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Sales impacts of direct marketing choices: treatment effects with multinomial selectivity

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Abstract

Producers who are planning to sell using direct marketing to consumers only or to both consumers and retailers experience declines in total sales. Based on survey data for US farmers from 2008 to 2010, the earnings decline is 71.3 per cent when marketing direct to consumers and 36.8 per cent for the diversified marketing decision. The direct marketing penalty is robust to inclusion of important demographic factors, farm experience and use of the internet, and characteristics of the farm operation such as crop choices and input use. Direct marketing is associated with higher sales declines for female farmers, highlighting a distributional impact on farmers that has not been discussed.

Keywords: treatment effects, direct marketing, mixed multinomial logit model

JEL classification: Q16, Q12, C25, Q13

1. Sales impacts of direct marketing choices: treatment effects with selectivity

An emerging agricultural marketing issue is increased emphasis on the promotion of local food systems that are designed to expand producer margins while offering consumers the benefits of locally grown food. The 'Know Your Farmer, Know Your Food' (KNF^2) initiative originated in the 2008 Farm Bill to strengthen USDA programmes promoting local foods and includes plans to enhance direct marketing and farmers' market programmes. Whole Foods Market (2014) promotes local foods that benefit farmers since 'minimising handling and transportation costs gives farmers, ranchers, growers and producers maximum return on their investment'. Sam's Club, the warehouse club unit of Wal-Mart Stores, is building a team of regional US buyers to bring in

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more local and organic groceries (Layne, 2016). These activities are in response to strategies used by rival Costco, now one of the largest US food retailers.

Research has not explicitly addressed how the choice of a direct marketing outlet impacts farm sales, an essential element in inducing continued producer involvement in these marketing decisions. Producers lack information on how sales depend on the choice of direct marketing channels, limiting the potential for developing and strengthening long-term sustainable partnerships with retailers or consumer outlets.

Our primary objective is to explore the impact of participation in direct marketing on sales at the farm level. We consider a set of marketing options applying a treatment effect model with a multinomial selection process and move beyond the binary choice option. The results confirm that producers who sell using direct marketing to consumers only or to both consumers and retailers experience declines in total sales. Based on survey data for US farmers from 2008 to 2010, the earnings decline is 71.3 per cent when marketing direct to consumers and 36.8 per cent for the diversified marketing decision. The direct marketing penalty is robust to inclusion of important demographic factors, farm experience and use of the Internet, and characteristics of the farm operation such as crop choices and input use. We also demonstrate that neglecting selectivity effects lead to systematic underestimates of the negative impact of marketing choice on farm sales.

A secondary objective is to highlight the distinct advantages and the flexibility of multi-valued treatment and outcome models while ensuring efficiency gains in statistical inference. First, both treatment and outcomes may be both non-normal and nonlinear and the approach accommodates multinomial, count, discrete or truncated data. Second, the treatment is endogenous and recognises that in our application producers choose marketing outlets. Third, latent, unobserved factors that influence the treatment and outcome are explicitly incorporated in the model and the empirical interpretation distinguishes between selection on observables and selection on unobservables.

We apply insights from two different disciplines to develop our findings. First, we review findings from the marketing science literature to draw out implications for direct marketing by agricultural producers. Second, we outline new techniques for evaluating the impacts of programmes with multi-valued treatment effects. The approach recognises that programmes frequently offer multiple choices, complicating the task of capturing the impact of a treatment choice on an outcome variable. The treatment here is the producer's choice of a direct marketing channel and the observed outcome is farm sales conditional on the choice of marketing outlet.

The agricultural economics and marketing science literature have both discussed when manufacturers or agricultural producers can benefit by engaging in direct sales. The emerging literature economics on trends in direct and intermediated marketing of local foods by farmers is comprehensively summarised in

Low *et al.* (2015), Low and Vogel (2011) and Martinez *et al.* (2010). Park, Mishra and Wozniak (2014) confirmed the significance of selectivity effects in the choice of direct marketing strategies but that approach is limited. The model provides no evidence on the size selectivity effects on farm sales, cannot measure how the effects vary by marketing option, and provides no information on treatment effects across the scenarios we develop in our model.

Chiang, Chhajed and Hess (2003) showed that direct sales indirectly increase the flow of profits through the retail channel and improve the overall profitability of the manufacturer by spurring demand in the retail channel. Arya, Mittendorf and Sappington (2007) demonstrated that direct marketing (or supplier encroachment) benefits suppliers and retailers by inducing lower wholesale prices and expanded downstream competition. Li, Xie and Zhao (2015) examined supplier encroachment in competitive supply chains featuring products that are homogeneous and completely substitutable, such as food commodities. The analytical results show that encroachment may lead to a 'lose–lose' outcome for the suppliers and the retailers as the profits of both decline. The conflicting theoretical results from marketing science literature suggest that manufacturers can benefit from direct sales or that they could face declining profit. This motivates the empirical approach we adopt in this analysis.

A second theme examines methods for evaluating multi-treatment programmes. Most current research on programme evaluation has focused on the evaluation of a single programme or policy choice, even as many social policies or market options consist of a variety of choices that are presented to participants. Labour market policies typically encompass a variety of activities such as job search assistance, vocational training programmes and wage subsidies. Fröhlich (2004) emphasises that evaluation 'requires the identification and estimation of many different treatment effects'. Participants in labour training programmes can receive different hours of training, households may be eligible for varying levels of transfers in the administration of anti-poverty programmes, farmers may enrol in a variety of agricultural programmes, and producers may allocate planting decisions across a portfolio of crops.

Multi-valued treatment effect models are designed to identify the impact of a treatment variable on an outcome variable, recognising that the treatments can take on multiple values and are rarely discrete. Cattaneo (2010) noted that multi-valued treatments may be discrete or continuous, finite or infinite, as well as ordinal or cardinal and concluded that 'a correctly specified model requires the joint estimation of all treatment effects (as opposed to the estimation of each treatment effect separately)'.

We apply the endogenous multinomial treatment effect model developed by Deb and Trivedi (2006a, 2006b), accounting for selection on unobservables and a continuous outcome variable. Morescalchi (2016) is an empirical application of the endogenous multinomial treatment effect model to a count measure of search effort for housing and households choose from a set of rental or ownership options. Applications of the Deb and Trivedi model to account for endogenous treatments effects have not appeared in the agricultural economics literature.

2. Decision framework and empirical approach

The research is designed to identify farm sales impacts that producers incur when they choose from a portfolio of direct marketing options so we initially discuss the farm sales measure and how it is related to the direct marketing choice. We follow the framework established by Low and Vogel (2011) on direct and intermediated marketing of local foods to identify four broad categories of marketing choices. Farmers can choose to market solely through direct-to-consumer outlets, such as roadside stands, on-farm facility, on-farm store, farmer's market or community supported agriculture. A second choice is to rely on retail outlets only for sales, a category that includes direct sales to local grocery stores or regional food distributors. A third option is for the producer to diversify and market products through both direct-to-consumer outlets and through retailers. The base category is to not engage in direct marketing efforts.

Figure 1 shows the percentage declines in total value of farm sales for producers engaging in each of the direct marketing options. Significant negative shocks to farm sales are observed across the marketing choices and there is substantial heterogeneity based on farm size. Larger farmers who sell only to retail outlets actually report a premium compared to farmers with no direct marketing. Selling directly to consumers only yielded the lowest mean sales.

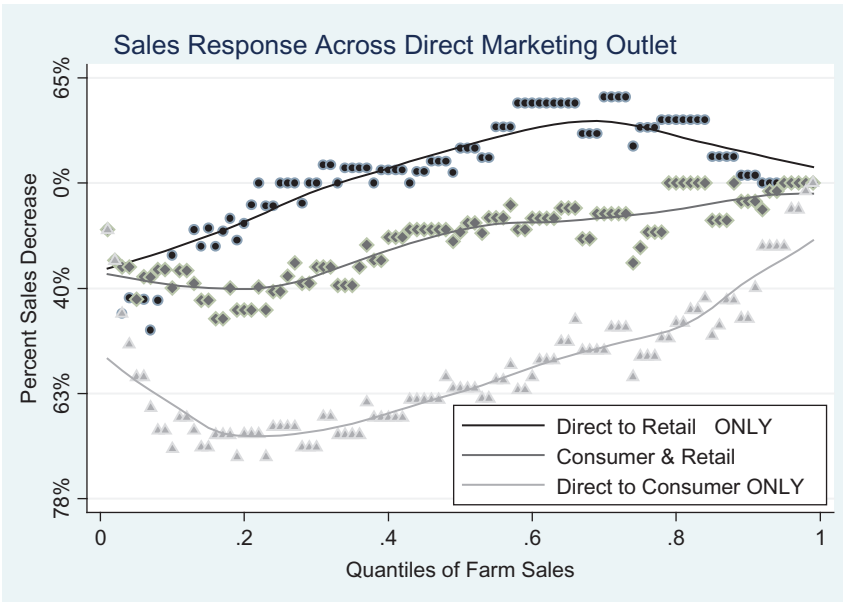

Fig. 1. Farm sales by direct marketing outlets.
Note: Marketing options listed from top to bottom in graph. All sales relative to no direct marketing option. Farmers selling to retail only shows higher premium compared to farmers with direct marketing to consumers or consumer and retail both.

The mean value of farm sales for farmers who do not participate in direct marketing is about USD326,000 compared with a mean value of USD419,000 for other operators. Farmers with no involvement in direct marketing have a slightly lower standard deviation for farm sales, suggesting that participation in direct marketing may dampen the volatility of sales.

These substantial differences both in returns to the marketing outlets and the changes associated with farm size motivate our analysis of selectivity effects. There are three main forms of selection bias that may be present in the choice of marketing channel. First, self-selection arises as optimising producers select marketing channels based on knowledge of their business operations, expertise in marketing, and managerial resources available to the farm household. Park and Lohr (2006) outlined the impact of selection by agricultural producers in choosing organic marketing channels but did not develop a treatment effect analysis.

Second, selection bias is linked to economic behaviour of supply chain entities such as retailers, brokers and marketing agents. Iyer and Villas-Boas (2003) recognised that managers frequently choose between using a single distribution channel or a mix of several types of channels and emphasised the role of unobserved factors such as bargaining and negotiation in coordinating marketing channels. Food hubs have emerged as local business ventures linking distribution of local foods from farmers to wholesale customer including institutions, restaurants and grocery stores and provide essential local information linking producers and consumers. Supply chain entities have various levels of expertise and capacity to provide information, develop transportation and distribution channels, expand brokerage services and manage technical assistance and producer development opportunities to induce entry by producers. Grocery stores and big-box retailers are aggressively expanding their locally grown offerings even as many food hubs promote a non-profit mission. These entities emphasise products that are valued by their consumer base even if they are more expensive to source and verify, such as organic and fair trade products (Matson, Sullins and Cook, 2013).

Customer choice also influences the access, growth and profitability of direct marketing channels and producers must adapt to buying and sourcing patterns of local foods consumers. Montaguti, Neslin and Valentini (2016) noted that multichannel consumers who purchase across a portfolio of outlets are recognised as more profitable for producers since these consumers generate more revenue, purchase more items in more categories, and purchase more frequently. Producers must develop marketing campaigns to induce consumers to buy through multiple channels and harvest. The benefits to producers in terms of higher profits to producers are ambiguous.

The general form of the econometric model is drawn from these selectivity effects and has two components based on the generating process of the treatment variables and the outcome equation. The choice of marketing outlet is the treatment and the sales variable is the observed outcome measure. Each producer i makes the marketing decision from a set of four treatments ($j = 0, 1, 2, 3$). Let EV_{ij}^{*} represent the indirect utility function associated with the jth treatment

$$EV_{ij}^{*} = z_i' \alpha_j + \sum_{j=1}^{J} \delta_{jk} l_{ik} + \eta_{ij}$$

where the z_i are the exogenous covariates with associated parameters α_j and the error term η_{ij} is an independently and identically distributed random shock. The indirect utility function EV_{ij}^{*} contains the latent factors l_{ik} which encompass the unobservable characteristics common to individual i's treatment choice and outcome such as awareness of marketing channel outlet options and the producer's human capital and entrepreneurial skills. The l_{ik} are assumed to be independent of η_{ij}. Without loss of generality, we let $j = 0$ represent the base group which is category 1, the decision not to engage in direct marketing. We normalise the indirect utility function to zero for the base choice so that $EV_{ij}^{*} = 0$. Since l_{ik} is unobservable, we use the binary variables d_j to represent the observed treatment choices or marketing options. The d_j measures follow a mixed multinomial logit (MNL) structure and $d_i = [d_{i1}, d_{i2}, \ldots, d_{iJ}]$. The probability function for the marketing choice is modelled by a latent class MNL:

$$\Pr(d_i | z_i, l_i) = \frac{\exp(z_i' \alpha + l_{ij})}{1 + \sum_{k=1}^{J} \exp(z_i' \alpha_k + l_{ik})}$$

and $j = 0, 1, 2, \ldots, J$. The equation for the expected outcome (sales) is

$$E(y_i | d_i, x_i, l_i) = \exp\left(x_i' \beta + \sum_{j=1}^{J} \gamma_j d_{ij} + \sum_{j=1}^{J} \lambda_j l_{ij} \right)$$

where x_i is the set of all exogenous covariates within z_i with the associated parameter vector β and γ_i's are the treatment coefficients relative to the base group of no direct marketing efforts. $E(y_i)$ is a function of each of the latent factors l_{ij} when the outcome variable (sales) is linked to unobservable effects which also influence the choice of the direct marketing channel. Factor loading coefficients λ_j are estimated for each marketing options.

We apply the endogenous multinomial treatment effect model developed by Deb and Trivedi (2006a, 2006b), accounting for selection on unobservables and a continuous outcome variable. The treatment variable is the direct marketing choice and the outcome measure is total sales by the operation. Estimation is carried out by maximum simulated likelihood techniques based on the joint distribution of the outcome and treatment variables. We use 1,000 Halton draws to ensure that maximisation of the simulated log likelihood is equivalent to maximising the log likelihood, yielding estimates that are consistent and asymptotically normal.

The mixed MNL model does imply the independence of irrelevant alternatives (IIA) property that places restrictions on the underlying preferences structure of the producer choosing across the direct market options. The IIA

property would be a constraint to test or to consider relaxing if the research objective is to examine the structure of preferences across these options. In our case, the main objective in the first stage is to use a discrete choice model that generates accurate predictions of the choice probability while explicitly controlling for the endogeneity of the marketing choices. The choice of an alternative discrete choice model does not offer any additional advantages in the flexible specification of the model. We did estimate a multinomial probit model and compared predictions from the MNL model and find no significant differences. These results are available upon request.

3. Variable description and model interpretation

The model is based on data from the nationwide Agricultural Resource Management Survey (ARMS) collected by the United States Department of Agriculture, Economic Research Service (ERS) and the National Agricultural Statistics Service (NASS) for 2008, 2009 and 2010. The ARMS provides information about agricultural production, resources and the environment as well as about the characteristics and financial conditions of farm households, marketing strategies, input management strategies and off-farm income. Data are collected from one respondent per farm, the senior operator making the management decisions. ARMS is the primary source of information to the US Department of Agriculture and the public on the financial conditions, production practices, and resource allocation decisions of America's farm businesses and the economic well-being of America's farm households. The survey is the primary information source for evaluation of many research issues related to US agriculture and the rural economy. NASS conducts the survey in collaboration with the ERS. As explained on the ERS website (ARMS information), ARMS is a nationally representative survey administered using several phases—sample screener, field-level, and farm-level phases—targeting about 5,000 fields and 30,000 farms each year. The web address (ARMS documentation) outlines the detailed screening procedures through three phases, a Screening Survey (Phase I), the Production Practices and Costs Report (Phase II) and gathering the Farm Business and Farm Household Information (in Phase III).

The survey elicits information on farmer participation in producing, raising or growing any commodities sold or provided directly to individual consumers for human consumption, directly to retail outlets, directly to regional distributors (including food hubs, CSAs and other local foods aggregators) or directly to institutions. This question is used to define participation in direct marketing efforts by producers. The survey does not gather reliable information about the amount of sales garnered in each direct marketing outlet.

3.1. Description of variables and exclusion restrictions

Table 1 shows the variable descriptions and summary statistics for the total value of farm sales from the ARMS along with the complete set of explanatory

variables that are discussed in more detail in the following section. Statistically, significant differences in the means of the explanatory across the direct marketing choices are noted in Table 1. Natural logs of the continuous variables were used as indicated in the model specification. Producer variables that are plausibly related to participation in direct marketing include the operator's experience, the gender and familiarity with and use of the internet for farm activities. These variables attempt to control for the producer's management ability and technical expertise.

The total value of farm sales tends to increase across the quantiles of the farm experience variable but shows a decline in the fourth quartile of the farm experience measure where operators have more than 38 years of experience. About 14 per cent of female farmers participated in direct marketing compared to 9 per cent of male farmers, although female farmers comprised of about 5 per cent of the overall sample. Both female and male farmers experience decreased sales when they participated in direct marketing. The decline in sales is higher for women (a drop of about 78 per cent) compared to men (a decrease of about 19 per cent). Another interesting effect is a difference in the variability of sales for males and females associated with participation in direct marketing. The riskiness of sales declines for females, with female farmers reporting a 64 per cent lower standard deviation in farm sales when participating in direct marketing. The standard deviation of farm sales actually rises by about 5 per cent for male farmers.

Access to information through the Internet and the use of the Internet for farm and marketing related information could influence the choice of direct marketing outlet. A measure of the internet use for farm-related news and information (weather, farm, local and other news; stock market and agricultural market information such as farm input pricing) can be gathered from the survey. A second measure recorded Internet use for farm-related commerce, such as purchases, sales, banking, online record keeping or accounting or operating your own website. Park, Mishra and Wozniak (2014) suggested that using the Internet to seek farm-related commerce has a positive impact on the propensity to choose a diversified set of direct marketing strategies. Farmers who market in both direct to consumer and in retail outlets reported the highest use of Internet activities for farm news and for farm commerce. These producers spend 3.22 h per week online news and 4.22 h per week for online commerce activities. Farmers who are not involved in direct marketing report the lowest amount of time online at about 4.90 h per week, a level that is about 52 per cent lower than internet use by farmers using a diversified direct marketing strategy.

We include a measure of entrepreneurial activities reflecting the long-term planning of the farm operator and household. Producer in the ARMS are asked about income received from other activities and we identify six choices from the available information. The activities include income from custom work and other agricultural services, income from grazing livestock, recreational and agri-tourism activities such as hunting, fishing, farm tours, hospitality services, sales of forest products, sales of farm machinery and vehicles,

Table 1. Variable definitions and descriptive statistics[a,b]

Variable	Description	Direct-to-Consumer ONLY Mean (standard deviation)	Direct-to-Retailer ONLY Mean (standard deviation)	Consumer and Retailer BOTH Mean (standard deviation)
Sales†	Total value of farm sales in (in USD1,000's)	273.07 (486.39)	681.41 (643.97)	524.63 (568.77)
Experience†	Number of years the farmer has operated	26.11 (14.97)	29.55 (14.27)	27.87 (14.84)
Gender†	Gender of operator (= 1 if male; 0 otherwise)	89	95	97
News	Internet used for farm-related news (h/week)	3.05 (6.35)	3.92 (6.26)	4.22 (6.91)
Commerce†	Internet used for farm-related commerce (h/week)	2.08 (5.65)	2.26 (4.60)	3.22 (6.92)
Acres†	Total acres farmed	256.76 (727.38)	1,550.58 (4,820.39)	563.54 (1,299.88)
Operator labour†	Hours of paid labour by operator (h/week over the year)	18.00 (71.46)	90.06 (171.09)	79.03 (161.40)
Hired labour†	Hours of paid labour by hired workers (h/week over the year)	255.20 (1073.48)	1,295.07 (2,681.31)	686.04 (1,499.79)
Grain share†	Share of sales accounted for by major grains	12.44 (30.91)	30.98 (45.06)	13.50 (31.52)
Vegetables share†	Share of sales accounted for by vegetables	29.76 (42.08)	17.41 (36.98)	47.71 (46.11)
Fruit share†	Share of sales accounted for by fruits	31.81 (43.66)	19.61 (39.45)	27.95 (42.01)
Dairy share†	Share of sales accounted for by dairy	4.30 (19.65)	2.76 (15.82)	1.61 (12.35)
Grocery growth	Growth rate in grocery stores in FIPS location of farm	−0.03 (0.19)	−0.05 (0/20)	−0.02 (0.24)
Supercentre growth	Growth rate in grocery stores in FIPS location of farm	0.24 (0.53)	0.34 (0.65)	0.27 (0.55)
Convenience store growth	Growth rate in grocery stores in FIPS location of farm	−0.04 (0.13)	−0.06 (0.28)	−0.03 (0.11)
Farmer's markets growth	Growth rate in farmer's markets in FIPS location of farm	0.38 (0.78)	0.38 (0.73)	0.73 (0.73)
Entrepreneurial activities†	Additional income earning activities undertake by operator (number of activities reported, up to six activities)	0.40 (0.65)	0.50 (0.74)	0.56 (0.85)
Distance to town†	Miles from home to nearest town/city with population over 10,000	26.82 (24.43)	17.91 (20.75)	17.72 (17.70)

(*continued*)

Table 1. (*continued*)

Variable	Description	Direct-to-Consumer ONLY Mean (standard deviation)	Direct-to-Retailer ONLY Mean (standard deviation)	Consumer and Retailer BOTH Mean (standard deviation)
Mountain	Farm is located in a mountain state (1 = yes, in %)	8	5	4
Midwest	Farm is located in a midwestern state (1 = yes, in %)	25	27	24
Northeast	Farm is located in a northeastern state (1 = yes, in %)	33	27	37
South	Farm is located in a southern state (1 = yes, in %)	21	27	22
Pacific	Farm is located in a pacific state (1 = yes, in %)	13	14	12
Sample size		234	157	180

[a]Descriptive statistics of raw data reported while model is estimated using total value of farm sales (in logarithms) as the dependent variable. Data from USDA's Agricultural Resource Management Survey.
[b]Model is estimated based on 5,959 observations with descriptive statistics for producers who do not engage in direct marketing omitted for brevity.
The † symbol statistically significant differences in the means of the explanatory variables across the direct marketing choices.

and sales of value-added goods produced by the farm. In each case the income is excluded from the farm sales measure if the goods were provided in a separate business enterprise so there is no double counting.

The farmer's administrative and managerial skills in identifying opportunities to earn additional income control for unobserved factors that influence the propensity and ability to take advantage of direct marketing opportunities. Only 25 per cent of the farmers who sell directly to retailers engage in one or more entrepreneurial activities in contrast to about 40 per cent of farmers who rely on both direct marketing outlets. The spine plot in Figure 2 reveals the significant variability in the propensity of producers to seek out and develop income earning opportunities across the different marketing options. We are interested in examining whether participation in the entrepreneurial activities influences farm sales.

The model includes controls for the impact of farm specialisation and cropping choices using shares of income from the categories of commodities: cash grains (Grain Share), vegetable (Vegetable Share), fruits (Fruit Share) and dairy products (Dairy Share). Key inputs such as acreage and the labour management decisions of the operator are also included.

We include regional effects for the five geographic production regions identified by Low and Vogel (2011) that account for regional differences in farm structure, marketing constraints, agronomic conditions and the availability of

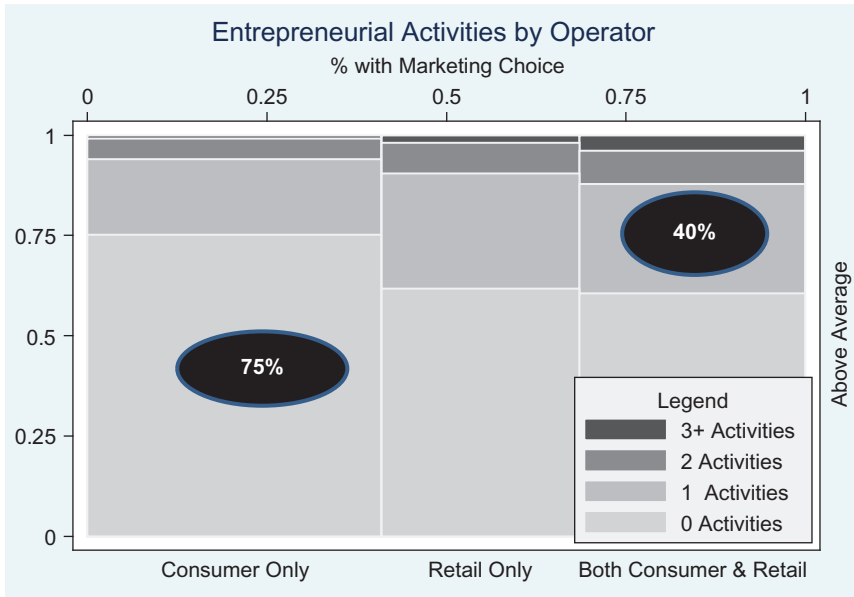

Fig. 2. Entrepreneurial activities by operator.
Note: The patterns suggest that the entrepreneurial activities are closely linked to the marketing options treatment. Farmers with direct marketing to consumers only used fewest number of entrepreneurial operations as 75 % do not participate in any activities.

farm extension resources. A dichotomous variable was created for each region, equal to one if the respondent's farm was in that region and zero otherwise. In the sample, the highest rate of participation in direct marketing was for farmers in the Northeast at 23 per cent with Midwest farmers showing the lowest level of direct marketing at 6 per cent. Producers in the Mountain region report the highest mean level of sales given direct marketing efforts ($426,000) with Southern farmers the lowest at $302,000. The relative sales declines reported for participation in direct marketing only range from 22 to 27 per cent for the Pacific, Mountain, Midwest and North Central regions with a smaller decline of about 9 per cent for Southern producers.

The determinants of the marketing choice include all of the producer variables and farm characteristics that determine the sales outcome defined above. The parameters of the outcome equation for the structural-causal model of sales are identified through the nonlinear functional form even if all the variables from the sales equation are included in the marketing choice. We also apply exclusion restrictions to ensure a robust identification of the model and describe variables that are excluded from the sales equation in the following paragraph.

The distance from the farm operator's home to the nearest town or city with a population of 10,000 or more is the first instrument. The distance to town is strongly negatively correlated with the marketing choice decisions and shows only a slight correlation with farm sales. We categorise farm distance from the nearest city into quartiles and note that farmers closest to population areas (the first quartile) are about four miles away. The most distant farmers (in the fourth quartile) are on average over 40 miles away from a small town or population area. For each of the three direct marketing options, farmers who are located nearest to the cities are the most likely to choose the direct marketing plan. We find that 40 per cent of farmers marketing directly to retailers are located within four miles of a major urban area (the first quartile of distance to town) and that this percentage is twice as high as the share for any other quartile. Farmers who do not rely on direct marketing are predominantly located the most distance from the population centre. The distance to town measure shows only a slight correlation with farm sales and clearly is established prior to the direct marketing decision, supporting the case for its exogeneity in the sales equation.

We also account for the influence of the local retail environment where the farm operator is located on the propensity to participate in direct marketing. The specification includes information on the availability of grocery stores, supercentres and club stores, convenience stores and farmers markets in the county where the farm operation was located. The number of each store type operating in each county was gathered from the Census of Business Patterns and the growth rate in each type of store over the period was calculated.

4. Results

Parameter estimates for the mixed MNL model of direct marketing choices are shown in Table 2. Our main interest is identifying the impact on sales

when producers actively sort into their preferred direct marketing option and this information is in Table 3. The instrumental variables that influence the direct marketing choice but are excluded from the sales equation are shown in Table 2.

The key findings for the analysis are the estimated coefficients on the marketing outlets variables and factor loadings associated with the latent factors for farm sales in Table 3. The coefficients are negative and significant when producers engage in direct market to consumers only and for direct marketing through both consumer and retail outlets. The impacts of direct marketing efforts are negative for these two marketing options, indicating that involvement in direct marketing to consumers only is associated with a decrease in farm sales. The direct marketing penalty is apparent even after controlling for producer factors, farming experience, characteristics of the farm operation such as crop choices and diversification across commodities, and geographic effects. After correcting for self-selection, the earnings decline is 36.8 per cent for the diversified marketing decision and 71.3 per cent when marketing direct to

Table 2. Parameter estimates for mixed MNL model of direct marketing choices[b]

	Direct-to-Consumer ONLY		Direct-to-Retailer ONLY		Consumer and Retailer BOTH	
Variable	Estimate	*T*-value[a]	Estimate	*T*-value	Estimate	*T*-value
Constant	−2.35	−3.96	−4.36	−6.20	−5.43	−6.43
Experience	0.16	1.22	0.13	0.85	0.21	1.24
Gender	−0.25	−0.82	0.04	0.11	0.96	1.83
News	0.05	0.42	−0.11	−0.89	0.15	1.12
Commerce	0.24	1.85	0.25	1.99	0.30	2.13
Acres	−0.52	−8.09	−0.03	−0.49	−0.48	−6.20
Operator labour	−0.15	−2.67	0.07	1.64	0.02	0.36
Hired labour	−0.09	−2.63	0.09	2.31	0.13	2.93
Grain share	−0.43	−1.41	−0.28	−1.09	0.43	1.07
Fruit share	3.31	12.64	1.86	6.34	3.72	10.57
Veg share	4.19	14.96	2.63	8.35	5.52	16.00
Dairy share	0.40	0.98	−1.21	−2.21	−0.37	−0.52
Grocery growth	0.08	0.22	−0.15	−0.39	0.33	0.71
Supercentre growth	−0.33	−2.13	−0.03	−0.21	−0.17	−0.97
Convenience growth	−0.17	−0.31	−0.33	−0.68	1.00	1.77
Farmer's markets	0.04	0.39	−0.01	−0.11	0.03	0.20
Entrepreneurial activities	0.30	2.00	0.29	2.19	0.72	5.05
Distance to town	0.02	0.20	−0.22	−2.52	−0.03	−0.26
Mountain	0.85	2.22	−0.36	−0.82	−0.48	−0.95
Midwest	0.57	2.15	−0.15	−0.59	0.06	0.19
Northeast	1.19	4.76	0.56	2.16	0.80	2.65
Pacific	−0.85	−2.67	−0.49	−1.53	−1.36	−3.58

[a]Indicates asymptotic *t*-values with significance at $\alpha = 0.10$ or higher level.
[b]Model is estimated based on 5,959 observations.

Table 3. Estimated coefficients for farm sales from multinomial treatment effects model[a]

Variable	Estimate	*T*-value[c]
Constant	8.66	87.40
Consumer ONLY	−1.25	−7.86
Retailer ONLY	0.09	0.42
Consumer and retailer	−0.46	−1.99
Entrepreneurial activities	−0.003	−0.17
Experience	0.02	1.01
Gender	0.16	2.42
News	0.12	6.80
Commerce	0.07	3.15
Acres	0.46	41.53
Operator labour	0.07	10.40
Hired labour	0.17	30.92
Grain share	−0.42	−11.03
Fruit share	−0.24	−2.82
Veg share	−0.14	−1.15
Dairy share	0.14	2.41
Mountain region	−0.21	−3.43
Midwest region	0.09	2.36
Northeast region	0.02	0.33
Pacific region	0.08	1.51
Factor loading[b]		
λ-Consumer only	0.36	2.24
λ-Retailer only	−0.24	−1.17
λ-Consumer + retailer	0.09	0.39
Number of observations	5,959	

[a]Dependent variable is total value of farm sales (in logarithms). Data from USDA's Agricultural Resource Management Survey.
[b]Factor loadings (λ's for each marketing option) represent the impact of unobservable factors influencing the probability that a given marketing option is selected.
[c]Indicates asymptotic *t*-values with significance at $\alpha = 0.10$ level.

consumers only. Both effects are statistically significant. The proportional impact of the discrete direct marketing choice indicator on sales is measured as $p_i = 100 * [\exp(\gamma_i - 1)]$ from the log linear model where γ_i is the coefficient of the direct marketing variable. We do not see a statistically significant sales decline when producers choose the direct to retailers only option.

The coefficients of the latent factors capture the effect on farm sales of unobserved characteristics that are related to the choice of marketing outlets. The factor loading coefficient is significant for the direct marketing to consumers only decision. The positive value indicates that unobserved factors that increase the relative probability of selecting a given marketing option lead to higher sales than if a producer was randomly assigned to a direct marketing option. We see evidence of statistically significant positive selection on unobservables for the option of market directing to consumers only.

Saitone, Sexton and Sumner (2015) develop a model for market equilibrium when food marketing intermediaries evaluate food quality based on the characteristics of the production process and specifically mention the case of locally grown or purchased directly from farmers. A key result from the model is that producers and consumers of these products may be harmed when buyers show a preference for purchases based on food quality characteristics. Farm profits and consumer surplus may decline as cost increases associated with direct marketing are initially incurred by the farmers entering the new market outlets. The earnings declines are also consistent with the implications of the Arya, Mittendorf and Sappington (2007) model. This model implies that retailers benefit when farmers begin direct marketing efforts as the new suppliers are induced to reduce prices in order to maintain retailer demand for the farm product.

We perform a likelihood-ratio test to determine if the choice of marketing outlets is exogenous by testing the joint hypothesis that the coefficients for the latent factors in the earnings equation are jointly equal to zero. The constrained likelihood is calculated as the sum of the log-likelihood values from the mixed MNL model and the log-linear model for farm earnings. The likelihood-ratio statistic for exogeneity follows a chi-square (χ^2) distribution, where the number of parameters is three or the number of estimated outlet parameters. The results from the test lead to a rejection of the hypothesis that the choices of direct marketing outlets are exogenous. The calculated χ^2 statistic (158.91 with three degrees of freedom) was well above the critical value at any conventional significance level. The null hypothesis of exogeneity is overwhelmingly rejected, supporting the proposed model.

In a second test, we follow Morescalchi (2016) in developing a check of the exogeneity assumption and estimate the same model and include the instrumental variables in the outcome equation. The coefficients are jointly not significant, indicating that the instruments do not have a direct effect on observed sales. This is a strong result supporting the model given the sample size and the significance of the other coefficients.

4.1. Farmer measures and information use

A primary objective is to identify the causal effect of the marketing choice on farm sales, recognising the marketing choice is an endogenous multinomial treatment effect. The coefficients from the multinomial treatment effect model show that female farmers involved in direct marketing are faced with larger sales declines compared to male farmers. Female farmers report sales that are about 58 per cent lower than male farmers and the difference is exacerbated when participating in direct marketing. Direct marketing to consumers only is associated with a sales gap for females that increases by 5.0 per cent while direct marketing to both consumers and retailers widens the gap by 11.1 per cent, with both effects statistically significant. Sales declines that are observed when farmers adopt direct marketing are not

alleviated by the experience of the farmer. The farm experience variable does not have a positive effect on sales.

Participation in direct marketing is associated with lower farm sales but farmers who use the Internet to gather information for farm-related news or commerce are able to limit the amount of the sales decline. We examine the situation when producers who market directly to consumer only increase the time using the Internet to gather news by one standard deviation, or about 5.5 h per week. Producers who participate in any of the three direct marketing choices report a standard deviation of Internet news use exceeding this level. This suggests that an adjustment of this magnitude is possible given the current usage rates. An increase in time spent on the Internet for news by this amount reduces the sales decline by about 11.08 per cent, or about USD 45,415 at the mean level of sales.

Internet time for farm-related commerce is another activity that has a positive and significant impact on sales. An increase in Internet use for commerce information of 3.80 h (or one standard deviation) mitigates decreased sales by about 5.04 per cent, or about USD20,658 from the mean level of sales. These findings suggest that farm operations that use the Internet are applying management and marketing skills that contribute to reducing declines in farm sales associated with direct marketing operations.

The coefficients on the acreage and labour variables in the log linear farm sales model represent elasticities. The output elasticities measure the change in sales as the input changes, indicating that a 10 per cent increase in acreage is associated with expanded sales of 4.56 per cent. The acreage output elasticity suggests that producers using direct marketing who also expand their acreage by 10 per cent can mitigate the sales drop associated with direct marketing for two of the marketing options. The output elasticities for labour (both operator and hired labour) suggest that a 10 per cent increase in labour is associated with expanded sales of 2.45 per cent.

4.2. Treatment effects of direct marketing outlets

The model offers policy relevant findings by demonstrating how sales change in response to the choice of direct marketing outlets for specific groups of farmers or scenarios. We consider a set of three scenarios but stress that extension agents and rural development specialists can use the model to consider scenarios for any specific groups of farmers unique to their region. The scenarios deal with the marketing options when producers engage in direct market to consumers only and for direct marketing through both consumer and retail outlets. The coefficients on these choices are statistically significant and indicate that farm sales are influenced by these options.

The average treatment effects are calculated for various values of the explanatory variables in the model. The baseline case is the average individual where the exogenous covariates are set equal to the mean of the values in the sample for continuous variables and at the mode (most common value) for the discrete

variables. The treatment effects for the average individuals in interesting subgroups are presented as we consider males versus females, new farmers compared to more experienced farmers, and two categories of internet users among agricultural producers. About 35 per cent of farmers access the Internet for both commerce and news-related activities and these farmers report sales that are about 52 per cent higher than other producers. We examine the impact of the direct marketing choice on the sales of these intensive Internet users. Treatment effects from models that do not account for endogeneity of the marketing choice are calculated to highlight the additional insight provided by this approach.

After accounting for self-selection of the marketing outlet, the average producer is predicted to experience a sales decline of about 67 per cent when participating in direct consumer outlets only. Choosing both outlets is associated with a sales decline of 28 per cent while the direct to retail option does not show a significant sales drop.

We look more closely at the groups of farmers who may be able cushion the sales penalty associated with direct marketing. Both male and female farmers experience a sales decline but the penalty for female farmers is higher compared to comparable male farmers. Compared to males, female farmers face a sales drop that is 85 per cent higher when selling only through direct to consumer outlets and is 66 per cent higher when selling through both outlets. Our results have uncovered distributional impacts associated with the direct marketing decision that should be considered by potential entrants to these markets.

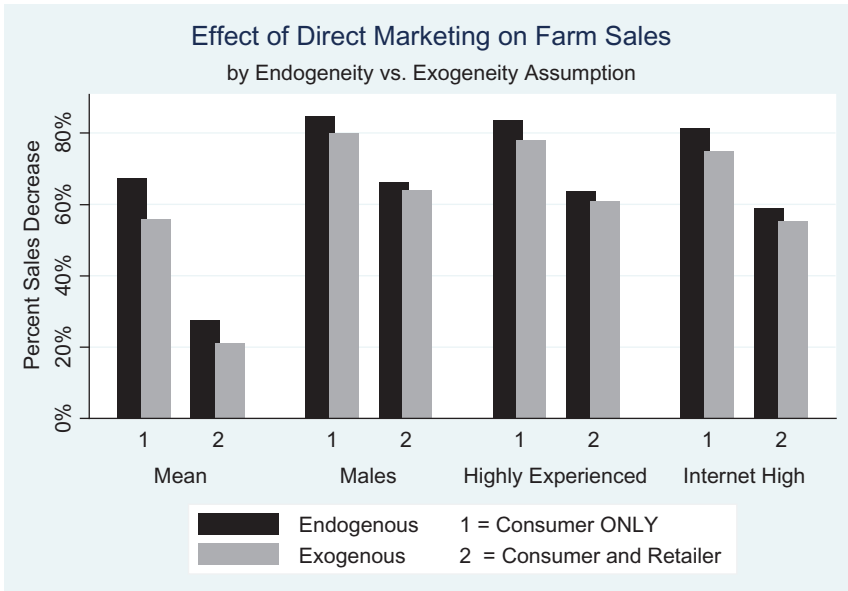

Fig. 3. Effects of direct marketing on farm sales by endogeneity versus exogeneity assumpt.
Note: Model with exogeneity assumption predicts sales decline that are smaller than the correctly specified endogenous model for all marketing channel outlets.
Source: Calculations from ARMS, ERS, USDA.

Another scenario examines the role of the internet in assisting producers in their marketing efforts. We identify high-Internet users as farmers who access the Internet for both marketing and commerce activities and compare their sales with those who do not use the Internet for either of these activities. Both male and female producers show similar internet adoption patterns as 35 per cent of each group falls in the high-Internet adoption category. There is not a scenario in which direct marketing is associated with higher farm sales but this analysis may reveal management strategies that can mitigate the decline. Farmers who do not rely on the Internet for either marketing news or for commerce activities when engaging in direct sales incur a higher sales penalty. The sales penalty for these farmers compared to producers with intensive Internet activity is 82 per cent higher in the direct to consumers only category.

To confirm the value of the endogenous marketing choice model, we evaluate sales from a model which assume the decision is exogenous. The estimated sales declines are uniformly too low from the model neglecting endogeneity for both the direct to consumer and multimarket decision to market in dual outlets. Figure 3 shows the percentage sales declines from the preferred endogeneity model and the exogeneity model that has been statistically rejected. In each scenario, the exogeneity model (grey bars) predicts sales declines that are smaller than those from the endogeneity model (black bars). Producers will systematically underestimate the loss in sales from the incorrect model and they may overlook needed adjustments in marketing resources to deal with this decline.

5. Conclusions

Our results assess how the sales of farmers are influenced by involvement in direct marketing. Gilg and Battershill (2000) noted that the sustainability of farm systems can be enhanced by evaluating the economic effects associated with specific marketing practices. The impacts of direct marketing efforts are negative for two options: direct to consumers only and marketing direct to consumers and retailers. Involvement in direct marketing is associated with a decrease in farm sales for these two options. The direct marketing penalty remains even after controlling for important demographic factors, farm experience and use of the Internet and characteristics of the farm operation such as crop choices and input use. Additional analysis is needed to understand the finding that direct marketing to retailers is not associated with a statistically significant sales decline.

One surprising finding is that direct marketing is associated with higher sales declines for female farmers, highlighting a distributional impact on farmers that has not been discussed. Direct marketing to consumers only is associated with a sales gap for females that increases by 5.3 per cent while direct marketing to both consumers and retailers widens the gap by 11.6 per cent. More generally, the results support the use of the treatment-outcome model for choice of marketing outlets that explicitly accounts for selectivity. The selectivity model yields estimates for the sales impact associated with the choice of alternative direct

marketing outlets. If selectivity effects are incorrectly overlooked, the predicted sales declines are actually too low and producers will not learn the full impact of the decision to participate in direct marketing.

We see evidence of favourable selection into the direct marketing to consumers only. This suggests that there are unobserved factors that enhance the ability of these producers to expand sales through these outlets. Survey data can be examined in more detail to provide additional information about the demographic and farm characteristics of these producers. In addition, working with extension experts, targeted surveys can be developed to elicit more detailed data from these producers about their marketing strategies or managerial and entrepreneurial skills.

We uncover new findings on the link between Internet activities and the sales impacts for farmers participating in direct marketing. Previous work has linked these activities only to the choice of marketing outlet. Producers who use the Internet to gather information for farm-related news or commerce are in a better position to manage sales uncertainty associated with direct marketing. Additional producer effort and time spent on using the Internet for news has a stronger impact on sales than activity involving farm-related commerce.

Additional research could be directed at extracting a wider set of indicators from producer survey (such as ARMS) and identifying management and marketing skills that contribute to alleviating declines in farm sales associated with direct marketing operations. One indicator is the type of off-farm business that the operator or spouse may be involved. Survey information is available for businesses such as wholesale trade, warehousing, transportation along with retail trade or personal services and these businesses may provide managerial skills that can be applied to direct marketing efforts. The impact of expertise of the spouse or non-primary operator on direct marketing can also be investigated. We plan to investigate these variables as additional years of the ARMS are made available and the direct marketing variable is maintained in the survey.

Retailers promoting local foods such as Whole Foods Markets and Wal-Mart are interested in understanding how participation in direct marketing is related to farm sales since significant sales declines may deter farmers from joining these efforts. Wal-Mart has set a goal to support farmers engaged in direct marketing efforts by selling USD1 billion in food sourced from 1 million small and medium farmers and increasing the income of small and medium farmers it sources from by 10–15 per cent. We estimate the impacts of direct marketing efforts on farm sales of agricultural producers for three marketing options but the model can be adapted for additional marketing choices. Whole Foods Markets promotes a 'Local Producer Loan Programme' of low-interest loans to farmers, ranchers and artisan producers and the retailer may favour providing these loans to farms below a specific sales level. The approach provides the most relevant information for understanding how producers are affected by participation in direct marketing and could provide information to target these loans more effectively.

The KNF[2] website (http://www.usda.gov/knowyourfarmer) lists opportunities for farm loan programmes such as direct and guaranteed ownership

loans for beginning farmers and socially disadvantaged groups, farm storage facility loans, value-added producer grants, beginning farmer and rancher development programmes, and technical assistance and marketing services for farmers engaged in local selling. Extension agents, crop consultants and agricultural marketing groups can use these results to predict the sales a farmer can expect if a direct marketing programme was initiated or to identify farmers who may be less susceptible to declines in sales. This information could be used in targeting farmer participation in the KNF^2 programmes.

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