**Business Risk Management payments and risk balancing:
Potential implications for financial riskiness of Canadian farms**

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Extended Abstract
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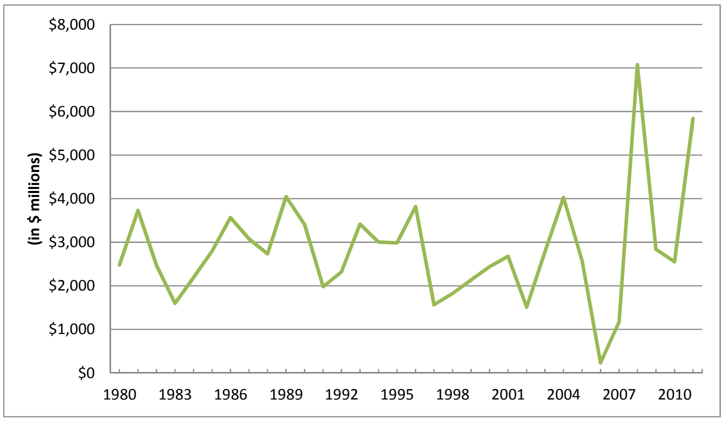
Introduction

In Canada, agricultural policy endeavours to reduce agricultural risk through a suite of programs known as Business risk management (BRM) programs. Although there has been a shift to reduce the emphasis on BRM in the new Growing Forward II policy framework, BRM continues to be the central focus of Canadian agricultural policy, (AAFC, 2012; Seguin, 2012). Indeed, the unprecedented volatility of income that has characterized the farming sector in recent years (Figure 1) is only expected to rise. Climate change and increased weather variability will increase production volatility. The higher production volatility, along with the tight worldwide supply/demand balance and the volatile energy prices, among other factors, will likely lead to increased price variability. Thus, it may seem appropriate for the government to assist farmers in coping with these gyrations in order to strengthen the viability of farm businesses and provide an environment which supports investment in the farming sector.

Figure 1. Net farm income – aggregate across all Canadian farms, 1980-2011



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

However, a growing number of studies show that the risk reducing effect of government programs generates responses in farmers' risk management strategies and often crowds out the effects of their strategies. For instance, Turvey (2012) finds that CAIS/AgriStability and AgriInvest create an incentive 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., Antón and Kimura, 2009; Coble et al., 2000) and may induce risk-averse producers to use higher levels of risk-increasing inputs (e.g., Serra et al., 2005; Hennessy, 1998).

The risk balancing literature (e.g., Gabriel and Baker, 1980; Collins, 1985) suggests yet another avenue through which government programs may influence farmers' risk management behaviour and increase (rather than reduce) farm risk. The risk balancing hypothesis contends that exogenous shocks that affect a farm's level of business risk may induce the farm to make offsetting adjustments in its financial leverage position, leading to increased (or decreased) financial risk in response to a fall (or rise) in business risk. Using this framework, Featherstone et al. (1988) and, more recently, Cheng and Gloy (2008), among others, showed theoretically that farm policies designed to reduce business risk can, through risk balancing, lead to increased financial leverage and total risk – the so-called paradox of risk balancing.

This paper aims to empirically measure the extent of risk balancing behaviour and the impact of BRM programs on risk balancing decisions by utilizing a longitudinal farm data set from Ontario. If farmers do balance business and financial risk, BRM programs can be argued to crowd out farmers' financial risk management strategies and make farms financially riskier. The paper begins with a conceptual framework about the fact that farmers may manage risk by trading business with financial risk. The next sections describe the empirical model and data used to examine the impact of BRM payments on risk balancing decisions. The section following features a discussion about the empirical results. Finally, the paper concludes with a discussion of the key findings and future work.

Conceptual Framework

In agriculture, the sources of total risk facing a business are universally equated to the sum of business (operating) risk and financial risk (e.g., Collins, 1985; Featherstone et al., 1988; Harwood et al., 1999). Business risk 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. Financial risk is defined as the added variability of net returns to the owners of equity that results from the use of debt.

From this emerges the risk balancing hypothesis that to maintain constancy in total risk (at the maximum tolerable level, as given by the decision-maker's level of risk aversion), any exogenous shocks that affect a firm's level of business risk could induce the firm to make offsetting adjustments in its financial leverage position. That is, any increase in business risk could be offset by a decrease in leverage. Conversely, upward adjustments in optimal leverage levels could be warranted whenever the level of business risk decreases. This is however only one way in which the firm could act. The other strategy could be to undertake production or investment activities that bring business risk back to the original level.

Two approaches have been used to derive the risk balancing hypothesis. One approach is based on the analysis of a firm's equilibrium conditions and 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. Under this framework, total risk is decomposed into the following additive relationship between business and financial risk:

where TR is the total amount of risk, $\bar{c}x$ is the expected net operating income without debt financing, σ is the standard deviation of net operating income without debt financing, and I is interest payments.

Business risk (first term in the resulting right-hand equation) is defined in terms of the variability of net operating income. Financial risk (second term) is determined by the degree of business risk inherent in the firm $\sigma/(\bar{c}x)$ and the relation $I/(\bar{c}x - I)$ which is determined by the financing decision. That is, financial risk is defined to be the added variability of net operating income of the owners of equity that results from the financial obligation associated with debt financing.

Let β be the maximum tolerable total risk. The total risk constraint is:

To see how the risk balancing hypothesis works, let there be an exogenously induced decline in business risk (e.g., a change in agricultural policy that reduces σ or raises $\bar{c}x$). Financial risk also will have fallen (due to its own business risk component). As a result, total risk would decline leaving slack in the risk constraint defined in equation (2). This would allow debt use and, consequently, financial risk, to increase. Alternatively, the firm may choose to undertake riskier and more profitable production or investment activities, increasing business risk.

The other approach is represented by the expected utility mean-variance analysis (e.g., Collins, 1985; Featherstone et al., 1988), which is a structural model of the overall debt-equity decision by farm operators. Structural variables include not only business risk, but also expected returns from farm operations and expected capital gains. That is, this model assumes that the decision-maker chooses the degree of financial leverage that maximizes the expected utility of the rate of return on equity, given his level of risk aversion.

This model defines total risk as the variability of the return on equity, with return on equity (ROE) defined as a function of the debt to equity ratio (δ), rate of return on assets (ROA) and interest rate of debt (i) – i.e, ROE= ROA(1+ δ)-iδ. That is, total risk is given by:

$$TR = \sigma^2_{ROE} = \sigma^2_{ROA}(1+\delta)^2 \quad (3)$$

where σ^2_{ROE} is the variance of the return on equity (total risk), σ^2_{ROA} is the variance of the return on assets (business risk), and δ is the degree of financial leverage (financial risk).[2]

Note that taking the standard deviation and differentiating equation (3) gives $\frac{\partial\sigma_{ROE}}{\partial\sigma_{ROA}} = (1+\delta)$ and $\frac{\partial\sigma_{ROE}}{\partial\delta} = \sigma_{ROA}$. That is, an increase in business risk increases total risk by (1+δ) and an increase in financial leverage increases total risk by σ_{ROA}, everything else held constant. In standard deviation form, financial risk is a linear multiple of business risk.

Under this framework, the following relationship between business and financial risk is derived:

where β is the risk aversion parameter and E(ROA) is the expected rate of return on assets. In equilibrium, the sign of equation (4) is negative, which supports the risk balancing hypothesis – a decline in business risk should produce an increase in desired financial risk.[3]

All in all, the risk balancing hypothesis assumes an inverse relationship between business and financial risk, regardless of the way the two types of risk are defined. This relationship forms the basis for the empirical analysis that follows.

Empirical Model

The paper uses a two-stage approach to examine the impact of BRM programs on farmers' financial risk management strategies. The first stage consists of assessing the effectiveness of BRM programs and measuring the extent of risk balancing behaviour, while the second stage consists of examining the impact of BRM payments on the likelihood of risk balancing.

Effectiveness of BRM programs and extent of risk balancing

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

[2] Note that *i* is assumed to be deterministic.

[3] However, this is a *ceteris paribus* result (Collins, 1985). A decline in business risk, if accompanied by a decrease in the expected rate of return on assets and/or an increase in interest rate, may well cause farm owners to reduce financial leverage.

reducing BR and 2) farmers exhibit risk balancing behaviour (taking on more FR when BR decreases as a result of BRM payments is just one strategy a farmer can use to respond; the other strategy could be to undertake activities that increase BR, such as plant riskier crops or use more risk-increasing inputs).

In order to see whether BRM payments (i.e., CAIS/AgriStability and ad-hoc payments) reduce BR, we compare the distribution of BR values with and without program payments. Unlike ad-hoc payments, which are received in the same year they are triggered, CAIS/AgriStability payments are received the following year. Thus, we consider two measures of BR with program payments – one in which CAIS/AgriStability payments are accounted for in the year they are triggered and the other when these payments are shifted to the year in which they are received. BRM programs are effective to the extent that they shift the distribution of BR to the left.

In order to measure the extent of risk balancing behaviour, we derive correlation coefficient measures of risk balancing for each farm in the dataset.[4] Pearson's correlations are calculated over parings between a one-year lagged BR and the current period's FR 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). We use the measure of BR calculated with CAIS/AgriStability payments shifted to the year in which they are received, as we think it better reflects what farmers take into account when assessing volatility. Since risk balancing involves an inverse relationship between BR and FR, the extent of risk balancing is given by the share of farms with negative and statistically significant correlation coefficients.

Impact of BRM payments on the likelihood of risk balancing

Because the amount of BRM payments a farm receives is different for farms in different sectors and size categories, we also ask the question of what the impact of payments on the probability of risk balancing is. To answer this question, we estimate logit and probit panel models such as:

$$\Pr (Y_{it}=1 \mid X_{it}, u_i) = G(\beta X_{it} + u_i) \quad (5)$$

with

$$Y_{it} = \beta X_{it} + u_i + e_{it} \quad (6)$$

where

Y_{it} = binary dependent variable – risk balancing behaviour, which is defined so that it takes the value of 1 when FR moves in opposite direction of BR in previous period and 0 otherwise
X_{it} = vector of covariates including BRM payments, enterprise diversification, operating profit margin, operating expense ratio, interest expenses, and farm size
u_i = individual-specific error component (assumed to not vary over time)
e_{it} = idiosyncratic error component (unique to each individual-year observation)

[4] Escalante and Barry (2003) also used the correlation coefficient between BR and FR as a proxy measure for the farmer's risk balancing behaviour. 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).

G(·) = standard normal cumulative distribution function (for the probit model) and logistic cumulative distribution function (for the logit model)

We do not make any assumption about G(·) and estimate both probit and logit models. Also, we estimate both fixed effects (logit) and random effects (probit and logit) models. The fixed effects model allows for correlation between the unobservable individual-specific component u_i 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, the farms that exhibit no variation in the risk-balancing dependent variable will be dropped from the estimation sample – hence, information is lost. The random effects model allows us to retain the full sample, but 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 towards risk, then u_i is very likely to be correlated with both diversification and interest expenses, for attitude towards 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). A longitudinal farm-level dataset is compiled from farms that participated in CAIS/AgriStability every year from 2003 to 2010 (data on other BRM payments are also available for these farms). Two subsets – i.e., of field crops and beef farms, based on share of revenues – are drawn from this dataset and analyzed separately to account for the different business environments the two sectors experienced over the 2003-2010 period – i.e., deteriorating for beef and favourable for crops. These sectors also represent the two largest groups in the OFID data.

Variable definition

Risk measures. Gabriel and Baker's approach to defining BR and FR is used due to the lack of balance sheet information. We initially measure BR as the coefficient of variation (i.e., standard deviation divided by the mean) of the farm's net operating income over a four-year period and FR as the ratio of interest expense to net farm income. However, we find that a fair share of farms alternate profits with losses and thus have close-to-zero four-year average net income. Since the coefficient of variation (BR) is sensitive to close-to-zero mean values, we also calculate BR and FR by replacing net operating income (i.e., operating revenue minus operating expenses) with the ratio of operating revenues to operating expenses in the above measures. The results we present herein are based on these latter measures of

BR and FR (note that the two relatively different ways of measuring BR and FR did not generate qualitatively different results).

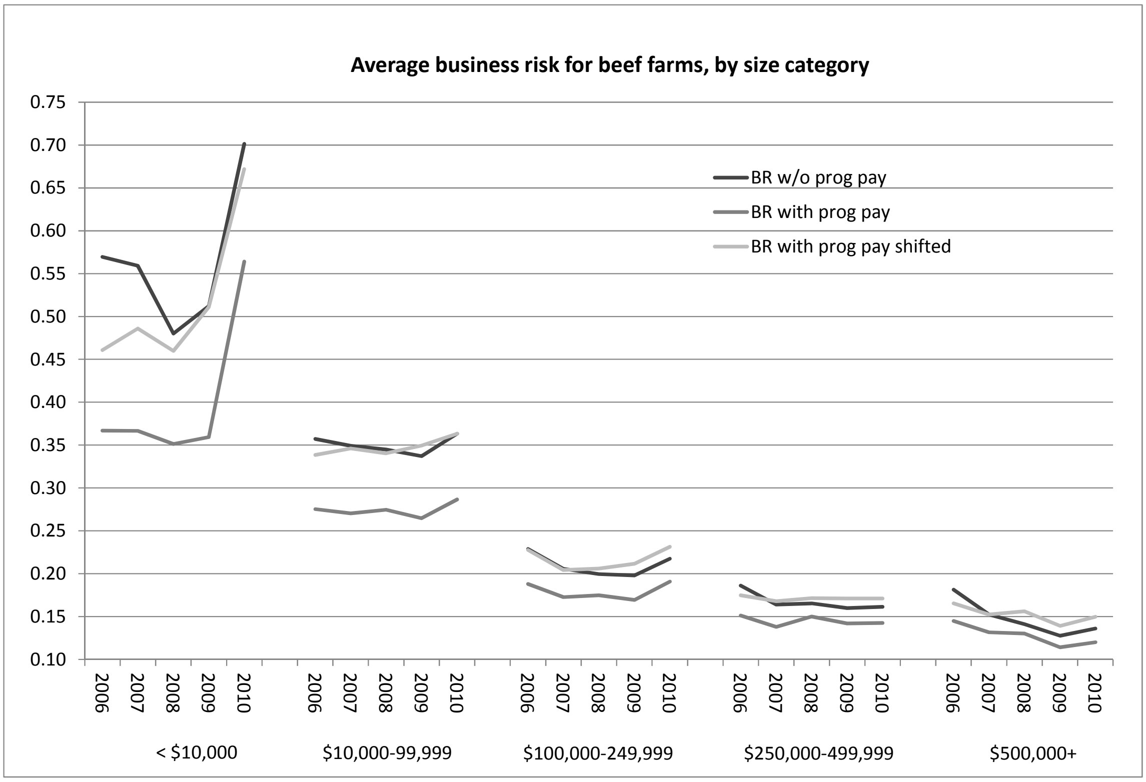
Explanatory variables. BRM payments (*brmpay*) represent payments from CAIS/AgriStability and ad-hoc programs, based on the year farmers received the money. BRM payments, along with all other monetary values, were adjusted to real 2003 dollars using the consumer price index. Enterprise diversification (*enterprdiv*) 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[2], with lower index values indicating greater levels of diversification. Operating profit margin (*opprofmrgn*) is calculated by dividing the farm's net operating income (before interest and taxes) by total operating revenue. Operating expense ratio (*opexpratio*) is calculated as total operating expense divided by total operating revenue. Interest expenses (*interestexp*) is a proxy measure for the amount of debt the farm has. Size category dummies are defined in terms of total sales. Farms are sorted into five size classes as follows: class 1 (*size1*) includes farms with less than $10,000 in sales, class 2 (*size2*) includes farms with sales of $10,000 to $99,999, class 3 (*size3*) includes farms with sales of $100,000 to $249,999, class 4 (*size4*) includes farms with sales of $250,000 to $499,999, and class 5 (*size5*) includes farms with more than $500,000 in sales.

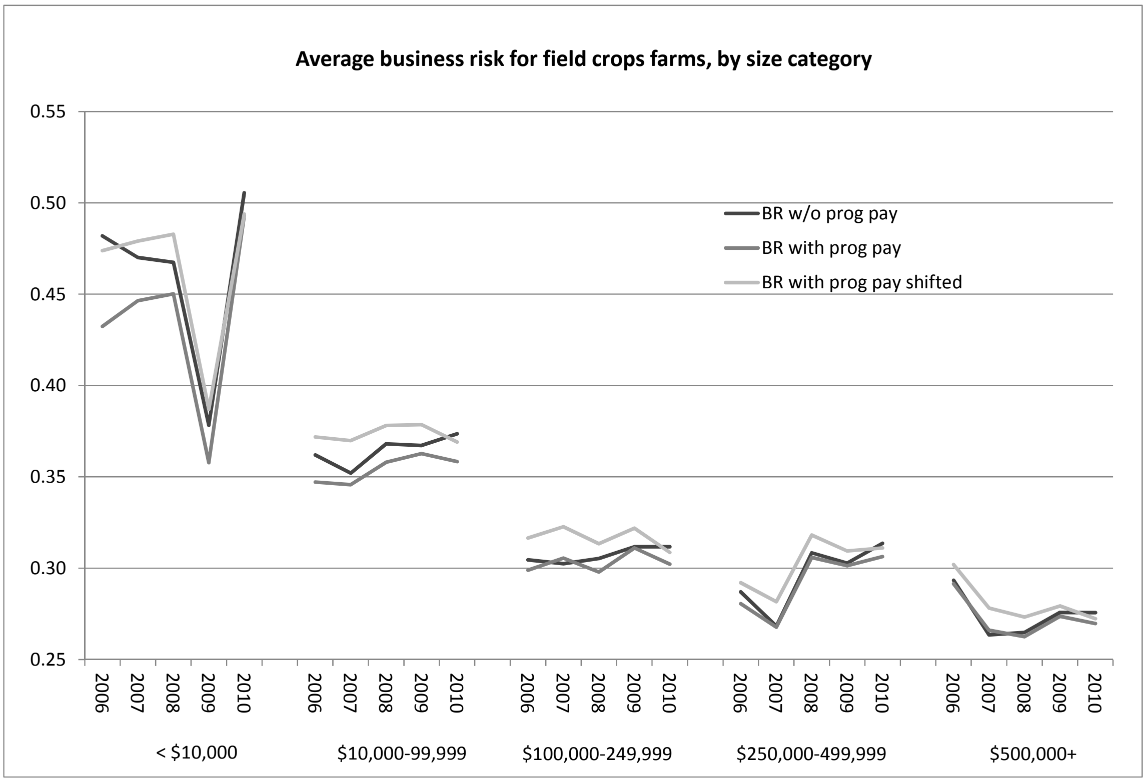
Results

Effectiveness of BRM programs

The distributions of BR without and with program payments (not shown here) reveal that BRM payments reduce BR only when CAIS/AgriStability payments are accounted for in the year they are triggered. When CAIS/AgriStability payments are shifted to the year in which they are received, BRM payments tend to increase (rather than reduce) volatility. That is, the lag of payment of CAIS/AgriStability reduces the effectiveness of BRM programs. This result also holds for almost all size categories (see Figure 1).

Figure 1. Impact of program payments on business risk, by size category

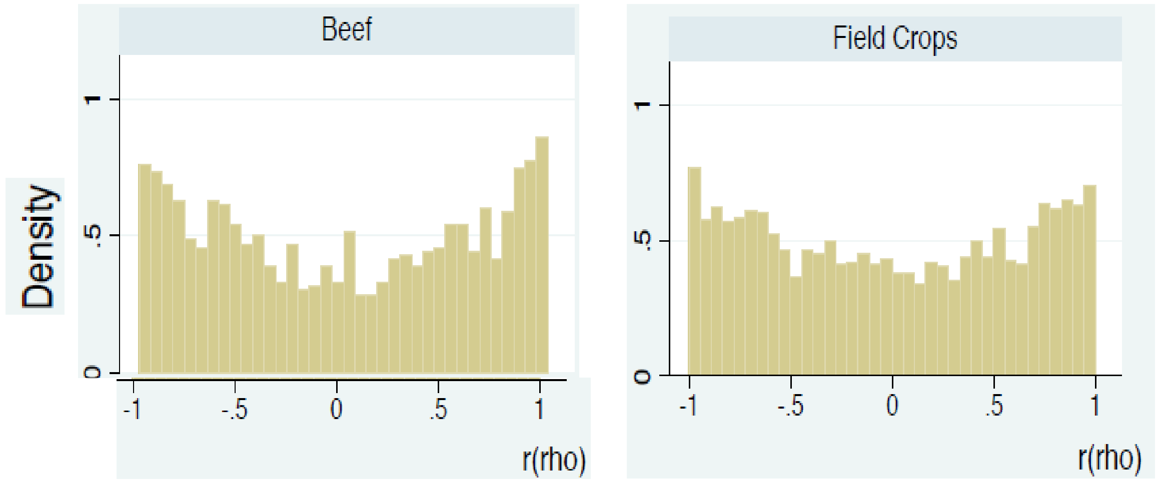

Average business risk for beef farms, by size category
0.75
0.70
0.65
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
BR w/o prog pay
BR with prog pay
BR with prog pay shifted
2006 2007 2008 2009 2010
< $10,000
$10,000-99,999
$100,000-249,999
$250,000-499,999
$500,000+


Average business risk for field crops farms, by size category
0.55
0.50
0.45
0.40
0.35
0.30
0.25
BR w/o prog pay
BR with prog pay
BR with prog pay shifted
2006 2007 2008 2009 2010
< $10,000
$10,000-99,999
$100,000-249,999
$250,000-499,999
$500,000+

Extent of risk balancing

Figure 2 illustrates the distribution of the correlation coefficient measures of risk balancing, by sector. Despite the difference in the business environment they experienced over the study period, the beef and field crops farms exhibit fairly similar behaviour.

Figure 2. Distribution of BR-FR correlations, by sector



42% of beef and 46% of field crops farms exhibit negative correlation between BR and FR (Table 1). However, the correlation coefficient is statistically significant (at the 5% level, based on a one-tailed test) for only 15% of beef and 15% of field crops farms (the small number of BR-FR pairs means correlation values have to be very large to be significant – i.e., ∣ rho ∣ ≥ 0.729). That is, only a small share of farms exhibit risk balancing behaviour.

Table 1. Extent of risk-balancing behaviour

Sector	Total no. of farms	Farms with negative correlations		Farms with significant negative correlations[i]	
		No. of farms	% of total farms	No. of farms	% of total farms
Beef	1,761	737	42%	263	15%
Field Crops	3,684	1,682	46%	551	15%

Note: i – significance is based on a one-tailed test at the 5% level.

Impact of program payments on the likelihood of risk balancing

Tables 2 and 3 summarize the results from the fixed effects (logit) and random effects (probit and logit) models for the beef and field crops sectors, respectively. For both sectors, the coefficient estimates are fairly consistent across the models (though more coefficients are significant in the random effects models than in the fixed effects model, perhaps due to the fact that the fixed effects model drops 25% of beef farms and 22% of field crops farms from the estimation sample). Also, the Hausman test suggests that we cannot reject the null hypothesis that there is no systematic difference between the fixed effects logit coefficients and the random effects logit coefficients.

Thus, we can conclude that BRM payments decrease the likelihood of risk balancing behaviour for both beef and field crops farms. In contrast, larger, more efficient operations, with larger interest expenses tend to be significantly more likely to risk balance. Interestingly, the impact of profitability on the incidence of risk balancing behaviour is positive (and significant) for beef farms and negative (though not significant) for field crops farms.

Table 2. Logit and Probit Estimates of Risk Balancing Behaviour in the Beef Sector

Dependent Variable: *riskbal*			
Independent Variable	Fixed Effects Logit	Random Effects Logit	Random Effects Probit
enterprdiv	.409	-.033	-.023
	(.298)	(.155)	(.095)
opprofmrgn	.084*	.094*	.057*
	(.044)	(.024)	(.014)
opexpratio	.102*	.118*	.072*
	(.048)	(.030)	(.018)
brmpay	-.089	-.185*	-.112*
	(.090)	(.084)	(.050)
interestexp	.807*	.513*	.308*
	(.364)	(.136)	(.080)
size2	.028	.388*	.238*
	(.207)	(.135)	(.081)
size3	.014	.810*	.496*
	(.259)	(.148)	(.090)
size4	.166	.935*	.573*
	(.313)	(.160)	(.097)
size5	.051	.853*	.523*
	(.368)	(.173)	(.105)
constant	-	-.948*	-.579*
		(.197)	(.119)
Number of farms in the estimation sample	1,324[ii]	1,761	1,761
Log-likelihood value	-2,045.72	-4,699.03	-4,698.10
Likelihood ratio/Wald chi^2			
- value	17.37	108.84	112.00
- p-value	0.043	0.000	0.000
Rho value	-	.158	.188
		(.017)	(.018)
Likelihood ratio test of rho=0			
- chi^2 value	-	124.71	126.96
- p-value	-	0.000	0.000
Hausman			
- chi^2 value	31.23		
- p-value	0.000		

Notes: * denotes statistical significance at the 5% level; ii – 437 farms (i.e., 25% of sample) dropped because of always risk-balancing or never risk-balancing.

Table 3. Logit and Probit Estimates of Risk Balancing Behaviour in the Field Crops Sector

Dependent Variable: *riskbal*			
Independent Variable	Fixed Effects Logit	Random Effects Logit	Random Effects Probit
enterprdiv	-.178	-.279*	-.172*
	(.298)	(.141)	(.086)
opprofmrgn	-.033	-.018	-.011
	(.024)	(.012)	(.007)
opexpratio	.006	.002	.001
	(.010)	(.004)	(.002)
brmpay	-.240*	-.263*	-.159*
	(.069)	(.061)	(.037)
interestexp	.217	.177*	.108*
	(.234)	(.081)	(.049)
size2	.088	.340*	.207*
	(.209)	(.157)	(.095)
size3	.190	.670*	.411*
	(.224)	(.160)	(.097)
size4	.178	.680*	.417*
	(.244)	(.166)	(.101)
size5	.378	.745*	.458*
	(.278)	(.176)	(.107)
constant	-	-.507*	-.311*
		(.205)	(.125)
Number of farms in the estimation sample	2,887[ii]	3,684	3,684
Log-likelihood value	-4,483.47	-9,958.78	-9,957.77
Likelihood ratio/Wald chi^2			
- value	24.42	107.48	109.14
- p-value	0.004	0.000	0.000
Rho value	-	.112	.137
		(.011)	(.012)
Likelihood ratio test of rho=0			
- chi^2 value	-	144.50	146.65
- p-value	-	0.000	0.000
Hausman			
- chi^2 value	20.72		
- p-value	0.014		

Notes: * denotes statistical significance at the 5% level; ii – 797 farms (22% of sample) dropped because of all positive or all negative outcomes

Concluding discussion

Preliminary results suggest that BRM payments reduce BR only when CAIS/AgriStability payments are accounted for in the year they are triggered. When CAIS/AgriStability payments are shifted to the year in which they are received, BRM payments tend to increase (rather than reduce) volatility. Also, we find that only a relatively small share of farms exhibit risk balancing behaviour – farms that respond to a decrease in BR by taking on more debt than they would take otherwise. Finally, regression results show that the likelihood of risk balancing decreases with the amount of BRM payments a farm receives. Taken together, these findings suggest that the impact of BRM programs on the financial riskiness of farms is limited. Interestingly, the results for the beef and field crops sectors are not qualitatively different.

The results also suggest that the potential crowding out effect of program payments on farmers' financial risk management strategies may be mitigated by other factors. For instance, enterprise diversification is found to decrease the likelihood of risk balancing. It is also found that farms with higher operating profit margins are less likely to risk balance.

This is work in progress. Apart from analyzing these results in further detail, we aim to extend the analysis to dairy to look at risk balancing in a supply managed sector. We also plan to include land price and/or agricultural product price as additional regressors to account for the impact of expected returns and/or expected capital gains on the decision to take on more debt.

Key words: risk balancing, business risk management programs, crowding out effect, farm-level data, correlation analysis, binary logit and probit panel models

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