of non-durables and services and consumption of durables plus residential investment computed for a shock to new orders using long-run restrictions are not significantly different from zero at any horizon. The IRF for non-residential investment is positive, and it is marginally significant at all horizons.

Overall, the IRFs for consumption of non-durables and services, consumption of durables plus residential investment, and non-residential investment computed for a unit shock to defense purchases using long-run restrictions imply that both private consumption and investment decrease persistently in response to a shock to defense purchases. They are inconsistent with the theoretical two-sector neoclassical models of

Ramey and Shapiro (1997) and Edelberg, Eichenbaum, and Fisher (1999) as well as the more traditional one-sector neoclassical and IS-LM models.

The IRFs for non-residential investment computed for a unit shock to new orders using long-run restrictions are inconsistent with the IS-LM model. They are consistent with the theoretical two-sector neoclassical models of Ramey and Shapiro (1997) and Edelberg, Eichenbaum, and Fisher (1999) as well as the more traditional one-sector neoclassical model. However, the lack of significance of the IRFs reported for the consumption variables is troublesome.

In Figure 6.3, the solid lines display the point estimates of the IRFs for employment in private industry, employment in the non-durables manufacturing sector, and employment in the durables manufacturing sector computed for a unit shock to the Ramey-Shapiro dummy variable, the alternative Ramey-Shapiro dummy variable, and the DP dummy variable. The dashed lines display the lower and upper bounds of sixty-eight percent confidence intervals.

The IRFs for employment reported for a shock to the Ramey-Shapiro dummy variable exhibit a hump-shaped pattern. After a delay of several periods, the IRF for employment in private industry increases significantly for more than one and a half years. In the period of a shock to defense purchases, the IRFs for employment in the non-durables manufacturing sector and employment in the durables manufacturing sector increase significantly for two and a half years.

The pattern and magnitude of the IRF for employment in private industry reported for a shock to the alternative Ramey-Shapiro dummy variable is very different from the one computed for a shock to the Ramey-Shapiro dummy variable. The IRF for employment in private industry reported for a shock to the alternative Ramey-Shapiro dummy variable is small for one and a half years after a shock to defense purchases, and then it declines persistently and significantly.

The patterns and magnitudes of the IRFs for employment in the non-durables manufacturing sector and employment in the durables manufacturing sector are similar to the ones computed for a shock to the Ramey-Shapiro dummy variable. They exhibit hump-shaped patterns and they increase significantly for two and a half years.

The pattern of the IRF for employment in private industry reported for a shock to the DP dummy variable is initially different from the one computed for a shock to the Ramey-Shapiro dummy variable and the alternative Ramey-Shapiro dummy variable. The IRF for employment in private industry reported for a shock to the DP dummy variable declines significantly for several quarters. Then, it increases steadily for a year, but it is not significant. Finally, it declines significantly and persistently. The IRFs for employment in the non-durables manufacturing sector and employment in the durables manufacturing sector exhibit hump-shaped patterns. After a delay of a year, they increase significantly for one and a half years.

Overall, the patterns of the IRFs for employment in private industry, employment in the non-durables manufacturing sector, and employment in the durables manufacturing sector computed for a unit shock to the Ramey-Shapiro dummy variable are consistent with the theoretical two-sector neoclassical models of Ramey and Shapiro (1997) and Edelberg, Eichenbaum, and Fisher (1999) as well as the more traditional IS-LM and one-sector neoclassical models.

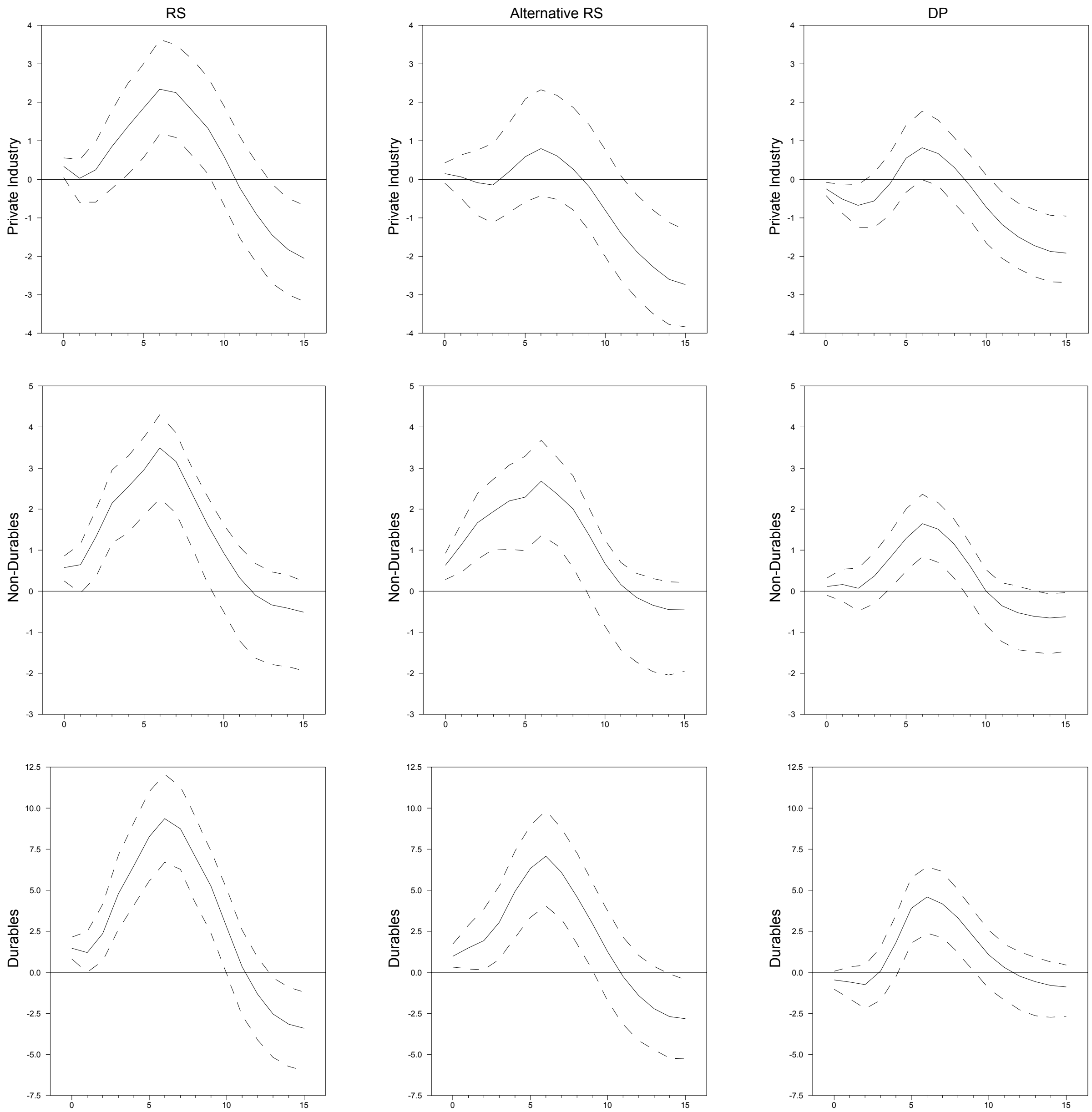

Figure 6.3: Point Estimates for Employment Computed Using Narrative Approaches
Ramey-Shapiro Dummy (RS), Alternative Ramey-Shapiro Dummy, Defense Purchases Dummy (DP)

The patterns of the IRFs for employment in private industry computed for a unit shock to the alternative Ramey-Shapiro dummy and the DP dummy variables are inconsistent with these theoretical models. However, the patterns of the IRFs for employment in the non-durables manufacturing sector and employment in the durables manufacturing sector computed for a unit shock to the alternative Ramey-Shapiro dummy and the DP dummy variables are consistent with these theoretical models.

In the first and second columns of Figure 6.4, the solid lines display the point estimates of the IRFs for employment in private industry, employment in the non-durables manufacturing sector, and employment in the durables manufacturing sector computed for a unit shock to defense purchases and new orders using the Choleski decomposition. The dashed lines display the lower and upper bounds of one-standard deviation confidence intervals computed using a Monte Carlo integration procedure.

The IRFs for employment in private industry for a unit shock to defense purchases using the Choleski decomposition exhibit hump-shaped patterns. After a delay of several periods, the IRF for employment in private industry increases significantly for a year. In the period of a shock to defense purchases, the IRF for employment in the non-durables manufacturing sector increases significantly for more than three years. After a delay of a quarter, the IRF for employment in the durables manufacturing sector increases significantly for two and a half years.

The IRF for employment in private industry and employment in the non-durables manufacturing sector computed for a unit shock to new orders using the Choleski decomposition also exhibit hump-shaped patterns, and they increase significantly for more than one and a half years. However, after a delay of more than one and a half years, the IRF for employment in the durables manufacturing sector decreases significantly and persistently. Given the other IRFs for employment reported, this result is puzzling.

In the third and fourth columns of Figure 6.4, the solid lines display the point estimates of the IRFs for employment in private industry, employment in the non-durables manufacturing sector, and employment in the durables manufacturing sector computed for a unit shock to defense purchases and new orders using long-run restrictions. The dashed lines display the lower and upper bounds of one-standard deviation confidence intervals computed using a Monte Carlo integration procedure.

The patterns of the IRFs for employment reported using long-run restrictions are very different from the ones presented using the narrative approaches or the Choleski decomposition. Furthermore, the IRFs for employment in private industry and employment in the durables manufacturing sector computed for a unit shock to defense purchases or new orders using long-run restrictions are not significantly different from zero at any horizon or are marginally and briefly significant.

Overall, the patterns of the IRFs for employment computed for a shock to defense purchases or new orders using the Choleski decomposition are consistent with the theoretical two-sector neoclassical models of Ramey and Shapiro (1997) and Edelberg, Eichenbaum, and Fisher (1999) as well as the more traditional IS-LM and one-sector neoclassical models, except for employment in the durables manufacturing sector. In this case, the IRF reported decreases significantly and persistently. Furthermore, the patterns of the IRFs for employment computed for a shock to defense purchases or new orders using long-run restrictions are inconsistent with these theoretical models.

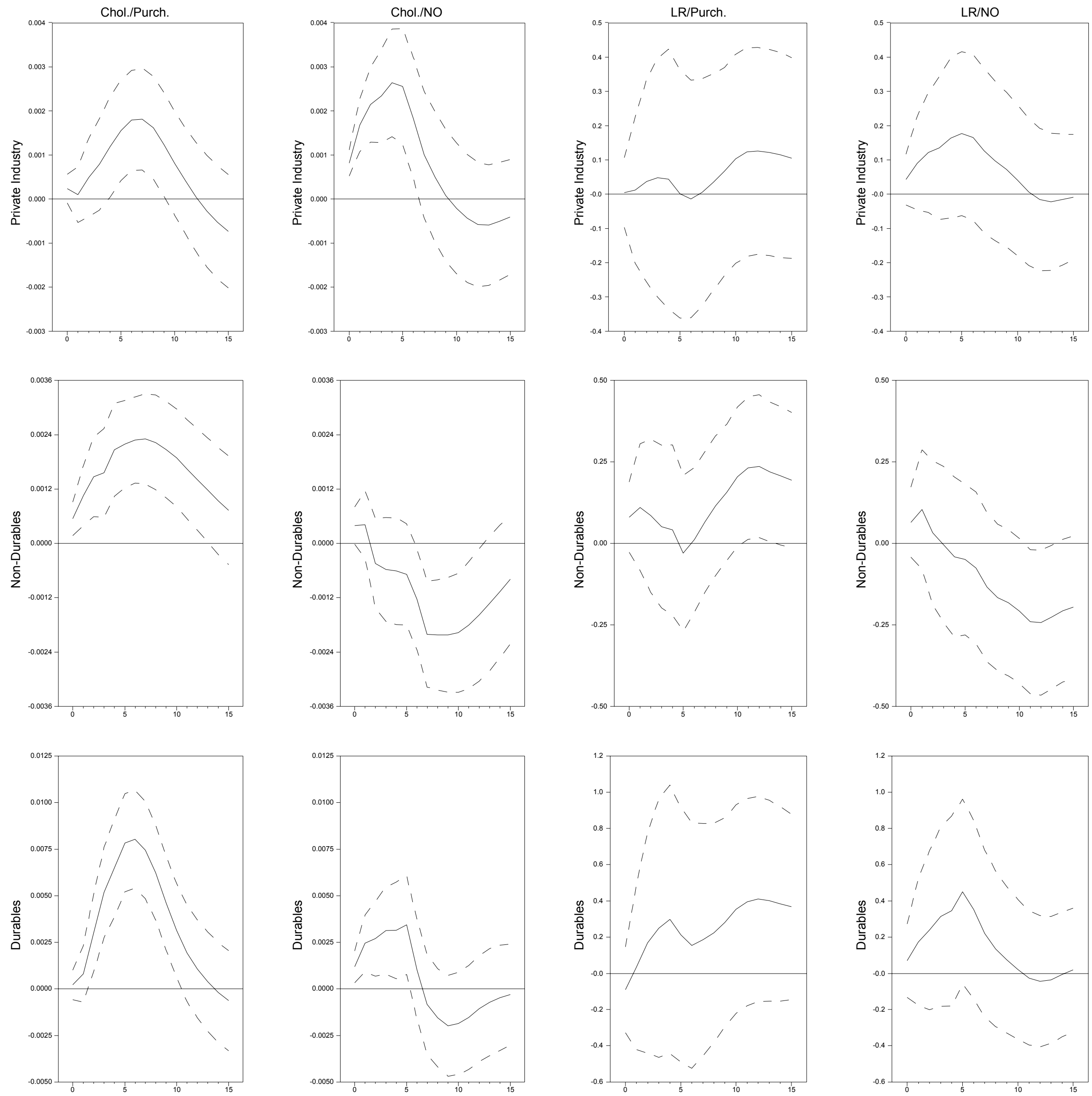

Figure 6.4: Point Estimates for Employment from Choleski Decomposition (Chol.) and Long-Run Restrictions (LR)
Defense Purchases (Purch.) and New Orders of Defense Products (NO)

In Figure 6.5, the solid lines display the point estimates of the IRFs for real wages in private industry, real compensation in the business sector, and real compensation in the manufacturing sector computed for a unit shock to the Ramey-Shapiro dummy variable, the alternative Ramey-Shapiro dummy variable, and the DP dummy variable.
The dashed lines display the lower and upper bounds of sixty-eight percent confidence intervals. Due to data availability, the model with real compensation in the manufacturing sector is estimated from 1950:3 to 1999:2.

The IRF for real wages in private industry computed for a unit shock to the Ramey-Shapiro dummy variable is never significantly different from zero. It is negative for a year after a shock to defense purchases, then it is positive for a year, and finally it is negative. The IRFs for real compensation in the business sector and manufacturing sector are negative for at least two and a half years after a shock to defense purchases. The IRF for real compensation in the business sector is significant for less than two quarters in the first year after a shock to defense purchases. The IRF for real compensation in the manufacturing sector is significant for two years after a shock, except for a couple of periods.

The IRF for real wages in private industry computed for a unit shock to the alternative Ramey-Shapiro dummy variable are initially different from the ones reported for a shock to the Ramey-Shapiro dummy variable. It is negative and significant for several quarters in the first year after a shock to defense purchases. The IRFs for real compensation in the business sector and manufacturing sector are fairly similar to the ones reported for a shock to the Ramey-Shapiro dummy variable. However, the IRF for real compensation in the business sector is never significantly different from zero, and the IRF for real compensation in the manufacturing sector is only marginally and intermittently significant.

The pattern of the IRF for real wages in private industry reported for a shock to the DP dummy variable initially are very different from the ones computed for a shock to the Ramey-Shapiro dummy variable and the alternative Ramey-Shapiro dummy variable. The IRF for real wages in private industry reported for a shock to the DP dummy variable declines significantly at the time of a shock to defense purchases. It remains significant for more than two quarters after a shock to defense purchases, and then it is not significantly different from zero.

Less than a year after a shock to defense purchases, the IRFs for real compensation in the business sector and manufacturing sector are positive. The IRF for real compensation in the business sector is marginally significant in the fourth year after a shock to defense purchases, and the IRF for real compensation in the manufacturing sector is marginally and briefly significant at the end of the first year after a shock.

Overall, the patterns of the IRFs for real wages and real compensation computed for a unit shock to the Ramey-Shapiro dummy variable and the alternative Ramey-Shapiro dummy variable are consistent with the theoretical two-sector neoclassical models of Ramey and Shapiro (1997) and Edelberg, Eichenbaum, and Fisher (1999) as well as the more traditional IS-LM and one-sector neoclassical models.

However, it is noted that the effects of the Ramey-Shapiro episodes on real wages and compensation are modest, and some of the IRFs for real wages and real compensation reported for a shock to the Ramey-Shapiro dummy variable and the

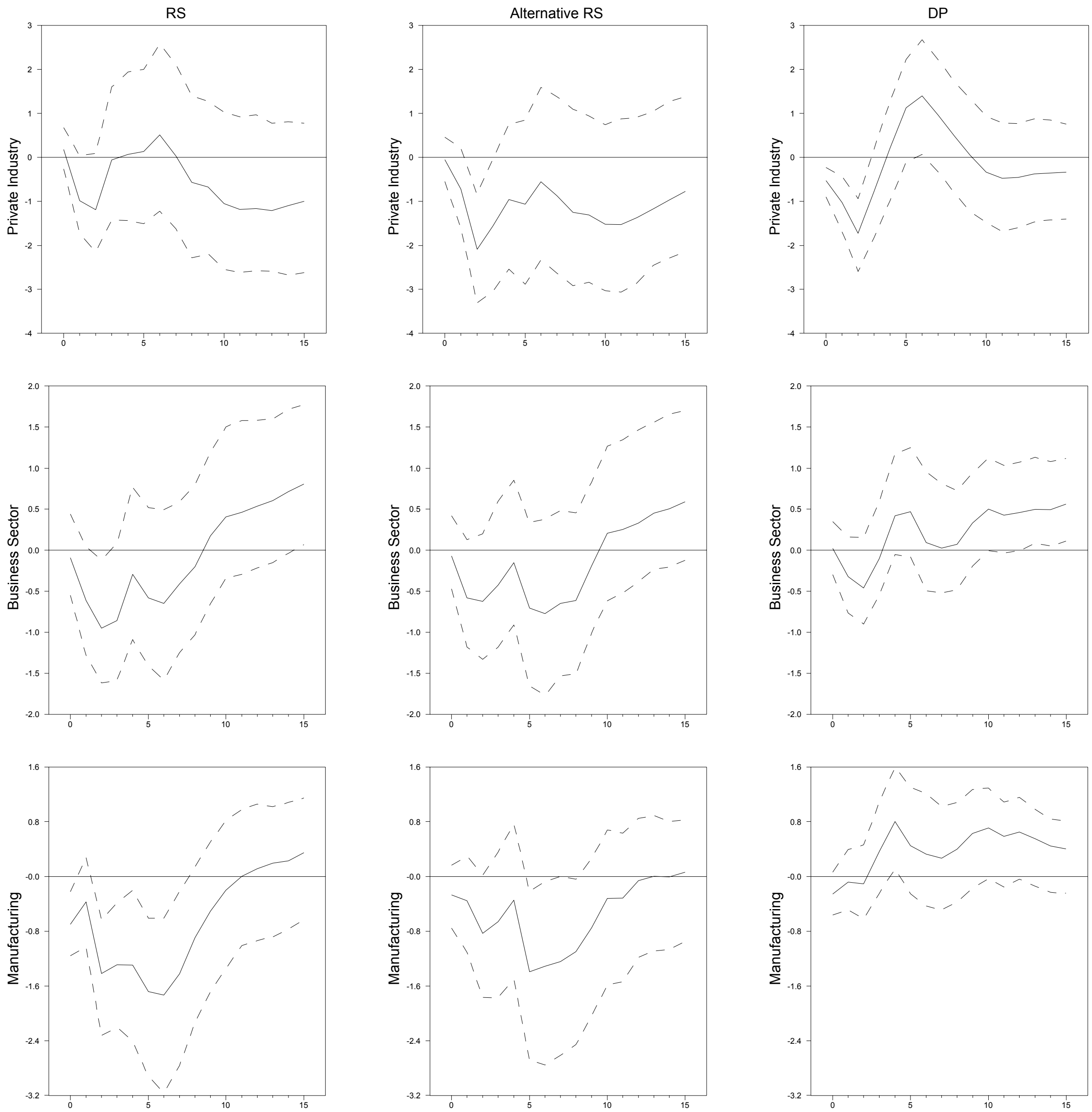

Figure 6.5: Point Estimates for Real Wages and Real Compensation Computed Using Narrative Approaches
Ramey-Shapiro Dummy (RS), Alternative Ramey-Shapiro Dummy, Defense Purchases Dummy (DP)

alternative Ramey-Shapiro dummy variable are not significantly different from zero at any horizon.

Furthermore, the pattern of the IRF for real wages in private industry computed for a unit shock to the DP dummy variable is consistent with the theoretical two-sector neoclassical models of Ramey and Shapiro (1997) and Edelberg, Eichenbaum, and Fisher (1999) as well as the more traditional IS-LM and one-sector neoclassical models. However, the patterns of the IRFs for real compensation in the business sector and manufacturing sector are not consistent with these models.

In the first and second columns of Figure 6.6, the solid lines display the point estimates of the IRFs for real wages in private industry, real compensation in the business sector, and real compensation in the manufacturing sector computed for a unit shock to defense purchases and new orders using a Choleski decomposition. The dashed lines display the lower and upper bounds of one-standard deviation confidence intervals computed using a Monte Carlo integration procedure.

The IRF for real wages in private industry computed for a unit shock to defense purchases using the Choleski decomposition exhibits a hump-shaped pattern. After a delay of more than a year, it increases significantly for two and a half years. The IRF for real compensation in the business sector declines significantly in the period of a shock to defense purchases, and then it increases persistently and it is significant two years after a shock to defense purchases. The IRF for real compensation in the manufacturing sector declines significantly in the period of a shock to defense purchases, and it remains negative for more than three years. However, it is only intermittently significant for one and a half years, and then it is not significantly different from zero.

The IRF for real wages in private industry computed for a unit shock to new orders using the Choleski decomposition exhibits a hump-shaped pattern, and it increases significantly for one and a half years after a shock to new orders. The IRF for real compensation in the business sector also exhibits a hump-shaped pattern; however, it is never significantly different from zero. The IRF for real compensation in the manufacturing sector becomes positive in the first year after a shock to new orders, and it is very marginally significant in the third year after a shock.

In the third and fourth columns of Figure 6.6, the solid lines display the point estimates of the IRFs for real wages in private industry, real compensation in the business sector, and real compensation in the manufacturing sector computed for a unit shock to defense purchases and new orders using long-run restrictions. The dashed lines display the lower and upper bounds of one-standard deviation confidence intervals computed using a Monte Carlo integration procedure.

The patterns of the IRFs for real wages and real compensation reported using long-run restrictions are very different from the ones presented using the narrative approaches or the Choleski decomposition. Furthermore, the confidence intervals reported using long-run restrictions are notably larger than the ones computed for the other identification schemes. The IRFs for real wages and real compensation reported for shocks to defense purchases using long-run restrictions are negative at all horizons. The IRF for real wages in private industry is significant for less than two quarters after a shock, the IRF for real compensation in the business sector is significant for two years,

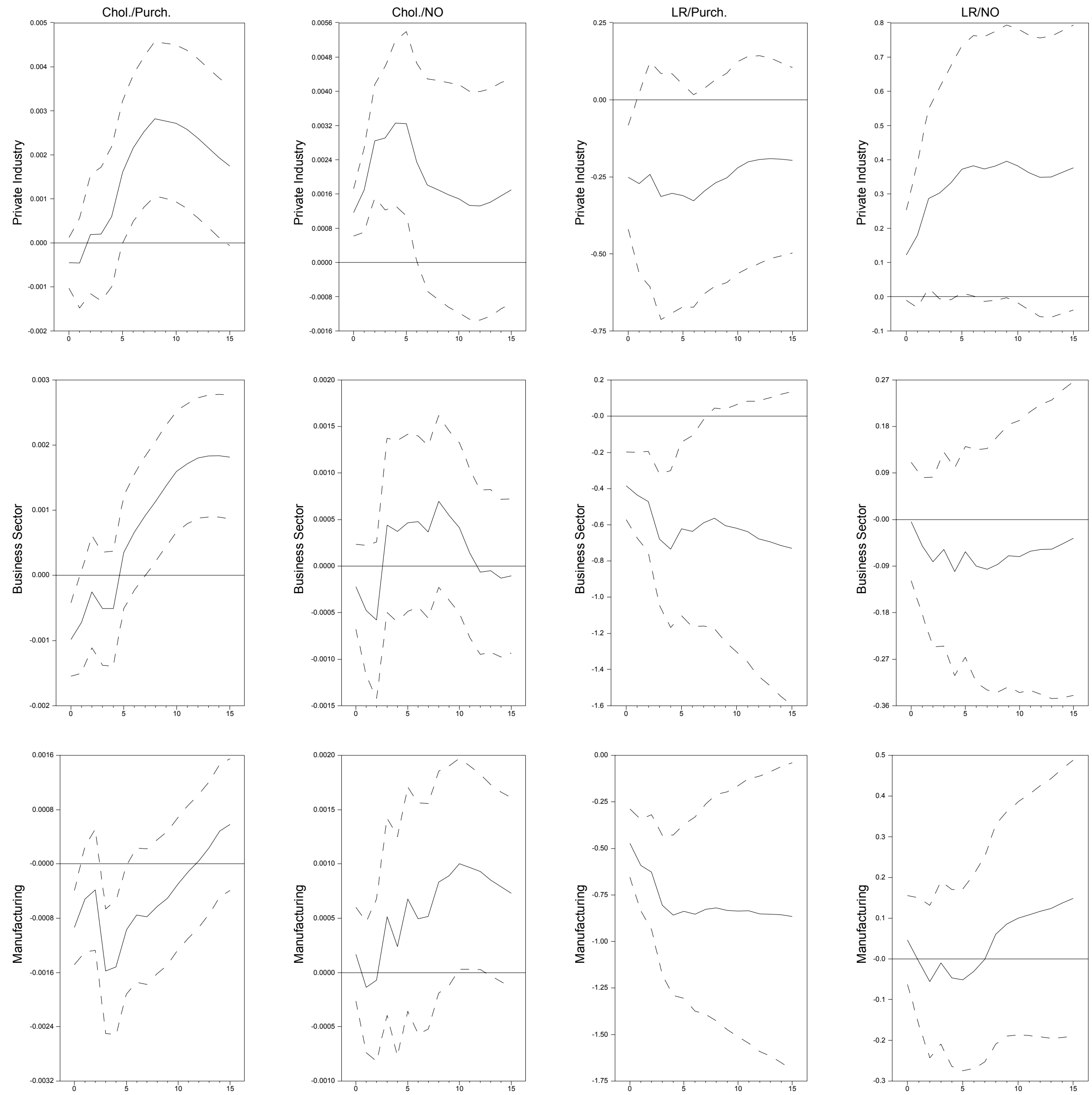

Figure 6.6: Point Estimates for Real Wages and Real Compensation from Choleski Decomposition (Chol.) and Long-Run Restrictions (LR)
Defense Purchases (Purch.) and New Orders of Defense Products (NO)

and the IRF for real compensation in the manufacturing sector is significant at all horizons.

The IRFs for real wages and real compensation reported for shocks to new orders using long-run restrictions exhibit different patterns. The IRF for real wages in private industry reported is positive at all horizons, and very marginally significant for one and a half years. The IRF for real compensation in the business sector is negative at all horizons significant; however, it is not significantly different from zero at any horizon. The IRF for real compensation in the manufacturing sector is mostly negative for two years, and then it is positive. It is not significantly different from zero at any horizon either.

Overall, except for real compensation in the manufacturing sector, the patterns of the IRFs for real wages and real compensation computed for a shock to defense purchases or new orders using the Choleski decomposition are inconsistent with the theoretical two-sector neoclassical models of Ramey and Shapiro (1997) and Edelberg, Eichenbaum, and Fisher (1999) as well as the more traditional IS-LM and one-sector neoclassical models.

Furthermore, the patterns of the IRFs for real wages and real compensation computed for a shock to defense purchases using long-run restrictions are consistent with these theoretical models. The IRFs for real wages and real compensation computed for a shock to new orders using long-run restrictions are never significantly different from zero.

In his study of the macroeconomic effects of fiscal policy, Perotti (2000) asks, “Is there at least a set of results that are consistent with a specific theory?” The IRFs for consumption, investment, employment, real wages and real compensation reported in this section as well as the IRFs for defense purchases, real GDP, RTB, and the GDP deflator presented in earlier chapters imply that there are sets of results that are consistent with specific economic theories.

The IRFs reported for the narrative approach of Ramey and Shapiro (1997) are consistent with the theoretical two-sector neoclassical models presented by Ramey and Shapiro (1997) and Edelberg, Eichenbaum, and Fisher (1999). However, the IRFs for key variables such as RTB, non-residential investment, and employment in private industry appear to be sensitive to using alternative dates for the onsets of the Ramey-Shapiro episodes.

In fact, when alternative dates selected earlier in the dissertation are used to construct the Ramey-Shapiro dummy or the DP dummy variable, the IRFs reported for non-residential investment and employment in private industry are inconsistent not only with the theoretical two-sector neoclassical models presented by Ramey and Shapiro (1997) and Edelberg, Eichenbaum, and Fisher, but also the more traditional IS-LM and one-sector neoclassical models.

When the Choleski decomposition and long-run restrictions are used to identify exogenous shocks to defense purchases, the IRFs reported for a shock to defense purchases are inconsistent with the theoretical two-sector neoclassical models presented by Ramey and Shapiro (1997) and Edelberg, Eichenbaum, and Fisher as well as the more traditional IS-LM and one-sector neoclassical models.

In particular, when the Choleski decomposition is used to identify exogenous shocks to defense purchases, the IRF reported for non-residential investment declines persistently. However, when extended models that included consumption and investment variables were estimated in the fourth chapter of the dissertation, the IRFs for RTB

computed using the Choleski decomposition declined persistently, and the IRFs for real GDP rose temporarily. Therefore, one should not expect the IRF for non-residential investment reported for shocks to defense purchases to decline persistently.

When the Choleski decomposition is used to identify exogenous shocks to new orders of defense products, the IRFs reported are consistent with an IS-LM model in which accelerator effects are considered, except for employment in the non-durables manufacturing sector. When long-run restrictions are used to identify exogenous shocks to new orders of defense products, the IRFs reported are inconsistent with the theoretical two-sector neoclassical models presented by Ramey and Shapiro (1997) and Edelberg, Eichenbaum, and Fisher as well as the more traditional IS-LM and one-sector neoclassical models.

In conclusion, in spite of methodological advances in estimating the effects of exogenous shocks to government purchases, there is still no consensus on the effects of these shocks. Therefore, as Perotti (2000) argues, "… We should admit that, at present, our area of ignorance even on the basic signs of fiscal policy multipliers is too great. At a minimum, this should suggest using fiscal policy very sparingly" (Perotti 2000, p. 24).

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VITA

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