Modeling Exit and Entry of Farmers in a Crop Insurance Program

Juan H. Cabas, Akssell J. Leiva, and Alfons Weersink

This paper examines the factors influencing farmer participation in crop insurance schemes, but unlike previous studies that focus on total demand, participation is disaggregated into entrants and those exiting. Modeling entry and exit decisions separately illustrates that the effect of a given variable is often muted by aggregation. In addition, the approach in this paper distinguishes between price and yield variables rather than total returns and is consequently able to demonstrate that price variables are particularly important for farmers considering enrolling in crop insurance, while yield variables and other risk management opportunities are more important for farmers who have been in the program but are deciding to exit. The result suggests that moral hazard is reduced significantly by calculating the coverage yield level for an individual producer on the basis of a moving average of past yields for that farmer. While yield and its variance are particularly influential in the participation decision for farmers currently enrolled, its significant impact on the insurance decision for all farmers highlights the importance of crop insurance as a potential adaptation strategy to weather events.

Key Words: crop insurance, entry and exit, panel data

Farmers increasingly are relying on crop insurance as a risk management tool that replaces government stabilization programs. Previous studies on the demand for crop insurance have not examined how the demand factors vary between those farmers currently enrolled in the program and those farmers without crop insurance. Past research on crop insurance participation has relied on aggregate state- or county-level data over a period of time or on a specific micro-level survey for a given period. Examples of the former include Goodwin and Smith (1995), Goodwin (1993), Barnett, Skees, and Hourigan (1990), Hojjatti and Bockstael (1988), Gardner and Kramer (1986), and Nieuwoudt et al. (1985). These time series studies generally estimate the proportion of eligible area within a region that is insured as a function of factors such as expected return to insurance and demographic/physical characteristics of the region that proxy alternative risk management options. Studies of the latter sample individual farmers at a given point in time and examine the decision to participate and the corresponding level of coverage as a function of socioeconomic and farm characteristics of the producer (i.e., Sherrick et al. 2004, Garrido et al. 2002, and Coble et al. 1996). None of the studies have used panel data to examine the drivers of exit and entry decisions in a crop insurance plan.

This paper decomposes demand into not only total participation but also the number of farmers who enter and exit a crop insurance program, and in the process illustrates that the effect of a given variable is often muted by the aggregation. While previous studies help us understand the factors that matter for *all* farmers enrolled in a crop insurance program, they offer limited information to understand how the same factors might influence the dynamic decisions of *new entrants* or

Juan H. Cabas is a Lecturer in the Facultad de Estudios Empresariales at the Universidad del Bío Bío in Chile. Akssell J. Leiva is a Research Analyst within the Program Development Division at Agricorp. Alfons Weersink is a Professor in the Food, Agricultural and Resource Economics (FARE) Department at the University of Guelph. This work was done while Cabas and Leiva were graduate student and research associate, respectively, in the FARE Department at the University of Guelph.

This paper was presented as a selected paper at the Crop Insurance and Risk Management Workshop, sponsored jointly by the Northeastern Agricultural and Resource Economics Association, the Risk Management Agency, the Farm Foundation, the Food Policy Institute at Rutgers University, and Cornell University, in Rehoboth Beach, Delaware, on June 12–13, 2007. The workshop received financial support from the Northeast Regional Center for Rural Development. The views expressed in this paper are the authors' and do not necessarily represent the policies or views of the sponsoring agencies.

This paper benefited from the helpful comments of Calum Turvey, Jerry Skees, Jason Hartell, and the anonymous journal reviewers. We also thank Agricorp for providing the crop insurance data, and particularly Irena Rajcan for technical assistance.

dropouts. For instance, previous studies have found that the demand for crop insurance is highly inelastic with respect to premium rates. Since these studies agglomerate all participating farmers, these models are not well-suited to capture any differential effect that premium rates might have on those farmers purchasing insurance for the first time versus those currently enrolled and considering continuing or canceling their policies. This study also finds own price demand to be inelastic for all farmers, but the decomposition also shows that demand is much more elastic for farmers considering enrolling in crop insurance.

Similarly, the effect of previous yield realizations and yield variability has remained relatively unexplored in the crop insurance literature, with the exception of Goodwin (1993). Both previous realizations and variance of crop yield are important variables because they represent one of the most tangible pieces of information regarding the risk profile of the farm enterprise. In addition, growing conditions in the previous crop year can have confounding effects on the likelihood of using crop insurance as a risk management strategy in the present year. For example, in the case of unfavorable weather events, lower yields are more likely to generate an indemnity payout from the crop insurance company and thus clearly illustrate the benefit of an insurance plan to a farmer. However, the lower yields reduce the moving average on which future payouts to the farmer are based and consequently the likelihood of such payouts. More importantly, the relative effect of previous yield realizations and perceived variability of yield might depend on whether the farmer is a new entrant or has purchased uninterrupted coverage in the past. Knowing the drivers of entry and exit decisions is not only important to evaluate the viability of a crop insurance program, but also an important piece of information to understand how program design might prevent or encourage farmer opportunistic behavior due to the information asymmetry inherent in these contracts.

The objective of this paper is twofold: first, to decompose farmer participation in a crop insurance program into exit and entry decisions; and second, to disentangle the effect of previous yield realizations on the demand for crop insurance. In the first component we investigate how the different types of decision makers (e.g., new entrants and dropouts) respond to the same set of economic, risk, and county-specific variables. In the second component, we examine whether an increase in previous yield has a greater effect on farmers opting out of the programs or farmers joining a program, and the implications for program design given the information asymmetry underlying these programs.

An understanding of the dynamics of participation in a crop insurance program is fundamental for delivering agencies to tailor their attention to the different types of clients they are serving. Moreover, a dynamic view of participation helps crop insurance providers to implement better strategies and allocate promotional funds to retain current clients and encourage the signing up of new clients. Disentangling the impact of previous yield realizations is of particular importance for policymakers, who allocate government funding, and farmer organizations, which seek to advise members on potential adaptation strategies against climate change. For instance, if increased yield variability leads to an increased participation in the programs, the delivering agency needs to proactively plan ways to manage the potentially higher financial exposure. Moreover, an increased demand for crop insurance would suggest that taxpayer money might be more efficiently allocated to strengthen and enhance these programs in lieu of ad hoc payments to farmers.

The remainder of the paper is as follows. The next section provides a brief survey of the previous literature on crop insurance participation and identifies the main factors that might influence enrollment decisions. After an overview of the literature, a conceptual framework is developed to conjecture different hypotheses regarding participation. In the two sections following that, the modeling strategy and estimation procedures are discussed. The paper concludes with a discussion on policy implications for crop insurance providers and farmer organizations.

Related Literature

A large body of literature has examined the factors underlying farmer participation in crop insurance programs. These studies approach insurance decisions at the aggregate level over time [see for example the work of Goodwin and Smith (1995), Goodwin (1993), Barnett, Skees, and Hourigan (1990), Hojjatti and Bockstael (1988), Gardner and Kramer (1986), and Nieuwoudt et al. (1985)] or at the micro level for a single period [see Sherrick et al. (2004), Sherrick (2003), Mishra and El-Osta (2002), Jose and Valluru (1997)]. From this literature has emerged a set of factors that influence decisions to purchase crop insurance such as farmer-specific characteristics (e.g., education, risk attitude, off-farm income), economic factors (e.g., crop returns, insurance premium), and farm-/region-specific characteristics (e.g., crop mix, location, soil quality). The empirical relationships established within these studies help us understand the *total* enrollment of farmers in a crop insurance program. However, there is not an empirical examination, to the best of our knowledge, of how the same factors might affect the different type of participants that simultaneously determine the overall participation, namely new entrants and dropouts.

The present paper complements the literature on crop insurance demand by decomposing crop insurance participation into entry and exit decisions. Clearly, the year-to-year change in participation rates is composed of three types of farmers: those who join the system (i.e., returning and new entrants), those who after joining the system decide to continue their enrollment, and those who drop out. This paper will focus on the decisions of farmers who join and exit the plan. While the factors influencing the three levels of crop insurance participation might be the same, the impact of each factor on each type of decision might be different. For instance, the crop insurance premium might be more important for farmers facing the initial participation decision than for farmers considering the dropout decision.

In addition, this study complements Goodwin's (1993) effort to establish the impact of previous year's yield on the decision to purchase insurance in future periods. While Goodwin establishes that higher yields in the preceding year are inversely related to the demand for crop insurance, his analysis does not establish whether the higher demand is due to new purchases of insurance or lower cancellation of policies. In this paper we disentangle those effects and discuss the implications for dealing with potential asymmetry that occurs in crop insurance contracts. For instance, experiencing a considerable number of dropouts after experiencing poor yield conditions in the previous period might indicate that farmers participating in the crop plan might not consider insurance a "substitute" for the good management decisions and effective input applications that improve the likelihood of producing a good yield. From the perspective of the insurance provider, this is a desirable result because it demonstrates how the plan design might mute the moral hazard and adverse selection problems.

Conceptual Framework

Consider a farmer who grows one crop, faces yield (Y) risk, and maximizes the expected utility[1] of profits. Crop yield, in particular, is distributed with a mean of $E(Y)$ and variance of $\text{var}(Y)$. Letting P_c represent crop price and C the cost of production per unit area of production, both of which are known at the time of purchasing insurance, profits without insurance (π_{NI}) can be expressed as

$$(1) \qquad \pi_{NI} = P_c Y - C .$$

Moreover, the expected utility of profit without crop insurance can be expressed in terms of its certainty equivalent, $CE(\pi_{NI})$, as

$$(2) \quad CE(\pi_{NI}) = E(\pi_{NI}) - 0.5\lambda\,\text{var}(\pi_{NI}) = P_c E(Y) - C - 0.5\lambda P_c^2\,\text{var}(Y),$$

where $E(\pi_{NI})$ is expected profit and $\text{var}(\pi_{NI})$ is the variance of profits without insurance.

For a premium (PRM), the farmer could use crop insurance against yield losses below a guaranteed level given by Y_g, which is a moving average on which future payouts to the farmer are based. If the actual yield (Y) is below this coverage level ($Y_g > Y$), then the farmer receives an indemnity (I), which is the yield difference multiplied by the crop price (P_c); $I(Y_g, Y) = P_c(Y_g - Y)$. Profit with insurance (π_I) is thus

[1] The conceptual framework assumes, for illustration of the principles only, that an exponential utility function with constant absolute risk aversion characterizes the decision maker's risk preferences. This assumption facilitates the analysis in terms of certainty equivalent measures.

(3) $$\pi_I = P_c Y - C - PRM \quad \text{if } Y > Y_g$$
$$= P_c Y + I - C - PRM \quad \text{if } Y < Y_g.$$

The certainty equivalent from the returns associated with purchasing insurance [$CE(\pi_I)$] is given by

(4)
$$CE(\pi_I) = E(\pi_I) - PRM + E(I) - 0.5\lambda\,\text{var}(\pi_I)$$
$$CE(\pi_I) = P_c E(Y) - C - PRM + E(I) - 0.5\lambda[P_c^2\,\text{var}(Y) + \text{var}(I) + 2\,\text{cov}(I,Y)],$$

where $E(I)$ and $\text{var}(I)$ respectively represent the mean and variance of the indemnity.

Farmers compare the expected utility of profits with and without insurance to make their purchasing decisions. The maximum willingness to pay for insurance (*PRM**) is equal to the sum of money that equates the certainty equivalents of profits with and without insurance [equations (2) and (4)]. This value is referred to in the literature as the reservation premium and is given in equation (5):

(5)
$$PRM^* = E(I) - 0.5\lambda[\text{var}(I) + 2\,\text{cov}(I,Y)]$$
$$PRM^* = E(I) - 0.5\lambda\left[\text{var}(I) + 2corr_{IY}\sqrt{\text{var}(I)}\sqrt{\text{var}(Y)}\right].$$

The reservation premium and values of the *CE* depend on whether the farmer is currently enrolled in crop insurance or not. However, certain variables will have the same impact on the participation decision regardless of previous insurance purchase decisions:

(6)
$$\frac{\partial PRM^*}{\partial \lambda} = \text{-}0.5[\text{var}(\pi_I) - \text{var}(\pi_{NI})] > 0 \quad \text{for } \lambda > 0,$$

(7)
$$\frac{\partial PRM^*}{\partial\,\text{var}(Y)} = [\text{-}0.5\lambda\frac{\sqrt{\text{var}(I)}}{\sqrt{\text{var}(Y)}}corr_{IY}] > 0,$$

(8)
$$\frac{\partial PRM^*}{\partial P_c} = \frac{\partial E(I)}{\partial P_c} - 0.5\lambda\frac{\partial\,\text{var}(I)}{\partial P_c}\left(1 + corr_{IY}\frac{\sqrt{\text{var}(Y)}}{\sqrt{\text{var}(I)}}\right) > 0.$$

A higher level of risk aversion will lead to a higher willingness to pay as long as insurance produces profits with less variance relative to the no-insurance case. Moreover, an increased variance in crop yield will increase the farmer's reservation premium due to the built-in hedging effect on crop insurance (e.g., $corr_{IY<0}$). In the case of higher crop prices, a higher willingness to pay for insurance results when the relative variability of the indemnities is not higher than the variance of yields and there is a sufficiently high hedging effect between the indemnities and yield risk.

The effect of previous yield, however, is more complex and might depend on previous participation decisions. For farmers who have been enrolled in the crop insurance program, the guaranteed yield and corresponding indemnity payments are based on the moving average of the farmer's yield reported in the previous years. Therefore, in this case, the insurer uses the farmer's production history to write the contracts, and lower (higher) crop yields reduce (increase) the moving average on which future payouts to a farmer with insurance are based (i.e., $\partial Y_g/\partial Y_{t-1} > 0$). Therefore, changes in past weather events, as embedded in crop yield, will have an impact on the reservation premium. The impact can be traced in equation (9).

(9)
$$\frac{\partial PRM^*}{\partial Y_{t-1}} = \underbrace{\frac{\partial E(I)}{\partial Y_g}\frac{\partial Y_g}{\partial Y_{t-1}}}_{(+)} - 0.5\lambda\underbrace{\frac{\partial\,\text{var}(I)}{\partial Y_g}\frac{\partial Y_g}{\partial Y_{t-1}}}_{(+)}\underbrace{\left(1 + corr_{IY}\frac{\sqrt{\text{var}(Y)}}{\sqrt{\text{var}(I)}}\right)}_{(+)/(-)}.$$

An increase in yield during the previous crop year will generate benefits in terms of both the expected payouts, but it can also produce negative impacts through an increase in yield variance. In particular, the first term in equation (9) will be positive since by definition a yield increase must not decrease the expected indemnities from the insurance via a larger Y_g. However, the higher Y_g

will also produce more variance as the indemnity and the yield functions overlap more closely. Thus, the net impact of the yield increase will depend on the sign of the last term of equation (9). Specifically, as long as the yield variance continues to be greater than the indemnity variance, and their combination with the hedging effect is strong, the yield increase will likely produce a higher reservation premium. Intuitively, it would be irrational for a farmer to engage in the insurance contract if the variance of the indemnities were greater than the yield variance, which of course would make the last part of equation (9) positive and leave the net impact of a yield increase indeterminate.

When the farmer is not currently part of the crop insurance scheme, the insurer lacks complete information about the farmer's production history. Consequently, the Y_g used to compute the indemnity is not a moving average based on the farmer's past yield but rather the county average yield. Assuming that the farmer's yield risk is independent of the county average yield, the farmer's yield in the previous year has no impact on the coverage level but only in the own variance of yield. Thus, the impact of the previous year's yield on the reservation premium of a non-participating farmer (PRM^{**}) can be derived by differentiation of equation (5), keeping in mind that $\partial Y_g/\partial Y_{t-1} = 0$, but $\partial \mathrm{Var}Y/\partial Y_{t-1} \neq 0$; that is,

$$\text{(10)} \quad \frac{\partial PRM^{**}}{\partial Y_{t-1}} = -0.5\lambda\left(\underbrace{corr_{IY}}_{(-)}\ \underbrace{\frac{\sqrt{\mathrm{var}(I)}}{\sqrt{\mathrm{var}(Y)}}\frac{\partial\, \mathrm{var}(Y)}{\partial Y_{t-1}}}_{(+)}\right)$$

Since the expected indemnity is not affected by last year's yield [$\partial E(I)/\partial Y_{t-1} = 0$], the sign of equation (10) depends on the second term in the right-hand side of the expression. Given that insurance payouts and yield realizations are negatively correlated by design, the sign will depend on how previous yield realizations change the variance of the yield distribution. If the change in yield is variance-increasing, $\partial \mathrm{Var}Y/\partial Y_{t-1} > 0$, then the farmer will have a higher reservation premium. In summary, non-participating farmers will have a greater willingness to pay for insurance when their experience suggests that the benefit of higher-yielding crops comes with the cost of increased yield variability.

Modeling Strategy

Measuring Participation

Previous research on crop insurance has measured participation using an array of dependent variables and methods. Some of the most common measures include the proportion of area insured in relation to total plantings, liability per planted acre (Goodwin 1993), proportion of eligible acres insured, and proportion of eligible bushels insured (Barnett, Skees, and Hourigan 1990). Most studies at the county level have measured changes in these participation measures across decision units in space, although some have combined spatial and time series data. Micro-level studies have used surveys to ask whether farmers use crop insurance or not, and have used limited dependent variable regression techniques to model the dichotomous choice on participation and/or coverage level to farmer characteristics (Sherrick et al. 2004, Sherrick 2003, Mishra and El-Osta 2002, Jose and Valluru 1997). These micro studies are at a single point in time, which constitutes a shortcoming in the study of dynamic crop insurance participation decisions.

Data on the crop insurance plan were provided by Agricorp, the risk management agency of Ontario. The data covers the 1988–2004 period for eight counties in southern Ontario: Chatham-Kent, Elgin, Essex, Haldimand-Norfolk, Huron, Lambton, Middlesex, and Perth. For each county and for any given year within the study period, the data set separates the number of soybean farmers who moved in and out of the program, the number of farmers who qualified for insurance claims, crop yield, and the monetary amount of the claim. For our purposes, however, the most salient feature of the data set is that it can be used to track the dynamic flows that determine the total number of farmers enrolled in the program at any point in time within a county. The measures on the movement of farmers in and out of the insurance program are useful in helping to overcome the static limitations of previous studies.

Four dependent variables are specified to capture crop insurance participation within a given county:

(i) the total number of farmers enrolled in the plan;

(ii) the proportion of soybean acres insured (a standard measure in the literature);

(iii) the number of farmers enrolling in the plan for the first time; and

(iv) the number of farmers canceling their enrollment.

Aggregate measure of participation such as (i) and (ii) above include all the farmers participating in the plan. Such a measure, however, does not allow one to distinguish between the type of farmer participating in the plan (new vs. existing), nor how each type of farmer responds to the same exogenous shock. For instance, measures (i) and (ii) above are of little use in investigating whether the lower *total* farmer participation associated with an insurance premium rate increase is due more to existing farmers canceling their policies or to fewer new farmers enrolling in the plan. Instead, we propose that such a question can be answered by decomposing participation in measures such as (iii) and (iv) proposed above. Using this dynamic approach to measure participation might be useful not only in investigating whether aggregate measures of participation potentially mute the impact of an individual demand driver, but also in testing to what extent the exit and entry decisions are symmetric to a particular shock. In addition, the decomposition allows one to investigate how the design of crop insurance contracts deals with the asymmetric information problem inherent in yield insurance applications.

The averages for the four participation measures over the 18 years of data are presented at the county level in Table 1. In addition, the trend of these dependent variables over time is illustrated in Figures 1 and 2 for Middlesex County, whose patterns closely resemble the mean produced by the eight-county sample. The number of soybean growers participating in the crop insurance program increased significantly from 1990 to 1993 (see Figure 1). After reaching a peak of 1,000 farmers in 1993, participation fell to approximately 900 farmers in 1995, but has fluctuated between 900 and 950 farmers since that time. In turn, the number of new entrants in the soybean plan in Middlesex fell from a peak of 279 producers in 1989 to approximately 127 in the following year. The number of new entrants has fluctuated between 100 and 200 farmers since that time. Moreover, the percentage of soybean area insured in Middlesex has increased steadily (see Figure 2). The total area harvested almost doubled from 110,000 acres (44 percent insured) in 1990 to 215,000 (52 percent insured) in 1997. Although the soybean acreage has declined since 1997, the insured acreage has continued to increase to levels exceeding 75 percent of the county soybean crop.

Independent Variables Affecting Participation

The factors affecting participation in crop insurance as determined from the theoretical model in the previous section are described in Table 2. Summary statistics and expected signs for each variable on the different participation measures are included in Table 3.

The premium rate is the price that Ontario farmers pay to enroll in the provincial crop insurance program. As explained in the theoretical model, farmers purchase crop insurance if their reservation premium is greater than the premium payment they make to the insurer. As the premium rate increases, the number of new entrants (dropouts) to the crop plan is expected to decrease (increase). The producer premium[2] rates corresponding to the soybean crop plan were provided by Agricorp and deflated by the CPI as reported by Statistics Canada.

The crop price will positively impact the demand for crop insurance if higher crop prices increase the mean and variance of the insurance payout and the higher price produces indemnities whose variability does not exceed yield variability [see equation (8)]. As long as the higher insurance payouts remain less variable than the crop yield, the reservation premium will increase with increases in the soybean price. It is hypothesized

[2] In Canada, the crop insurance premium is partly subsidized by the provincial and federal governments. Although percentage of premium subsidized has varied between the 50–60 percent rate, this analysis is based on the proportion of the premium rate actually paid by the producer.

Table 1. Crop Insurance Participation Measures by County (1988–2004) (annual average)

County	Total Insured	% Soybean Area Insured	Entrants	Exits
Huron	912	70	169	138
Perth	624	66	126	97
Haldimand-Norfolk	505	60	109	98
Middlesex	892	61	163	136
Lambton	1126	57	160	127
Elgin	511	57	98	86
Kent	1785	72	242	224
Essex	1243	77	158	165
Overall	964	66	151	134

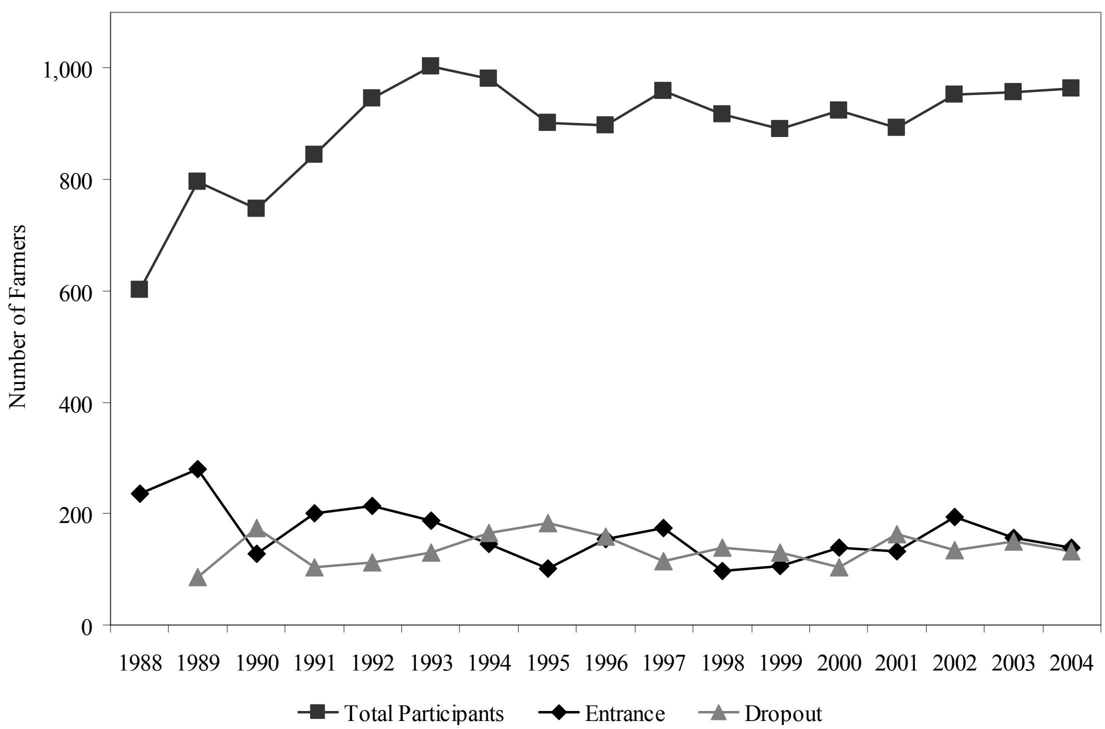

Figure 1. Farmer Crop Insurance Participation in Middlesex County (1988–2004)

that an increase in the soybean price has a positive (negative) effect on the number of new entrants (dropouts) in the plan. The soybean price used is the provincial annual average collected from the Ontario Ministry of Agriculture, Food and Rural Affairs website. It was deflated by the CPI.

Conversely, the variance in the soybean price contributes to the variance of profits and will likely result in a reduced reservation premium. If soybeans experience an increase in price risk, farmers will more likely switch towards crops with less volatile prices such as wheat or corn. Thus, reduced soybean acreage will cause a de-

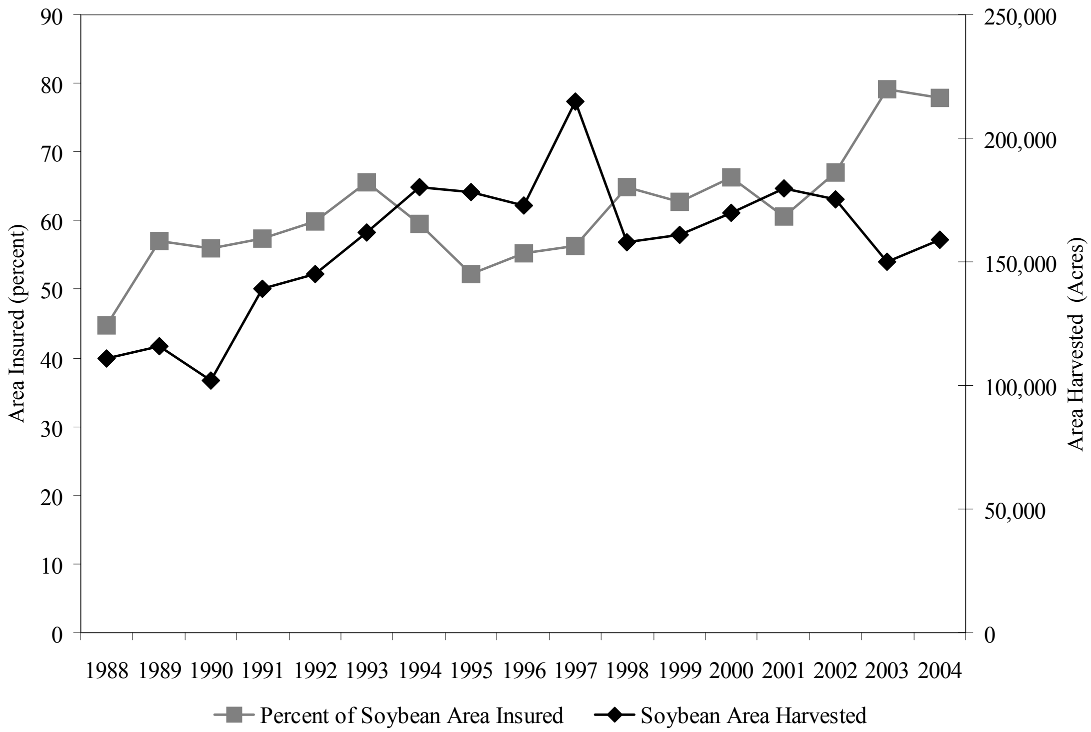

Figure 2. Soybean Area Harvested and Insured in Middlesex County (1988–2004)

cline in the crop insurance participation measures. Therefore, an increase in the variance of soybean price is expected to decrease (increase) the number of new entrants into (dropouts from) the crop insurance program. The variance of price was calculated as a weighted moving average of the previous three years.[3]

Yield in the previous year, which embodies the effect of weather conditions, has an ambiguous effect on the reservation premium for farmers currently enrolled in the crop insurance program [see equations (9) and (10)]. If the previous year's yield is high, farmers who purchased insurance will feel they lost the payment on the insurance premium and may decide to cancel their coverage. However, the increase in yield will also increase the yield moving average on which the level of insurance coverage is based. The likelihood of receiving a payout from the program is thus increased, as is the farmer's incentive to remain in the program. Lagged yield is expected to increase the willingness to pay for insurance when the benefit of a potentially higher expected indemnity outweighs the disutility of lower or variable profits associated with yield reductions. In the case of new entrants, previous realizations of yield will not affect future payouts. Thus, new participants will purchase insurance when they feel that yield increases in the past will produce more variable yields in the future.

Increases in the variance of yield[4] due to weather variability will increase the risk premium that producers are willing to pay to avoid risk. Thus, an increase in the variance of yield might be associated with a lower dropout rate, but with

[3] The subjective variance for prices and yields is assumed to be defined in a manner similar to supply response models (i.e., Adesina and Brorsen 1987). Specifically, they are defined as follows:

$$\mathrm{var}(p) = 0.5\{p_{t-1} - E_{t-2}(p_{t-1})\}^2 + 0.33\{p_{t-2} - E_{t-3}(p_{t-2})\}^2 + 0.17\{p_{t-3} - E_{t-4}(p_{t-3})\}^2$$

$$\mathrm{var}(y) = 0.5\{y_{t-1} - E_{t-2}(y_{t-1})\}^2 + 0.33\{y_{t-2} - E_{t-3}(y_{t-2})\}^2 + 0.17\{y_{t-3} - E_{t-4}(y_{t-3})\}^2.$$

[4] Please refer to footnote 3.

Table 2. Definition of Explanatory Variables Affecting Crop Insurance Participation

Notation	Variable Definition
PREMIUM	Average of the provincial producer-paid real premium rate for the soybean plan ($/acre)
PRICE	Real November futures price of soybeans adjusted for exchange rate and moving weighted average
PRICEVAR	Variance of the expected soybean price
YIELD	County soybean yield in preceding year (bushels/acre)
YIELDVAR	Variance of county yield
CLAIMS	Number of farmers qualifying for insurance payout in the preceding year
SOYPROP	Proportion of total acreage devoted to soybeans at the county level

Table 3. Summary Measures and Expected Sign of Explanatory Variables Affecting Crop Insurance Participation

Variable	Mean	Std. Dev.	Insured/ Entrants	Exits
PREMIUM	7.92	2.28	-	+
PRICE	6.67	1.39	+	-
PRICEVAR			-	+
YIELD	36.87	4.65	+	-
YIELDVAR			+	-
CLAIMS	347	327	+	-
SOYPROP	0.48	0.12	+	-

a higher number of new farmers signing up for the plan.

The number of farmers receiving an insurance payout is also expected to have a positive (negative) sign in participation (number of dropouts). The indemnity is the most tangible benefit for a farmer participating in the crop insurance program. For those farmers who are considering whether to participate or not, the increase in the number of beneficiaries has a "neighborhood effect," and thus encourages participation. Similarly, for those already in the system, the indemnity confirms their expectations and benefits of their insurance decisions; therefore, a higher number of indemnities should be associated with a lower number of dropouts.

The proportion of area planted with soybeans is expected to have a positive (negative) effect on crop insurance participation (exits). Diversification is a non-commercial management tool that farmers can implement to reduce risk. As the relative proportion of area planted with soybeans increases, the average crop farm is becoming less diversified, and consequently there is a greater need for a commercial yield risk management tool such as crop insurance. Moreover, this variable controls for the relative importance of the crop within the crop portfolio. In other words, if farmers allocate more land to other crops, then they will likely use their limited risk management funds to insure the other crops.

Estimation Procedures

Combining cross-sectional and time series data provides additional information on the economic behavior across the different decision units, but it also raises issues on how the unobservable heterogeneity across counties should be accounted for in the model. The panel nature of the data can be estimated using either a fixed effects model, which controls for omitted variables that differ between counties but are constant over time, or a random effects model, which considers that some omitted variables may be constant over time but vary between cases or vice versa. The type of assumption made about the source of heterogeneity has important implications for the econometric estimation.[5]

A Breusch and Pagan test and a Hausman specification test were used to determine if a fixed effects or a random effects approach should be used to model the three participation equations.[6] A random effects model was rejected as the appropriate means of estimating the panel data on the basis of the Breusch and Pagan Lagrangian multiplier test for the four models. The Hausman test produced similar conclusions. Therefore, the insurance participation functions were

[5] The data were tested for unit roots using the multivariate augmented Dickey-Fuller (MADF) test for panel data proposed by Sarno and Taylor (1998). Based on the MADF test, the null hypothesis of joint non-stationarity was rejected for all the data in the model. Test results are available from the authors upon request.

[6] The specific tests are available from the authors upon request.

estimated using a fixed panel model or a least squares dummy variable estimation approach. This model assumes that each county has a unique but constant source of variation and that the source of heterogeneity is fixed.

Empirical Results

The estimated coefficients for the exogenous variables in the fixed effects panel model are listed in Table 4 for the four models of insurance participation. The corresponding elasticities are listed in Table 5. The overall fit of insurance participation models are good with adjusted R^2 values of approximately 0.88, 0.70, 0.66, and 0.55 for the four models, respectively. In addition, most of the variables are statistically significant and of the expected sign.

The demand for insurance is inversely related to its price as expected and consistent with downward-sloping demand curves found in other crop insurance participation models (Goodwin 1993, Cannon and Barnett 1995). Increases in the premium rate decrease the number of entrants and increase the number of dropouts (columns 4 and 5 of Table 4). The statistical significance of the insurance premium on the entry/exit numbers versus its insignificant effect on the total number of farmers with soybean insurance demonstrates the value of decomposing the participation decision. At an aggregate level, the cost of insurance does not appear to influence overall participation (columns 2 and 3 of Table 4) but it does alter the number of new entrants and the number of producers opting out of the insurance program.

Based on the overall measures of participation, one can conclude that farmer participation in crop insurance exhibits a low responsiveness to changes in the premium rate. However, disaggregating the components of overall participation illustrates that farmers who have not participated in the program during the previous two years are more sensitive to changes in the premium rate than those currently enrolled (Table 5). The elasticity measures indicate that a one percent increase in the price of insurance is associated with a 0.44 percent decline in the number of new entrants to the system, while the number of dropouts increases by only 0.30 percent. One explanation for the different responses between potentially new participants and current participants might be that the latter might have learned more about the benefits of the program upon their enrollment, which further increases their reservation premium. On the other hand, farmers who are new or returning to the system might need a greater price reduction to overcome their skepticism about the benefits of the system. Since the premium has a slightly greater influence on the number of producers insuring their soybean crop than on those deciding to exit, the premium has a positive, albeit insignificant, effect on overall numbers insured.

Soybean price is positively related to the total number of farmers with soybean crop insurance and the number of new entrants into the program, and inversely related to the number exiting the system. The positive effect of crop price increases on participation is consistent with the conceptual model and the findings of Hojjatti and Bockstael (1988). A higher crop price leads to a higher expected indemnity and consequently increases the value that risk-averse farmers derive from the hedging effect of the insurance policy. The positive sign indicates that those benefits are greater than the effect of price in increasing the variance of the indemnity. Therefore, an increase in the price of the crop increases the reservation premium and the participation in the insurance system and decreases the number of farmers that drop out.

The influence of soybean price, as with the insurance premium, is muted at the aggregate level. The elasticity of the total number insured with respect to soybean price is 0.14 compared to -0.62 for those exiting the program and 1.27 for those entering the crop insurance plan (see Table 5). Similar to the effect of premium rates, price is particularly important in the participation decision for those currently not enrolled in crop insurance.

An increase in soybean price was found to lead to a decline in the proportion of soybeans insured. The apparent paradox is due to two confounding effects. As noted above, a higher soybean price increase leads to more farmers insuring their crop. However, it also leads to an increase in the area of soybeans planted that is greater than the increase in the area of soybeans insured. Consequently, soybean price has an inverse effect on the percentage of soybean area insured.

The variance of soybean price has a statistically insignificant effect on crop insurance enrollment

Table 4. Estimated Regression Coefficients Explaining Total Number of Farmers, the Number of New Entrants, and the Number of Exits for Soybean Crop Insurance in Ontario

Explanatory Variable	Total Number Insured	% of Soy Area Insured	Number of Entrants	Number of Exits
Intercept	273.323	0.67	-100.664	466.20
	(1.88)+	(6.92)**	(1.50)	(8.04)
PREMIUM	0.003	0.000004	-0.008	0.005
	(1.15)	(1.21)	(-3.98)**	(3.11)*
PRICE	21.81	-0.0349	28.68	-13.24
	(2.64)**	(-5.47)**	(6.53)**	(-3.30)**
PRICEVAR	-5.08	0.0111	-6.50	-1.51
	(-1.50)	(6.91)**	(5.89)**	(-0.77)
YIELD	6.109	0.0042	1.544	-3.31
	(3.58)**	(2.38)*	(1.24)	(-3.66)**
YIELDVAR	0.319	0.00023	0.308	-0.266
	(1.94)+	(1.48)	(2.83)**	(-3.52)**
CLAIMS	0.141	0.0001	0.095	-0.046
	(3.64)**	(2.55)*	(3.44)**	(-1.73)
SOYPROP	604.337	-0.072	189.897	-326.95
	(5.16)**	(-0.74)	(2.80)**	(-5.15)**
COUNTY DUMMIES				
Perth	-246.486	-0.025	-16.152	-73.21
	(-2.16)*	(-1.12)	(1.14)	(-1.98)*
Haldimand-Norfolk	-431.433	-0.045	-62.053	-37.27
	(-6.02)**	(-1.55)	(3.18)**	(-1.98)+
Middlesex	-38.644	-0.072	-14.157	12.22
	(-0.54)	(-3.29)**	(1.01)	(0.64)
Lambton	92.571	-0.095	-59.124	63.88
	(1.01)	(-3.13)*	(2.91)**	(2.46)*
Elgin	-416.848	-0.084	-69.799	-35.38
	(-5.90)**	(-3.50)**	(4.48)**	(-1.69)+
Kent	706.996	-0.0034	-3.387	168.54
	(8.71)**	(-0.11)	(0.16)	(4.86)**
Essex	124.156	0.09	-76.509	118.61
	(1.52)	(2.64)	(3.36)**	(4.48)**
R-squared	0.88	0.70	0.66	0.55
Durbin-Watson	1.69	1.79	1.69	1.46

Note: t statistics in parentheses. "+" is significant at the 10 percent level, "*" is significant at the 5 percent level, and "**" is significant at the one percent level.

when measured by total farmer participation and the number of dropouts. However, the number of soybean farmers that join the program decreases with the increased uncertainty around soybean price. The negative effect of crop price variability is parallel to the negative effect that profit variance has on crop insurance participation (Hojjatti and Bockstael 1988). Interestingly, the proportion of soybean acreage insured increases when farmers face more uncertain soybean prices. This latter result might indicate that while farmers respond to higher price variability by reducing their total soybean acreage, the number of acres insured does not fall as rapidly or remains the same. The statistically insignificant effect of price variance on overall participation and dropout indicates that

Table 5. Elasticity Measures of Variables Affecting Crop Insurance Participation

Variable	Total Insured	% of Soy Area Insured	Entrants	Exits
PREMIUM	0.025	0.042	-0.445	0.302
PRICE	0.143	-0.33	1.266	-0.628
PRICEVAR	-0.025	0.082	-0.220	-0.055
YIELD	0.232	0.231	0.395	-0.913
YIELDVAR	0.014	0.015	0.096	-0.087
CLAIMS	0.051	0.052	0.230	-0.12
SOYPROP	0.302	-0.052	0.640	-1.184

farmers who have engaged in crop insurance contracts in the past will continue their enrollment. In other words, farmers already enrolled do not reduce their demand for insurance in the face of higher soybean price variance, although they might reduce their total soybean plantings.

Previous yield realizations have a positive effect on insurance participation of soybean farmers in Ontario as measured by both aggregate participation measures. While this result is in direct contradiction to the work by Goodwin (1993), it is consistent with the hypothesized effect discussed earlier in the theoretical model. Equations (9) and (10) outline the conditions under which increasing lagged yields will lead to an increase in the reservation premium. The empirical results for Ontario confirm that the benefits of an increase in the base coverage level through an increase in lagged yield outweigh the costs of the yield increase on the variance. The result highlights that using a moving average of the farmer's actual yield to calculate the coverage yield serves to mute moral hazard and adverse selection problems associated with crop insurance. Farmers are less likely to jump out of the system as their expected coverage level increases. In contrast to farmers not enrolled in the program, the most important variable affecting the decision of farmers with current enrollment is lagged yield. The lack of explanatory power of the regression for new entrants further confirms that this variable impacts the reservation premium via changes in the expected indemnity from insurance.

The variance of yield has a positive and statistically significant impact for the absolute measures of participation, although the effect disappears in the proportion of acres insured. The positive impact of yield variability on crop insurance enrollment is consistent with the theoretical model and with previous empirical results from Cannon and Barnett (1995). However, similar to the case of the premium rate, the impact of yield variance is muted at the aggregate participation measure. Both the coefficients and elasticities for the new entrants and dropouts are very similar in magnitude, but carry opposite signs. This variable also reflects the significance of weather variability in the insurance decision and reveals the potential for crop insurance as an adaptation strategy to climate change.

The number of farmers receiving indemnity payments in the previous period has a positive (negative) effect in the models explaining overall participation and entry (exit). The result suggests that potential new entrants may rely on observations of farmers currently participating in the system to assess the benefits of the insurance program. While the monetary value of claims per acre could have been incorporated, it is excluded from this study due to the high degree of correlation and potential source of multicollinearity that this variable has with the yield variable. Similar to previous studies, however, the indemnity indicator has a positive effect on participation.

The proportion of the total area planted to soybeans has a positive and statistically significant effect on the total number of farmers with crop insurance and the number of new entrants into the system. The inverse effect estimated for farmers exiting the crop insurance program is consistent with previous findings (Barnett, Skees, and Hourigan 1990, Nieuwoudt et al. 1985). An increase in the proportion of total crop area planted to soybeans indicates that the county is less diversified and farmers are more exposed to the risk of the dominant crop (i.e., soybeans). The elasticity measures suggest that this is one of the more important explanatory variables, particularly for those farmers currently enrolled in the program.

The set of dummy variables provide a spatial insight on crop insurance participation. As explained above, the fixed effects model assumes that all the decision units respond equally to the exogenous variables, but that their heterogeneity is captured by letting the intercept vary. Using the total number of insured as the participation measure, the results indicate that farmers located in the southwestern part of the province have a substantially higher degree of participation in the program. For instance, the coefficients for Kent and Essex are positive and statistically significant, suggesting that farmers in these soybean-intensive counties are likely to be heavy users of crop insurance. In contrast, Elgin, Perth, and Haldimand-Norfolk have been characterized by a more diversified agricultural mix, so crop insurance is not required as a risk management strategy to the same extent as in the southwest.

Summary and Conclusion

In this paper we developed and tested a framework to decompose crop insurance participations into entry and exit decisions. While the previous literature has established the factors affecting aggregate purchasing decisions, the role of the same factors in the dynamic components embodied in exit and entry decisions is unexplored. Applying the framework to the case of the Ontario soybean crop insurance plan, we have established the importance of disaggregation to discover how a factor whose effect might not seem to matter when all participating farmers are examined might actually have an impact on some of the farmers, depending on their enrollment status.

The empirical findings are interesting for several reasons. First, it is important to understand that not all farmers react in the same fashion to changes in a particular demand determinant. For instance, it was shown that farmers enrolled in a crop insurance plan are more sensitive than their non-enrolled counterparts to a change in the preceding year's yield. More importantly, the results suggest that the number of farmers canceling their coverage actually declines after increases in the average county yield in the previous crop year. The implications of this finding are particularly relevant to crop insurance providers in that the practice of determining guaranteed yields based on the moving average of the previous years might actually be useful to mitigate the information asymmetry problems inherent in yield insurance contracts. Second, there are variables that have a symmetric effect in the exit-entry component of participation. For instance, the results indicate that although yield variability is significant only at the 10 percent level of significance for the total number of participants, the decomposition shows that both new entrants and dropouts are responsive to variable yields at the one percent level. This symmetric effect on the yield variability suggests that if farmers perceive that yields are more likely to increase their variability, aggregate participation levels are likely to increase due not only to fewer policy cancellations, but also to more farmers purchasing the plan. Finally, given that increasing weather variance will more likely result in more participation, it is important for insurance providers to investigate the effects of this increasing demand in the context of projected climate change. For instance, an increase in participation might mean more financial requirements and greater premium adjustments, along with other changes that might affect the long-term financial viability of the insurance provider.

References

Adesina, A., and B.W. Brorsen. 1987. "A Risk Responsive Acreage Response Function for Millet in Niger." *Agricultural Economics* 1(3): 229–239.

Barnett, B.J., J.R. Skees, and J.D. Hourigan. 1990. "Examining Participation in Federal Crop Insurance." Staff Paper No. 275, Department of Agricultural Economics, University of Kentucky, Lexington, KY.

Cannon, D.L., and B.J. Barnett. 1995. "Modeling Changes in the Federal Multiple Peril Crop Insurance Program between 1982 and 1987." Selected paper presented at the American Agricultural Economics Association Meetings, Indianapolis, IN.

Coble, K.H., T.O. Knight, R.D. Pope, and J.R. Williams. 1996. "Modeling Farm-Level Crop Insurance Demand with Panel Data." *American Journal of Agricultural Economics* 78(2): 439–447.

Gardner, B.L., and R.A. Kramer. 1986. "Experience with Crop Insurance Programs in the United States." In P.B.R. Hazell,

C. Pomareda, and A. Valdes, eds., *Crop Insurance for Agricultural Development: Issues and Experience.* Baltimore, MD: Johns Hopkins University Press.

Garrido, A., M. Bielza, and J.M. Sumpsi. 2002. "The Impact of Crop Insurance Subsidies on Land Allocation and Production in Spain." Report No. AGR/CA/APM 16, Organization for Economic Cooperation and Development.

Goodwin, B.K. 1993. "An Empirical Analysis of the Demand for Multiple Peril Crop Insurance." *American Journal of Agricultural. Economics* 75(2): 425–434.

Goodwin, B.K., and V.H. Smith. 1995. *The Economics of Crop Insurance and Disaster Aid.* Washington, D.C.: The AEI Press.

Hojjatti, B., and N.E. Bockstael. 1988. "Modeling the Demand for Crop Insurance." In H. Mapp, ed., *Multiple Peril Crop Insurance: A Collection of Empirical Studies*. Southern Cooperative Series Bulletin No. 334.

Jose, H.D., and R.S.K. Valluru. 1997. "Insights from the Crop Insurance Reform Act of 1994." *Agribusiness* 13(6): 587–598.

Mishra, A.K., and H.S. El-Osta. 2002. "Managing Risk in Agriculture Through Hedging and Crop Insurance: What Does a National Survey Reveal?" *Agricultural Finance Review* 62(2): 135–148.

Nieuwoudt, W.L., S.R. Johnson, A.W. Womack, and J.B. Bullock. 1985. "The Demand for Crop Insurance." Agricultural Economics Report No. 1985-16, Department of Agricultural Economics, University of Missouri-Columbia.

Sarno, L., and M. Taylor. 1998. "Real Exchange Rates under the Current Float: Unequivocal Evidence of Mean Reversion." *Economics Letters* 60(2): 131–137.

Sherrick, B.J. 2003. "Farmers' Preferences for Crop Insurance Attributes." *Review of Agricultural Economics* 25(2): 415–429.

Sherrick, B.J., P.J. Barry, P.N. Ellinger, and G.D. Schnitkey. 2004. "Factors Influencing Farmers' Crop Insurance Decisions." *American Journal of Agricultural Economics* 86(1): 103–114.