Farm Support Payments and Risk Balancing: Implications for Financial Riskiness of Canadian Farms

Nicoleta Uzea,[1,*] Kenneth Poon,[2,*] David Sparling[3] and Alfons Weersink[4]

[1]*Post-Doctoral Research Associate, Ivey Business School, Western University, 1255 Western Road, London Ontario N6G 0N1, Canada (corresponding author: phone: 519-661-2111, ext. 89142; fax: 519-661-3959; e-mail: nuzea@ivey.ca).*
[2]*Research Associate, Department of Food, Agricultural and Resource Economics, University of Guelph, J.D. MacLachlan Building, Guelph, Ontario N1G 2W1, Canada (phone: 519-824-4120, ext. 53855; e-mail: poonk@uoguelph.ca).*
[3]*Professor and Chair of Agri-Food Innovation, Ivey Business School, Western University, 1255 Western Road, London, Ontario N6G 0N1, Canada (phone: 519-661-3456; e-mail: dsparling@ivey.ca).*
[4]*Professor, Department of Food, Agricultural and Resource Economics, University of Guelph, J.D. MacLachlan Building, Guelph, Ontario N1G 2W1, Canada (phone: 519-824-4120, ext. 52766; e-mail: aweersin@uoguelph.ca).*

Risk balancing refers to the balancing of business risk (BR) and financial risk (FR) by firms through their investment and borrowing decisions. Assuming the concept holds, a decrease in income variability (BR) prompts the firm to incur greater debt levels thereby increasing FR. Reducing (BR), which continues to be the central objective of Canadian agricultural policy through programs such as Canadian Agricultural Income Stabilization Program (CAIS)/AgriStability, may lead farmers to take on more FR than they would take otherwise, which, in turn, increases the risk of equity loss. However, it is not known whether Canadian business risk management (BRM) programs offset BR as intended, and whether any potential reduction leads to increased FR (risk balancing) and possibly higher levels of overall risk for individual farm operations. This paper represents the first attempt to shed light on whether Canadian BRM programs fail to reduce farm risk as a result of farmers' risk balancing behavior using a longitudinal farm-level data set from Ontario. Results are mixed: (1) BRM payments reduce BR for beef farms but not for field crops farms (though the latter result may be due to the lack of data on Crop Insurance payments); (2) risk balancing holds particularly for the larger farms, and (3) BRM programs overall have no significant effect on the likelihood of increased debt use for either sector, on average; however, participation in CAIS/AgriStability increases the probability that farms take on more debt than they would take otherwise for both sectors. Further analysis is needed to determine whether BRM programs increase the probability of default for farms.

L'équilibre des risques fait référence à l'équilibre des risques de l'entreprise et des risques financiers que visent les entreprises dans leurs décisions d'investissement et d'emprunt. À supposer que le concept soit valable, une diminution de la variabilité du revenu (risque de l'entreprise) inciterait l'entreprise à hausser son niveau d'endettement, ce qui ferait augmenter le risque financier. La diminution des risques de l'entreprise, qui constitue le principal objectif de la politique agricole canadienne et de divers programmes, tels que le Programme canadien de stabilisation du revenu agricole (PCSRA) et

[*]Senior authorship is shared by the first two authors.

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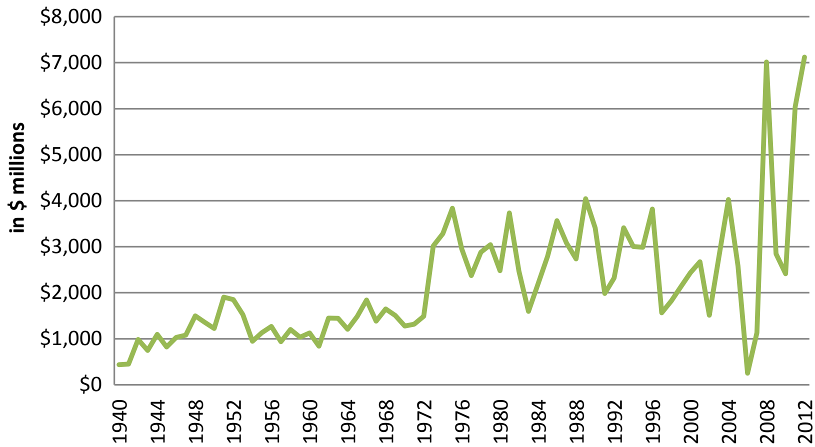
le programme Agri-stabilité, pourrait amener les agriculteurs à courir davantage de risques financiers ce qui, par conséquent, augmenterait le risque de perte de capitaux propres. Toutefois, on ne sait pas si les programmes canadiens de gestion des risques de l'entreprise (GRE) contrebalancent ou non comme prévu les risques de l'entreprise ni si une diminution potentielle des risques de l'entreprise entraîne ou non une hausse du risque financier (équilibre des risques) et possiblement une hausse des niveaux de risques dans le cas des exploitations agricoles individuelles. Le présent article se veut une première tentative visant à déterminer, à l'aide d'un ensemble de données longitudinales provenant directement de fermes ontariennes, si les programmes canadiens de GRE font croître les risques de l'exploitation compte tenu du comportement des agriculteurs vis-à-vis l'équilibre des risques. Les résultats varient : 1. les paiements accordés dans le cadre d'un programme de GRE diminuent les risques de l'entreprise dans le cas des exploitations bovines mais non dans le cas des exploitations de grandes cultures (bien que le dernier constat puisse être attribuable à un manque de données sur les paiements d'assurance-récolte); 2. l'équilibre des risques vaut particulièrement pour les grandes exploitations; 3. dans l'ensemble, les programmes de GRE n'ont pas d'effets marqués sur la probabilité d'utiliser l'accroissement de la dette peu importe le secteur; en revanche, la participation au PCSRA ou au programme Agri-stabilité accroît la probabilité que les exploitations des deux secteurs précités s'endettent davantage. Des analyses supplémentaires sont nécessaires afin de déterminer si les programmes de GRE augmentent ou non la probabilité de non-remboursement des exploitations agricoles.

INTRODUCTION

Business risk management (BRM) continues to be the central objective of Canadian agricultural policy, and this was reinforced with the recent introduction of the Growing Forward II policy framework (Agriculture and Agri-Food Canada 2012b; Seguin 2012). Risk management plays a fundamental role in the financial health of farm operations and the overall sector given the degree of inherent variability in price and production. Farm income, while higher, on average, than before the commodity price boom that began in 2006, is also significantly more volatile (see Figure 1—note that these numbers include government payments). For example, corn prices doubled from around \$2 per bushel in the fall of 2006 to about \$4 per bushel in 2007 and reached a high of nearly \$8 per bushel in the summer of 2012 but have since fallen back to \$4 per bushel. The drought that resulted in the record high nominal prices in 2012 also highlighted the growing concern that climate change may increase the variability in production.

The potential growing volatility in farm income associated with variations in price and production suggests a growing importance for government programs that assist farmers in coping with these gyrations in order to strengthen the viability of farm businesses and provide an environment that supports investment in the farming sector. There is extensive empirical evidence that supports the general perception that uncertainty curtails investment using both aggregate data (e.g., Fernández-Villaverde et al 2011) and industry or firm-level data (e.g., Bloom et al 2007; Baum et al 2010).[1]

[1] Uncertainty may spur investment too—for example, when investment is characterized by long lags (as in Bar-Ilan and Strange 1996).



Source: Statistics Canada, CANSIM Table 002–0009: Net farm income.

Figure 1. Net farm income—aggregate across all Canadian farms, 1940–2012

However, policy makers need to also consider any unintended side effects of government programs that may cause the programs to fail at achieving their objectives (Wolf 1979). Indeed, a growing number of studies show that the risk-reducing effect of BRM programs generates responses in farmers' risk management strategies that often crowd out or offset the effects of the government provided financial aid, leading to an increase (rather than a decrease) in farm risk. For instance, Turvey (2012) finds that the Canadian Agricultural Income Stabilization Program (CAIS) and its successor, AgriStability and AgriInvest, create incentives for farmers to specialize in riskier crops that generate higher returns—that is, the risk-reducing effect of these programs allows farmers to take on more risk in their crop diversification strategies. Kimura and Antón (2011) find that CAIS/AgriStability also reduces farmers' incentives to use crop insurance, as it already provides coverage for the same layers of income risk. Studies from other countries show that the reduction in risk associated with government payments may weaken farmers' incentives to hedge price through forward contracting (e.g., Coble et al 2000; Antón and Kimura 2009) and may induce risk-averse producers to use higher levels of risk-increasing inputs (e.g., Hennessy 1998; Serra et al 2005).

Another avenue through which government programs may lead to unintended consequences on farmers' risk management behavior and thus fail to reduce farm risk is through risk balancing. The risk balancing hypothesis contends that exogenous shocks that affect a farm's level of business risk (BR) may induce the farm to make offsetting adjustments in its financial leverage position, leading to increased (or decreased) financial risk (FR) in response to a fall (or rise) in BR (Gabriel and Baker 1980; Collins 1985). Using this framework, Featherstone et al (1988) and, more recently, Cheng and Gloy (2008), showed theoretically that farm policies designed to reduce BR can, through risk balancing, lead to increased financial leverage and probability of farm financial failure. This so-called paradox of risk balancing has been used as a theoretical argument about the futility of risk-reducing agricultural policies (Skees 1999). It is not known whether Canadian BRM programs offset BR, and if so, whether this reduction in BR leads to increased FR and possibly higher levels of overall risk for individual farm operations.

This paper aims to shed light on whether Canadian BRM programs fail to reduce farm risk as a result of farmers' risk balancing behavior. Specifically, the paper empirically measures the effectiveness of Canadian BRM programs in reducing BR, the extent of risk balancing behavior, and the impact of BRM programs on the decision to take on more debt by utilizing a longitudinal farm data set from Ontario. If BRM programs do reduce BR and farmers do balance BR and FR, BRM programs can be argued to crowd out farmers' FR management strategies and make farms financially riskier. The paper begins with a conceptual framework presenting the risk balancing hypothesis and how farmers may manage risk by trading BR with FR. The next sections describe the empirical model and data used to examine the effectiveness of BRM programs, the extent of risk balancing behavior, and the impact of BRM programs on the decision to take on more debt. The section following features a discussion of the empirical results. Finally, the paper concludes with a discussion of the key findings and future work.

CONCEPTUAL FRAMEWORK

The sources of total risk facing a business are universally equated to the sum of BR (operating) and FR (e.g., Collins 1985; Robison and Barry 1987; Featherstone et al 1988; Harwood et al 1999). BR is defined as the inherent variability in the operating performance of the firm, independent of the way the firm chooses to finance its operations. Its level is influenced by external factors, such as price variability for outputs and inputs, uncertain availability and quality of inputs, and yield variability, as well as by internal factors, such as investment decisions and management skills. FR is defined as the added variability of net returns to the owners of equity that results from the use of debt.

In order to maintain a maximum tolerable level of total risk as given by the decision-maker's level of risk aversion, the risk balancing hypothesis says any exogenous shocks that affect a firm's level of BR could induce the firm to make offsetting adjustments in its financial leverage position. That is, any increase in BR could be offset by a decrease in leverage. Conversely, upward adjustments in optimal leverage levels could be warranted whenever the level of BR decreases.

Two approaches have been used to derive the risk balancing hypothesis. One approach is represented by the seminal work of Gabriel and Baker (1980). The authors developed a conceptual framework that linked production, investment, and financing decisions via a risk constraint. In their model, the decision maker maximizes net returns subject to the constraint that total risk does not exceed the maximum tolerable level. Total risk is decomposed into the following additive relationship between BR and FR

$$TR = \frac{\sigma_{NOI}}{(E[NOI] - I)} = \frac{\sigma_{NOI}}{E[NOI]}\frac{E[NOI]}{(E[NOI] - I)} = \frac{\sigma_{NOI}}{E[NOI]} + \frac{\sigma_{NOI} I}{E[NOI](E[NOI] - I)} \tag{1}$$

where TR is the total amount of risk, $E[NOI]$ is the expected net operating income without debt financing, σ_{NOI} is the standard deviation of net operating income without debt financing, and I is fixed interest payments. BR, which is the first term in the right-hand side of Equation (1), is defined in terms of the variability of net operating income. BR increases with the variance in income and decreases with expected income. FR, the second term in the right-hand side of Equation (1), is equal to the degree of BR inherent in the firm $\sigma_{NOI}/E[NOI]$ and the relation $I/(E[NOI] - I)$ that is determined by the financing decision. That is, FR is defined to be the added variability of net operating income of the owner's equity that results from the financial obligation associated with debt financing. Increases in interest payments thus increase FR.

Total risk (TR) is assumed to be constrained to a maximum tolerable level set at β

$$\frac{\sigma_{NOI}}{E[NOI]} + \frac{\sigma_{NOI} I}{E[NOI](E[NOI] - I)} \leq \beta \tag{2}$$

If there is an exogenously induced decline in BR (e.g., a change in agricultural policy that reduces σ_{NOI} or raises $E[NOI]$), FR will also subsequently fall due to its own BR component. As a result, total risk declines leaving slack in the risk constraint defined in Equation (2). This would allow debt use and, consequently, FR, to increase. Alternatively, the firm may choose to undertake riskier and more profitable production or investment activities, increasing BR.

The other approach to representing the risk balancing hypothesis is through a structural model of the overall debt-equity decision by farm operators (e.g., Collins 1985; Featherstone et al 1988). This model assumes that the decision-maker chooses the debt level that maximizes the expected utility of wealth (net equity), given his level of risk aversion. The result is an optimizing behavior that balances increased expected return to equity against the additional risk inherent with leverage.[2] Specifically, the optimization problem is given by

$$\max_{\delta} EU[ROE] = E[ROE] - \frac{\alpha}{2}\sigma^2_{ROE} \tag{3}$$

where ROE is the rate of return on equity, $EU[ROE]$ is the expected utility of ROE, $E[ROE]$ is the mean ROE, σ^2_{ROE} is the variance of ROE, and α is the risk aversion parameter. ROE is assumed to be a function of the rate of return on assets (ROA), debt to assets ratio (δ), and fixed interest rate of debt (i)—that is

$$ROE = ROA(1+\delta) - i\delta \tag{4}$$

[2] This basic formulation has been extended and refined by Ramirez et al (1997) using stochastic optimal control rather than a single period model, but the basic structural implications of the model remain unchanged.

Substituting the mean and variance of *ROE* in Equation (3), the optimization problem becomes

$$\max_{\delta} EU[ROE] = (E[ROA] - i\delta)(1-\delta)^{-1} - \frac{\alpha}{2}\sigma_{ROA}^2(1-\delta)^{-2} \tag{5}$$

The variance of the return on equity, $\sigma_{ROE}^2 = \sigma_{ROA}^2(1-\delta)^{-2}$, represents the total risk facing the firm. It is broken down into two marginal effects. First, BR is captured through the variability in the return on assets. Second, because the variance of the return on equity is an increasing function of leverage, FR is also captured as the incremental increase in the variability of equity returns due to increases in debt relative to assets. Solving Equation (5) for the optimum debt to asset ratio yields

$$\delta^* = 1 - \frac{\alpha\sigma_{ROA}^2}{E[ROA] - i} \tag{6}$$

That is, the optimum level of FR (δ) depends on the expected net rate of return on equity, interest rate, and degree of risk aversion, as well as on BR (σ_{ROA}^2). Specifically, the optimal debt to assets ratio is inversely related to BR as long as the interest rate of debt does not exceed the rate of return on assets from operations and capital gains—that is

$$\frac{\partial\delta^*}{\partial\sigma_{ROA}^2} = -\frac{\alpha}{E[ROA] - i} < 0 \tag{7}$$

which is consistent with the trade-off derived by Gabriel and Baker (1980)—a decline in BR would produce an increase in desired FR, everything else held constant, for a risk-averse expected utility maximizer. Collins (1985) and Featherstone et al (1988) also show formally that agricultural policies that increase income, as well as reducing risk, would induce an increase in the debt to asset ratio, which, in turn, increases FR.

By differentiating Equation (6) with respect to the expected return on assets, interest rate, and risk aversion parameter, it is clear that *ceteris paribus* an increase in the expected return on assets will trigger an increase in the use of debt, an increase in the cost of debt will cause a reduction in financial leverage, and more risk-averse individuals will use less debt than less risk-averse individuals

$$\frac{\partial\delta^*}{\partial E[ROA]} = \frac{\alpha\sigma_{ROA}^2}{(E[ROA] - i)^2} > 0 \tag{8}$$

$$\frac{\partial\delta^*}{\partial i} = -\frac{\alpha\sigma_{ROA}^2}{(E[ROA] - i)^2} < 0 \tag{9}$$

$$\frac{\partial\delta^*}{\partial\alpha} = -\frac{\sigma_{ROA}^2}{E[ROA] - i} < 0 \tag{10}$$

The concepts of BR, FR, and risk balancing have also been applied in a portfolio theory framework to evaluate the possible responses in financial structure to changes in a firm's operating environment (e.g., Barry and Robison 1987). In portfolio theory, financial activities are considered through the introduction of a risk-free asset that can be combined with portfolios of risky assets. Positive and negative holdings of the risk-free asset represent borrowing and lending, respectively, at the risk-free interest rate.[3] BR arises from the variability of returns to the investor's risky assets and is independent of the financial structure of the investor's portfolio. FR arises from the composition and terms of the financial claims on the assets (e.g., borrowing or leasing is a form of financial leveraging and adds to the investor's FR). Again, BR and FR combine to determine total risk.

In equilibrium, the investor chooses the portfolio of risky assets that, in combination with the risk-free asset, yields the highest possible return per unit of risk. Risk balancing comes into play when any change in the expected return and standard deviation of risky assets, as well as the risk-free cost of borrowing, makes the original portfolio nonoptimal and portfolio adjustments (offsetting responses in BR and FR) are needed to restore equilibrium.

In summary, the risk balancing hypothesis assumes an inverse relationship between BR and FR. This relationship forms the basis for the empirical analysis that follows. But before proceeding with the analysis, it is worth emphasizing that the risk balancing hypothesis may not always hold (Appendix A lists the main empirical studies of the risk balancing hypothesis and their results). As Gabriel and Baker (1980) acknowledge, upward adjustments in debt use are only one way in which a firm could respond to an exogenously induced decline in BR. The other strategies could be to undertake production activities, investment activities, or a combination of the two that bring BR back to the original level. In a similar vein, a firm could respond to an exogenously induced rise in BR with a strictly financial decision—refinancing some of the existing debt with either a debt with longer maturity or with equity capital. Alternatively, a reorganization of production activities toward less risky, lower return activities could take place, lowering BR.

Also, Collins (1985) shows that a decline in BR may well cause farm owners to reduce financial leverage if accompanied by an increase in interest rate and/or a decrease in the expected rate of return to assets from operations and capital gains. In a similar vein, a rise in BR may lead rational decision makers to increase financial leverage if accompanied by a fall in interest rate and/or an increase in the expected rate of return to assets.

EMPIRICAL MODEL

The paper uses a three-stage approach to examine the impact of BRM programs on farmers' FR management strategies. The first stage consists of assessing the effectiveness of BRM programs (see Appendix B for a list of the main farm support programs triggered by Ontario farmers over the study period) in altering BR across sectors and time. The second stage examines the extent of risk balancing behavior by comparing BR and FR for individual operations. The third stage estimates the determinants of the likelihood of increasing debt use with a focus on the impact of BR (i.e., test for risk balancing) and participation in CAIS/AgriStability.

[3] The impacts of risky financing activities have also been considered (e.g., Fama 1976; Elton et al 2009).

Effectiveness of BRM Programs

The risk balancing literature suggests that BRM programs may, through risk balancing, lead farmers to take on more FR than they would take otherwise, which, in turn, increases the risk of equity loss. However, two conditions are necessary for this result to hold: (1) BRM payments are effective at reducing BR and (2) farmers exhibit risk balancing behavior (taking on more FR when BR decreases as a result of BRM payments is just one strategy a farmer can use to respond; alternatively, the farmer could undertake activities that increase BR, such as plant riskier crops or use more risk-increasing inputs).

In order to see whether BRM payments reduce BR, we compare the distributions of BR with and without program payments. BRM programs are considered to be effective to the extent that they reduce the average across farms of individual farm BR. We initially define BR as the ratio of the standard deviation to average income (see Equation 1) with specific definitions provided in the next section. However, the use of standard deviation as a measure of risk is based on the assumption of normal distribution (and symmetry)—variability is equal regarding what happens above the mean (gain) and below the mean (loss). Time-series farm income distributions tend to be asymmetric with fat tails—that is, more of the variability is the result of infrequent extreme deviations as opposed to frequent modestly sized deviations—and the interesting part of the distribution from a risk perspective is the left tail (losses). Thus, we use the left-side semikurtosis, which measures the thickness of the left tail (i.e., the frequency of catastrophic losses), as a measure of BR (i.e., downside risk).[4] The use of downside risk is also more in line with how programs work—for example, CAIS/AgriStability provides coverage for *large declines* in farm income (caused by circumstances such as low commodity prices and rising input costs) and the various ad hoc programs help producers return their farm businesses to operation following *disaster situations*. For comparative purposes, we also report the results based on the use of the standard deviation divided by the mean of the farm's net income.

Extent of Risk Balancing

In order to measure the extent of risk balancing behavior, we look at how individual decision makers respond to changes in BR. To do this, we derive correlation coefficient measures of risk balancing for each farm in the data set over the study period. Pearson's correlations are calculated over parings between a one-year lagged BR and the current period's FR.[5] We consider a one-year lag of BR to account for the fact that farm financial structure decisions made in the current year could be based on the previous year's BR level (the implicit assumption here is that historical experiences of business fluctuations are used as basis for forming expectations of future BR trends). Since risk balancing involves an inverse relationship between BR and FR, the extent of risk balancing is given

[4] Markowitz (1959) suggested using the left-side semivariance as a measure of risk when distributions are asymmetric. However, the left-side semikurtosis offers advantages over the left-side semivariance, as it places more emphasis on the fatness of the left tail (Desmoulins-Lebeault 2013). The left-side semivariance is concerned with observations (losses) close to the mean—frequent yet small losses are overweighed.

[5] Correlation coefficient is calculated over five BR-FR pairs with the first pair being BR in 2006 and FR in 2007.

by the share of farms with negative correlation coefficients.[6] The statistical significance of the coefficients is less relevant, given the short time series of the data.

Impact of BRM Programs on the Likelihood of Increased Debt Use

We examine the impact of BRM programs overall (through their impact on BR)[7] and participation in CAIS/AgriStability, in particular, on the probability of increased debt use by estimating logit panel models such as:

$$\Pr(Y_{it} = 1 \mid X_{it}, u_i) = G(\beta X_{it} + u_i)$$

with

$$Y_{it} = \beta X_{it} + u_i + e_{it}$$

where

Y_{it} = binary dependent variable that takes the value of 1 when interest expenses increase from previous year and 0 otherwise;

X_{it} = vector of covariates including BR in previous year, participation in CAIS/AgriStability in current year, CAIS/AgriStability payment triggered in previous year, enterprise diversification in current year, interest expenses in previous year, operating profit margin, operating expense ratio, farm size, change in borrowing cost, and change in farmland value;

u_i = individual-specific error component (assumed to not vary over time);

e_{it} = idiosyncratic error component (unique to each individual-year observation);

$G(\cdot)$ = logistic cumulative distribution function.

We focus on CAIS/AgriStability because a farmer needs to actively participate in this program in order for payments to trigger;[8] other BRM programs are mainly ad hoc, requiring no action from the farmer for payment to trigger. Also, while decreasing in recent years, CAIS/AgriStability payments represent the largest share of BRM payments over the 2003–11 period (Agriculture and Agri-Food Canada 2012a).

We use previous years' BR in order to ensure that risk is exogenous to the decision to take on more debt. While we are interested in the effect of risk on borrowing and investment decisions, a causal relationship operating in the opposite direction is likely also present. For example, the decision to increase leverage to undertake a risky investment may introduce heightened uncertainty over future returns. Past uncertainty, while it tends to predict current uncertainty, cannot be influenced by current borrowing and investment decisions.

We estimate both fixed effects and random effects logit models. The fixed effects model allows for correlation between the unobservable individual-specific component u_i

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6 Escalante and Barry (2003) and De Mey et al (2013) also used the share of negative BR-FR correlations to measure the extent of risk balancing behavior.

7 Other recent studies that used regression analysis to test for risk balancing include Turvey and Kong (2009) and De Mey et al (2013). The other approach used to test for risk balancing is represented by risk programming models (e.g., Escalante and Barry 2001; Cheng and Gloy 2008).

8 AgriInvest is another such program, though most farmers participate in it.

and the observed explanatory variables X_{it}. However, because the fixed effects estimator relies only on the time-series variation in Y (and Xs) within a given farm, farms that exhibit no variation in the risk balancing dependent variable are dropped from the estimation sample—hence, information is lost. The random effects model allows us to retain the full sample. However, it makes the potentially restrictive assumption that u_i and X_{it} are uncorrelated. Why would we expect correlation between the unobservable individual-specific characteristics and one or more regressors? If we let u_i stand for farmer's attitude toward risk, then u_i is very likely to be correlated with both diversification and interest expenses, for attitude toward risk often determines the degree of diversification (diversify more if risk-averse) and the degree of indebtedness (take on less debt if risk-averse).

DATA

Data Source

The analysis uses data from the Ontario Farm Income Database (OFID), which is a longitudinal farm-level data set compiled from Ontario farm tax-file records. The data set is used to calculate CAIS/AgriStability payments, but includes all Ontario tax-filing farm operations every year from 2003 to 2011[9] (data on other BRM payments are also available for these farms). Having access to data on both participants and nonparticipants in CAIS/AgriStability and other BRM programs allowed us to clearly ascertain the impact of government programs on farmers' risk management behavior by using the nonparticipants as the control group. As Coase (1964) argued, the most effective approach to be used in ascertaining the effects of a government policy is to compare a group that is affected by the policy with a group not subject to the policy.

Two subsets—that is, of field crops and beef farms, based on share of revenues in six out of the nine years—are drawn from this data set and analyzed separately to account for the different business environments the two sectors experienced over the 2003–11 period—that is, deteriorating for beef and favorable for crops; see Weersink et al (2012, 2013) for an analysis of the financial performance of the field crop and beef sectors, respectively, over that period. These sectors also represent the two largest groups in the OFID data—there are 6,216 field crops and 2,801 beef farms in the panel of 13,540 farms used for analysis (i.e., 46% and 21% of the total, respectively).

Variable Definition

Risk measures

Gabriel and Baker's (1980) approach to defining FR and BR is used due to the lack of balance sheet information. We measure FR as the ratio of interest expense to total operating revenue (since no balance sheet information is available, we use total operating revenue to account for changes in farm size over time[10]). BR is initially measured as

[9] Data prior to 2003 were not available. While the time series of this data set is relatively short, especially for the correlation analysis, an advantage of focusing the analysis on the time period from 2003 onward is the consistency of BRM programs under the Agricultural Policy Framework (2003–07) and Growing Forward (2008–12).

[10] This allows one to compare between the different levels of FR a farm experienced in different years.

standard deviation divided by the mean of the farm's net operating income over a four-year period. As mentioned in the previous section, the use of standard deviation as a measure of risk is based on the assumption of normal distribution. Normality of the net income variable cannot be rejected for 90% of field crops farms and 89% of beef farms in our data set. However, we lack confidence in these tests due to the short time series of the data (i.e., nine years). Moreover, we find that normality is rejected for the time series of aggregate net farm income for all Canadian farms from 1926 to 2012—the distribution is asymmetric with fat tails. Since the interesting part of the distribution from a risk perspective is the left tail, we use the left-side semikurtosis as a measure of risk (i.e., downside risk). The summary statistics for these BR and FR measures are reported in Table 1 together with those for the explanatory variables below (all monetary values were adjusted to real 2003 dollars using the consumer price index).

Explanatory variables

To capture the effect of expected CAIS/AgriStability payments, two dummy variables were constructed: a dummy variable to account for the fact that a *farm participates in CAIS/AgriStability in the current year*, and a dummy variable to account for the fact that a *farm triggered a CAIS/AgriStability payment in the previous year*. Information on receipt of payment in previous years is captured in the BR measure, since payments from all programs (except for Crop Insurance[11]) are included in the semikurtosis calculation. If farms are indeed risk balancing, we expect both participation and payment trigger to be positively correlated with an increase in interest expense, since payments both raise farm income and reduce downside risk.

Enterprise diversification represents revenue allocations among various operations (e.g., field crops, beef, dairy, swine, etc.) and is calculated based on the concept of a Herfindahl index,[12] with lower index values indicating greater levels of diversification. Enterprise diversification is a risk management strategy and we expect an increase in diversification to be positively correlated with the ability and likelihood of taking on more debt.

Operating profit margin, calculated by dividing the farm's net operating income (before interest and taxes) by total operating revenue, is used as a measure of profitability. We use an average margin over the previous four years in our analysis (to account for the fact that some years are better than others), and expect an increase in average profitability over the previous four years to increase the likelihood of more debt taken on in the following year.

Operating expense ratio, calculated as total operating expense divided by total operating revenue, is used as a measure of operating efficiency. We also use the average ratio over the previous four years and expect a decrease in average efficiency over the previous four years to increase the likelihood of more debt taken on in the following year.

Interest expense in the previous year is a proxy measure for the amount of debt a farm has. We would expect farms with high historic debt level to be less likely to take on more debt.

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[11]Data on Crop Insurance payments were not available for this analysis.

[12]Herfindahl index, $H = \sum_{i=1}^{n}(share_i^2)$.

Table 1. Summary statistics (average and standard deviation), by sector and size category, 2006–11

Variable	Statistic	<$10,000	$10,000–99,999	$100,000–249,999	$250,000–499,999	$500,000+
Field crops						
Number of farms		112	3,509	1,570	615	410
Business risk	Avg	2.30	2.33	2.31	2.34	2.33
w/o prog pay	Std dev	0.61	0.60	0.60	0.60	0.59
Business risk	Avg	2.33	2.33	2.31	2.32	2.32
with prog pay	Std dev	0.60	0.60	0.60	0.60	0.60
Financial risk	Avg	0.25	0.11	0.08	0.07	0.06
	Std dev	1.14	0.57	0.12	0.12	0.14
Number of farms that take	Avg	38.00	1,102.40	574.20	233.00	153.00
on more debt	Std dev	8.66	203.89	130.14	60.81	57.28
Number of farms that participate	Avg	65.40	2,638.60	1,275.00	503.60	322.60
in CAIS/AgriStability	Std dev	31.26	371.52	81.30	28.75	54.02
Number of farms that trigger	Avg	17.17	434.67	157.33	50.67	29.50
CAIS/AgriStability payments	Std dev	15.17	369.95	163.80	54.53	28.40
Enterprise diversification	Avg	0.95	0.93	0.90	0.89	0.88
	Std dev	0.14	0.16	0.17	0.17	0.19
Operating profit margin	Avg	−0.78	−0.18	0.05	0.12	0.09
	Std dev	3.97	1.78	0.67	1.06	0.44
Operating expense ratio	Avg	0.61	0.54	0.49	0.48	0.46
	Std dev	1.64	0.84	0.29	0.36	0.22
Interest expenses, $	Avg	$1,359	$3,890	$11,245	$21,749	$50,618
	Std dev	$3,276	$6,985	$13,444	$21,928	$59,265

(*Continued*)

Table 1. Continued

Variable	Statistic	<$10,000	$10,000–99,999	$100,000–249,999	$250,000–499,999	$500,000+
Beef						
Number of farms		159	1,716	460	256	210
Business risk	Avg	2.35	2.35	2.35	2.36	2.36
w/o prog pay	Std dev	0.60	0.60	0.60	0.60	0.60
Business risk	Avg	2.34	2.33	2.36	2.35	2.31
with prog pay	Std dev	0.60	0.60	0.60	0.60	0.60
Financial risk	Avg	0.22	0.12	0.06	0.04	0.03
	Std dev	0.63	0.35	0.11	0.07	0.14
Number of farms that take on	Avg	42.40	536.20	172.00	98.20	88.60
more debt	Std dev	14.45	119.37	50.30	38.47	46.35
Number of farms that participate in	Avg	99.40	1,299.20	385.60	237.40	190.60
CAIS/AgriStability	Std dev	9.45	156.44	19.98	11.24	6.35
Number of farms that trigger	Avg	38.83	475.33	126.17	79.17	54.83
CAIS/AgriStability payments	Std dev	16.88	278.89	86.66	52.15	34.87
Enterprise diversification	Avg	0.91	0.83	0.78	0.77	0.83
	Std dev	0.17	0.20	0.20	0.20	0.19
Operating profit margin	Avg	−1.80	−0.58	−0.09	−0.07	0.00
	Std dev	3.91	1.94	0.48	1.39	0.32
Operating expense ratio	Avg	0.98	0.73	0.77	0.80	0.82
	Std dev	1.35	0.88	0.36	0.33	0.24
Interest expenses, $	Avg	$1,166	$ 3,101	$7,385	$13,305	$43,319
	Std dev	$2,071	$ 5,554	$9,677	$15,281	$91,042

Change in farmland value is included to account for the impact of expected capital gains (land being the most important asset for the two sectors under study) on the decision to take on more debt. Since no specific information on land value appreciation rate for each individual farm is available, the average appreciation rate for Ontario, as provided by Farm Credit Canada, is used to account for differences in land value between years.[13]

Changes in borrowing rates are calculated as the percentage change in the assumed average borrowing rate[14]—annual average prime rate plus 1%—since no specific information on the borrowing rate for each individual farm is available. Percentage change in borrowing rate is used as a proxy for differences in borrowing cost between years. It is expected as borrowing cost increases, the likelihood of taking on more debt decreases, *ceteris paribus*.

As there may be large-scale effects in the use of debt, we include *size* category dummies. Size classes are defined in terms of average total operating revenue over the study period. Farms are sorted into five size classes as follows: (1) farms with less than $10,000 in sales; (2) farms with sales of $10,000–$99,999; (3) farms with sales of $100,000–$249,999; (4) farms with sales of $250,000–$499,999, and (5) farms with more than $500,000 in sales. Larger farms are expected to be more likely to take on more debt, as they are generally in a better position to do so. Farms with sales of $10,000–$99,999 are used as the reference category, as they represent the largest group.

RESULTS

Effectiveness of BRM Programs

Figure 2 (panels a–d) illustrates the average across farms for BR with and without program payments. The results for each sector are presented by year and size category. Also, both measures of BR are reported for comparative purposes.

As expected, the standard deviation measure of BR, which focuses on the observations close to the mean (i.e., frequent small gains and losses), is significantly smaller than the left-side semikurtosis measure, which places more emphasis on the infrequent yet extreme losses. Specifically, the former measure ranges between 0.10 and 0.55[15] (field crops farms generally exhibit higher variability of income than beef farms and smaller farms face higher net income variability than larger farms in both sectors), while the latter measure is fairly constant across farm sectors and sizes—that is, between 2.3 and 2.4 (i.e., farms of different sizes operating in different sectors are characterized by similar downside risk or frequency of extremely large losses).

For both sectors, BRM payments are effective at smoothing net income for all farm size categories, especially the smaller farms. Also, payments reduce downside risk most of the time for all farm size categories in the beef sector. However, for crop farmers, no clear pattern can be seen for any of the classes, except for the smallest class for which payments

[13]Average land value appreciation rates were: 5.9% in 2006, 3.9% in 2007, 6.5% in 2008, 6.1% in 2009, 6.7% in 2010, and 13.8% in 2011.

[14]Average borrowing rates were: 6.81% in 2006, 7.10% in 2007, 5.73% in 2008, 3.40% in 2009, 3.60% in 2010, and 4.00% in 2011.

[15]These values are similar to those found by Escalante and Barry (2003) for U.S. Illinois grain farms and, more recently, by De Mey et al (2013) for farms of different types in various EU-15 countries (both studies measured BR as the standard deviation divided by average of net income).

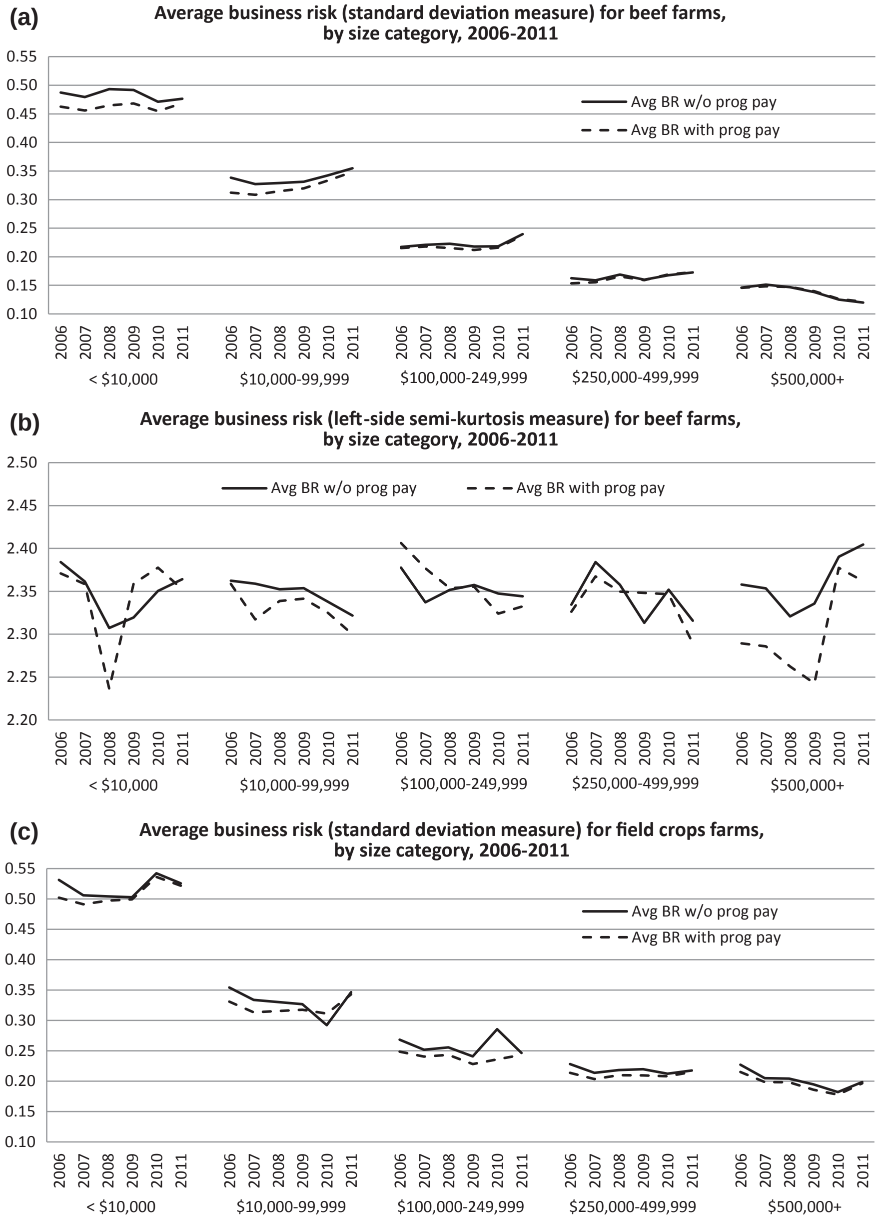

Figure 2. Impact of program payments on BR, by sector and size category, 2006–11
Notes: Panel a: Average across farms of individual farm BR (standard deviation measure)—Beef; panel b: average across farms of individual farm BR (left-side semikurtosis measure)—Beef; panel c: average across farms of individual farm BR (standard deviation measure)—Field Crops; and panel d: average across farms of individual farm BR (left-side semikurtosis measure)—Field Crops.

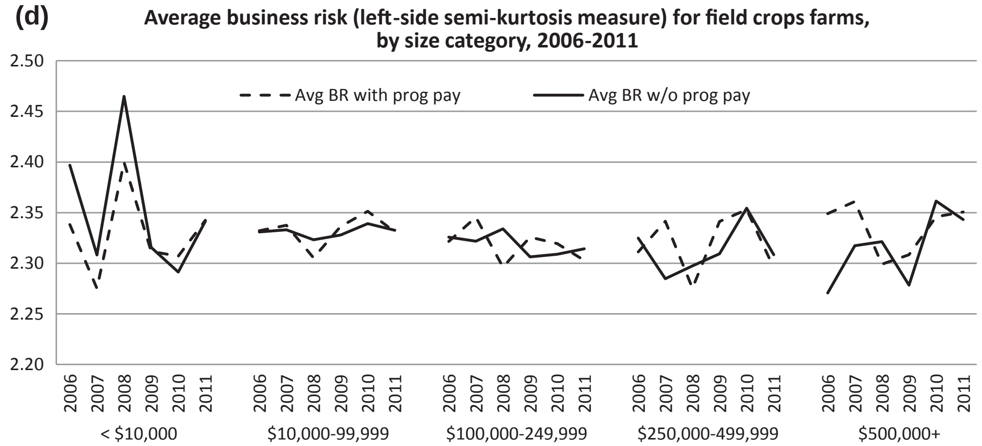

Figure 2. *(Continued)*

decreased downside risk in most of the years. This result may be due to the lack of data on Crop Insurance payments, which are significant for crop farms.

Extent of Risk Balancing

Despite the difference in the business environment they experienced over the study period, beef and field crops farms exhibit fairly similar behavior. As Figure 3 (panels a and b) shows, the distributions of the correlation coefficient between FR and BR of previous year are similar across the two sectors. The correlation is negative for 42% of the sample of beef farms, with an average correlation coefficient for this group of −0.49. As for field crops, 43% of the sample exhibit risk balancing behavior and the average correlation coefficient for these farms is equal to −0.48. Note that the correlation coefficient for risk balancers tends to be larger (in absolute value), on average, for larger farms in both sectors (see Table 2).

What differentiates risk balancers from nonrisk balancers? As Table 2 shows, risk balancers are characterized by larger share of medium and large farms (farms with over $100,000 in sales) than nonrisk balancers. Also, risk balancing farms exhibit substantially higher likelihood to take on more debt and larger FR than nonrisk balancing farms. Taken together, these findings suggest that risk balancing holds particularly for larger farms—the risk-reducing effect of BRM payments induces larger farms to take on more debt, leading to potentially higher default risk for these farms. That is, the potential failure of BRM programs to reduce farm risk is larger for larger farms.

Impact of BRM Programs on the Likelihood of Increased Debt Use

The results of the random effects logit model on the factors affecting the likelihood of taking on more debt are reported in Table 3. A fixed effects model was also estimated but the explanatory power is similar across models as are the coefficients on the main variables of interest. Since the Hausman test suggests that there is no systematic difference

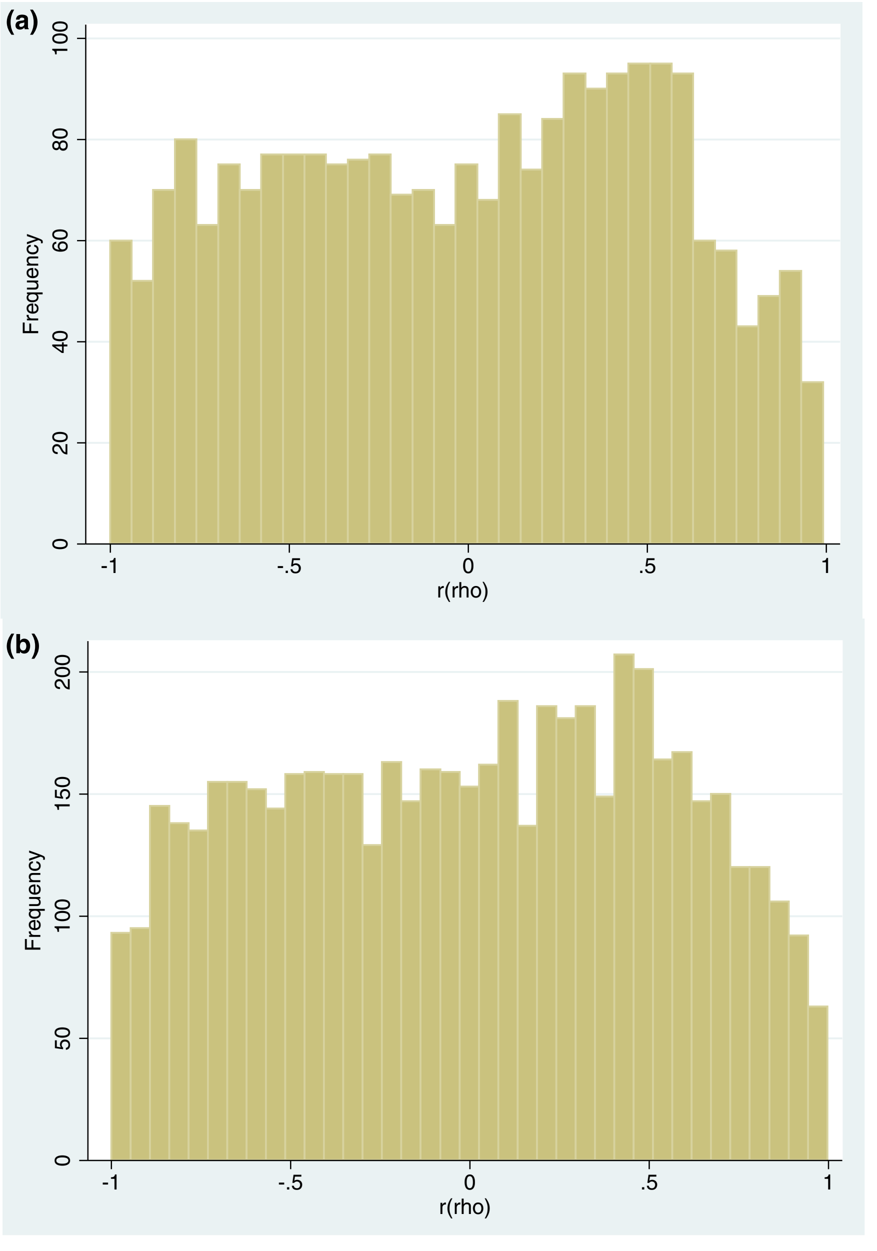

Figure 3. Frequency of BR-FR correlation coefficient, by sector
Notes: Panel a: Frequency of BR-FR correlation coefficient—Beef; and panel b: frequency of BR-FR correlation coefficient—Field Crops.

Table 2. Mean values for risk balancers vs. nonrisk balancers, by sector, 2006–11

	Field Crops		*Beef*	
	Risk balancers	Nonrisk balancers	Risk balancers	Nonrisk balancers
Number of farms	2,681	3,535	1,176	1,625
Distribution across size classes				
<\$10,000	1.5%	2.1%	4.3%	6.7%
\$10,000–99,999	52.1%	59.7%	59.2%	62.8%
\$100,000–249,999	27.6%	23.5%	18.9%	14.6%
\$250,000–499,999	11.0%	9.1%	9.1%	9.2%
\$500,000+	7.8%	5.7%	8.6%	6.7%
BR-FR correlation coefficient across all farms	−0.48	0.45	−0.49	0.45
BR-FR correlation coefficient by size class				
<\$10,000	−0.49	0.42	−0.46	0.48
\$10,000–99,999	−0.47	0.45	−0.48	0.46
\$100,000–249,999	−0.46	0.45	−0.51	0.46
\$250,000–499,999	−0.51	0.44	−0.52	0.40
\$500,000+	−0.48	0.46	−0.50	0.42
Business risk w/o prog pay	2.33	2.33	2.37	2.34
Business risk with prog pay	2.32	2.33	2.34	2.33
Financial risk	0.11	0.09	0.12	0.08
Share of farms that take on more debt in any given year	29%	22%	30%	22%
Share of farms that participate in CAIS /AgriStability in any given year	79%	76%	79%	79%
Share of farms that trigger CAIS/AgriStability payments in any given year	7.3%	7.2%	23.9%	25.3%
Enterprise diversification	0.90	0.92	0.81	0.83
Operating profit margin	−0.08	−0.09	−0.49	−0.47
Operating expense ratio	0.53	0.50	0.78	0.75
Interest expenses, \$	\$12,021	\$9,437	\$8,735	\$6,853

between the fixed effects and the random effects coefficients, only the random effects logit model results are reported.[16]

The coefficient for BR is positive (risk balancing is rejected, on average) and not significant for both sectors. This result is not surprising, given the finding in the previous section that less than a half of farms are risk balancers (take on more debt when BR decreases) with the rest being nonrisk balancers (reduce debt use when BR decreases).

[16]The results to the other models and the Hausman test results are available from the authors upon request.

Table 3. Random effects logit model estimates of the determinants of the likelihood to take on more debt

Dependent variable: *Increase in debt from previous year*		
Independent variables	Field crops	Beef
Business risk (previous year)	0.004	0.043
	(0.022)	(0.033)
Enterprise diversification (current year)	−0.259***	−0.263**
	(0.092)	(0.105)
Participation in CAIS/AgriStability (current year)	0.119***	0.160***
	(0.034)	(0.055)
CAIS/AgriStability payment triggered (previous year)	0.124***	−0.011
	(0.039)	(0.044)
Operating profit margin (average of previous four years)	−0.033*	0.0005
	(0.001)	(.026)
Operating expense ratio (average of previous four years)	0.154***	0.279***
	(0.043)	(0.062)
Interest expenses (previous year)	−0.328***	−0.204**
	(0.074)	(0.090)
Percentage change in farmland value	−0.233***	−0.155***
	(0.027)	(0.039)
Percentage change in borrowing rate	1.526***	2.312***
	(0.073)	(0.113)
Farm size		
<*\$10,000*	−0.495***	−0.511***
	(0.094)	(0.098)
\$100,000–249,999	0.372***	0.327***
	(0.033)	(0.060)
\$250,000–499,999	0.510***	0.353***
	(0.049)	(0.077)
\$500,000+	0.682***	0.567***
	(0.068)	(0.090)
Constant	−0.439***	−0.723***
	(0.112)	(0.144)
Number of farms in the estimation sample	6,216	2,801
Log-likelihood value	−19,380.39	−8,554.70
Wald chi^2		
value	805.34	581.94
p-Value	0.000	0.000
Rho value	0.067	0.086
	(0.007)	(0.011)
Likelihood ratio test of rho = 0		
chi^2 value	114.19	81.92
p-Value	0.000	0.000

Note: ***, **, * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

BRM programs overall have no significant effect on the likelihood of increased debt use for either beef or field crops farms.

However, participation in CAIS/AgriStability in the current year increases the likelihood of taking on more debt for both field crops and beef farms. This finding is consistent with the relationship between US Federal Crop Insurance participation and farm-level debt use found by Ifft et al (2013). Also, the coefficient for CAIS/AgriStability payment triggered in the previous year is positive and significant for field crops farms. Taken together, these results suggest that CAIS/AgriStability participation leads to increased debt use and potentially higher default risk for farmers.

As for the control variables, operating efficiency increases the probability of taking on more debt for both field crops and beef. The impact of profitability, while also positive, is not significant for either sector. As expected, the less diversified and the more indebted a farm is, the less likely it is to take on more debt for both sectors. Less expected are the results that there is a negative and significant relationship between changes in farmland value and the likelihood of taking on more debt, and a positive and significant relationship between changes in borrowing cost and the probability of taking on more debt for both field crops and beef farms. The former result may reflect farmers' increasing concerns that land is overpriced. The latter result suggests that farmers did not take on more debt despite the fall in borrowing cost. This result may also be due to the very low levels of borrowing rates and the relatively small change in these low levels. Finally, larger beef and field crops operations tend to be significantly more likely to take on more debt.

CONCLUDING DISCUSSION

Risk management continues to be the central objective of Canadian agricultural policy. Indeed, the unpredictability and volatility that has characterized the farming sector in recent years is only expected to rise. Thus, it may seem appropriate for the government to assist farmers in coping with the growing volatility in income in order to strengthen the viability of farm businesses and foster investment in the farming sector. However, this is only a necessary condition for the implementation of BRM programs. When designing the programs, policy makers need to also consider their unintended consequences—how the programs can fail at achieving their objectives.

This paper represents the first attempt to shed light on whether Canadian BRM programs fail to reduce farm risk as a result of farmers' risk balancing behavior. The risk balancing literature suggests that BRM programs may, through risk balancing (offsetting adjustments between BR and FR), lead farmers to take on more FR than they would take otherwise, which, in turn, increases the risk of equity loss. Farm debt levels and leverage have been increasingly covered in the media with titles such as the "farm debt boom" (e.g., Financial Post 2013). Apart from concerns related to concentration of debt or the risk of farm leverage increasing if farm income or farm asset values decline, there are also concerns with the high cost to taxpayers of BRM payments and potential distortions to planting decisions.

The results from this study of Ontario field crops and beef farms are mixed. First, we find that BRM payments reduce BR for beef farms but not for field crops farms (though the latter result may be due to the lack of data on Crop Insurance payments, which are significant for crop farms). Also, the correlation analysis results suggest that risk balancing holds particularly for the larger farms—the risk-reducing effect of BRM payments induces larger farms, in particular, to take on more FR, which, in turn, increases the risk of equity loss. Finally, regression results show that BRM programs overall have no significant effect on the likelihood of increased debt use for either beef or field crops farms, on average; however, participation in CAIS/AgriStability increases the probability that farms take on more debt than they would take otherwise for both sectors.

The potential sector-wide impacts of a linkage between farm debt use and BRM programs are important to recognize. If program participation does increase debt use, there could be positive or negative consequences for the farming sector. On the positive side, farm sector investment and profitability could increase through relaxed credit constraints (to the extent that participation lowers BR, it might allow lenders to accept loan applications with lower collateral or for operations that are more leveraged). On the negative side, some producers could take on higher levels of debt than they would have without availability of BRM programs and debt repayment difficulties could potentially increase farm bankruptcies.

However, further analysis is needed to determine whether BRM programs increase the probability of default. A comprehensive measure of the probability of default would include debt coverage measures, owner equity ratios, working capital, and current ratio, among others. Also, the results from this study must be interpreted with caution for at least two reasons. First, the analysis lacks the balance sheet information needed to account for the impact of expected capital gains (e.g., land value appreciation) on the decision to take on more debt. Second, it lacks data on Crop Insurance payments, which are significant for the field crops sector. Despite these limitations, this study provides motivation for future work on the potential crowding out effect that BRM programs can have on farmers' FR management strategies. Future work could extend present analysis to incorporate balance sheet information, Crop Insurance data, and estimates of default risk.

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APPENDIX: A LIST OF EMPIRICAL STUDIES ON THE RISK BALANCING HYPOTHESIS

Author(s)	Year	Data	Methodology	Hypothesis confirmation
Gabriel and Baker	1980	Aggregate U.S. data	Linear regression	Yes
Featherstone et al	1990	U.S. crop-hog farm	Discrete stochastic programming model	Inconclusive
Ahrendsen et al	1994	U.S. dairy farm	Regression analysis	Yes
Escalante and Barry	2001	Representative U.S. grain farm	Simulation-optimization	Yes, conditional
Escalante and Barry	2003	U.S. grain farm	Regression analysis using (i) panel data and (ii) cross-sectional time series	Yes, conditional
Escalante and Rejesus	2008	Representative U.S. grain farm	Simulation-optimization	Yes, conditional
Turvey and Kong	2009	Survey of Chinese smallholders	Regression analysis	Yes
De Mey et al	2013	EU-15 farms of different types	Regression analysis on panel data and correlation analysis	Yes

APPENDIX: B LIST OF MAIN FARM SUPPORT PROGRAMS TRIGGERED DURING 2003–11

Program name	Paid to sector
AgriInvest	All
BSE Fed (Cows)	Beef
BSE Feeder (Calves)	Beef
Canadian Agricultural Income Stabilization (CAIS)/AgriStability	All
Cost of Production (COP) Program for Grains and Oilseeds	All
Farm Innovation Program	All
Federal Grains and Oilseeds Payment Program	Grains and Oilseeds
Interim Outstanding of AgriStability Payments	All
MRI Payout	All
MRI Topup	All
Ontario BSE Recovery Initiative (OBSERI/OBSERI P3A)	Beef
Ontario Cattle Hog and Horticulture Program (OCHHP)	Beef (Swine, Horticulture)
Ontario Cost Recognition Top-up (OCRT) Program	All
Ontario Grains and Oilseeds Program (OGOP)	Grains and Oilseeds
Production Insurance Premium Adjustment (PIPA)	All (Crops only)
Risk Management Program (RMP) (Cost of Production based)	Grains and Oilseeds