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FACTORS AFFECTING VARIABILITY IN FARM AND OFF-FARM INCOME

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Abstract

The purpose of this paper is to examine the factors affecting the relative variability in farm and off-farm income for Canadian farm operators. Previous attempts have been limited by the lack of available data combining both farm and off-farm income levels for farm operations over time. Statistic Canada's Farm Micro-Longtidinal Dataset of 17,000 farm operators from 2001 to 2006 allowed such an analysis. The coefficient of variation (CV) in farm income is significantly greater than that for off-farm income but both measures are inversely related to the permanence of the income source to the operation. The greater the reliance on farm income and the greater the labour demand within the farm, the lower (greater) the relative variability in farm (off-farm) income. Larger commercial operations tend to experience larger farm income volatility either because they are less risk averse and/or have the ability to manage more risk. Diversification and off-farm employment appear to be substitute for risk management strategies for commercial operations. Pension and lifestyle farms have lower coefficient of variation for both farm and off-farm income compared to business-focused farms since they are possibly more risk averse and benefit from a permanent stream of off-farm revenue. Government payments have mixed effects on the relative variability of both income sources, which may be due the lag between the time of the income reduction and the time at which the aid is received.

Résumé

Cet article examine les facteurs qui influent sur la variabilité relative des revenus agricoles et hors ferme des exploitants agricoles canadiens. Les tentatives précédentes ont été limitées par le manque de données chronologiques combinant les revenus agricoles aux revenus hors ferme des exploitations agricoles. Notre analyse utilise de la banque de données de Statistiques Canada *Farm Micro-Longtidinal Dataset* qui compile de l'information sur 17000 exploitants agricoles de 2001 à 2006. Le coefficient de variation (CV) du revenu agricole est nettement supérieur à celui du revenu hors ferme, mais les deux mesures sont inversement proportionnelles à la permanence de la source du revenu considéré. Plus grande est la dépendance à l'égard du revenu agricole et plus grande la demande de travail au sein de la ferme, plus faible (grande) sera la variabilité du revenu agricole par rapport au revenu hors ferme. Les grandes exploitations commerciales ont tendance à afficher une plus grande volatilité du revenu agricole, soit parce qu'elles sont moins sensibles au risque et/ou ont une capacité accrue de gestion des risques. La diversification et un emploi hors ferme semblent être des substituts pour des stratégies de gestion des risques pour les fermes commerciales. Les fermes appartenant à un retraité et les fermes d'agrément ont un plus faible coefficient de variation pour les revenus agricoles et non agricoles par rapport aux fermes commerciales possiblement parce que les opérateurs sont plus riscophobes et bénéficient d'un flux permanent de revenus hors ferme. Les paiements gouvernementaux ont des effets mixtes sur la variabilité relative des deux sources de revenu, probablement à cause du décalage temporel entre la réduction des revenus et l'envoi de l'aide.

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Factors Affecting Variability in Farm and Off-farm Income

Introduction

Economic well-being is affected not only by the level of income but also its fluctuations. The financial hardship caused by unexpected income losses are the basis for a range of public policy programs that provide a safety-net in times of need. In the agricultural sector, income stabilization is a major objective of government programs, such as Canadian Agricultural Income Stabilization (CAIS) and AgriStability, which compensate farm operators when they experience a decline in income or production margin. The payouts from these programs have risen from $2.56 billion in 2002 to a peak of $3.97 million in 2005 and have since fallen back down to $2.83 million in 2008. However, payments received per operator have risen from $3,500 in 1995 to approximately $11,500 for crop operations and $20,900 for livestock operations in 2008 (calculations from CANSIM, 2010). The potential for greater market volatility in the future (FAO, 2010) implies potentially greater demands on these programs and greater scrutiny surrounding which types of farms require support. In addition to knowing how the levels of government funds may flow to alternative farm types, it is important to know whether these funds do stabilize farm income as opposed to encouraging greater risk-taking behavior on the part of farms.

Income stabilization for farms no longer means income stabilization for farm families as approximately half of Canadian and American farm operators have off-farm employment (Niekamp 2009, O'Donoghue *et. al*. 2009). Thus, understanding the financial well-being of farm families requires assessing the variability of off-farm income as well as farm income variation. Depending on the type of farms, the pursuit of off-farm income opportunities may be construed

as a self-insurance mechanism complementing government programs to stabilize household income or it could be motivated by changes in labour market conditions that impose significant hardship on low-equity families relying more on off-farm income than revenue from the farm to pay for household expenditures.

While income variation remains a focus of public policy programs, the factors affecting its variability are not well-understood. Schurle and Tholstrup (1989) found income variability for Kansas farms to be influenced by factors affecting business risk such as enterprise mix, returns and size. Using an updated sample of the same Kansas farms, Purdy, Langemeier and Featherstone (1997) found specialization and business risk position increased the variance of returns on equity. Barry, Escalante and Bard (2001) also found that diversification reduced farm income variability by using a panel of Illinois farms as opposed to a single cross-section. The majority of studies on off-farm income have examined the factors affecting the decision to participate in off-farm employment (Huffman 1980). A few recent studies have extended this analysis to consider the dynamics of the participation decision and more specifically the duration of the participation (e.g., Ahituv and Kimhi 2002; Phimister *et al.* 2002; Corsi and Findeis 2000). The role of off-farm income on the adoption of risk-mitigating strategies has been analyzed by Valendia *et al.* (2009). None of these studies have examined the variability in off-farm income nor have studies examined the variance in both sources of income.

The purpose of this paper is to examine the factors affecting the variability in farm and off-farm income for Canadian farm operators. The paper begins with a conceptual framework about labour allocation among alternative farm enterprises and off-farm employment. We use labour allocations to compute the variances in farm and off-farm income. We then identify and measure the impact of factors conditioning these variances. . The next section presents summary

statistics for the approximate 17,000 farm operators included in the Farm Micro-Longitudinal Dataset used for the analysis. The fourth section examines how the relative ranking of the coefficients of variation for farm and off-farm income vary across farm types. It also features a discussion about the estimation results regarding the impacts of factors conditioning variations in farm and off-farm incomes. The paper concludes with a discussion of the policy implications stemming from the analysis.

Conceptual Framework

In order to assess the factors affecting income variance, we must model the decision on how to allocate effort among potential income sources. The farm operator is assumed to maximize expected utility of wealth $E[U(W)]$ through the allocation of labour (l) across three income generating options: two agricultural activities (crops (C) and livestock (L)) plus off-farm or market employment (M). Wealth is defined as

$$W = p_C C(l_C) + p_L L(l_L) + w(T - l_C - l_L) + Gov + W_0 \quad (1)$$

where p_i is the net output price of agricultural activity i (i=C, L), l_i is the amount of labour allocated to activity i , with the level of output resulting from this input choice determined by the corresponding production functions $C(l_C)$ and $L(l_L)$. Income from agricultural production is stochastic and this is captured by assuming net output prices are random variables with mean $\overline{p_i}$ and variance, $\sigma^2_{p_i}$. Wages from off-farm employment (w) are also random although the relative variability is assumed less than the returns from agriculture ($\sigma^2_w/\overline{w} < \sigma^2_{p_i}/\overline{p_i}$). The amount of time allocated to off-farm employment (l_M) and agricultural activities is equal to the fixed, total amount of time the farm operator has available to work (T) which implies l_M=T-l_C-l_L. Income

can also be earned from two additional sources: government payments related to agricultural production (*Gov*) and initial or exogenous wealth (W_0).

The maximization of expected utility of wealth can be defined in terms of maximizing its certainty equivalent (*CE*) assuming constant absolute risk aversion and a normal distribution for the random variables (Meyer 1987, Robison and Barry 1987);

$$CE(W) = \mathrm{E}(W) - 0.5\,\lambda\, var(W) \tag{2}$$

$$CE(W) = \overline{p_C}C(l_c) + \overline{p_L}L(l_L) + \overline{w}(T - l_c - l_L) + \overline{Gov} + W_0$$
$$-0.5\lambda\{\sigma^2_{p_C}C^2 + \sigma^2_{p_L}L^2 + \sigma^2_w(T - l_c - l_L) + \sigma^2_{Gov} + 2\sigma^2_{p_c,p_L} + 2\sigma^2_{p_c,w}$$
$$+ 2\sigma^2_{p_c,Gov} + 2\sigma^2_{p_L,w} + 2\sigma^2_{p_L,Gov} + 2\sigma^2_{w,Gov}\}$$

where λ is the Arrow-Pratt coefficient of absolute risk aversion. Assuming that both C and L can be produced by farmers and that some time is allocated to off-farm work, the optimal labour allocation is determined by maximizing CE with respect to the two choice variables and simultaneously solving the respective first order conditions which are;

$$\frac{\partial CE}{\partial l_c} = \overline{p_C}C_{l_c} - \overline{w} - 0.5\lambda\{2\sigma^2_{p_C}CC_{l_c} - 2\sigma^2_w(T - l_c - l_L)\} \leq 0 \tag{3}$$

$$\frac{\partial CE}{\partial l_L} = \overline{p_L}L_{l_L} - \overline{w} - 0.5\lambda\{2\sigma^2_{p_L}LL_{l_L} - 2\sigma^2_w(T - l_c - l_L)\} \leq 0 \tag{4}$$

If both equations (3) and (4) hold with equality, then the farmer earns income from all three sources. If one of the above equations does not hold with equality, then farm income would be derived from only one source. If neither equation held with equality, then all the time allocated to work would be allocated to off-farm work. Some farmers may be completely specialized in either *C* or *L*. The optimization would account for that and the time allocation would be explained by a single FOC.

Whether a farmer decides to seek off-farm employment depends on comparing the marginal returns to farm employment ($p_i\ C_{l_i}$) to the wage rate with all labour allocated to farm work. If the reservation wage is less than the market wage, then the operator will work off the farm until the FOCs are satisfied (Huffman 1980). Note that the optimal labour allocation (l*) depends on the marginal productivity of labour in the alternative activities, the variability in those efforts, the covariance, and risk aversion. Substituting the optimal labour choices determines the expected returns among the three income sources along with the variability in those returns.

The variance in income sources will thus depend on the factors influencing the optimal effort across these sources. One variable will be farm type. In terms of farm income variability, price and production uncertainty will vary across sectors. Production uncertainty tends to be lower for livestock productions than for crop productions because the former are less impacted by weather conditions which are inherently volatile. Price levels will be higher and variability lower for supply managed sectors due to the nature of the mandated policies.

Farm type influences off-farm income variability in several ways. Sectors with lower relative returns, and thus a lower reservation wage, will be more inclined to work off the farm and this could either reduce or increase off-farm income variance. Farmers on such operations might be employed full-time in stable off-farm work which would lower off-farm income variance. On the other hand, these farmers might be in and out of the off-farm labour market, getting into off-farm activities that do not require a substantial time commitment, and this would be associated high higher off-farm income variance. In addition, some sectors are more likely to have surplus labour at some points during the year and are more conducive to off-farm employment than more labour-demanding sectors such as dairy (Alasia *et al.* 2009). Finally,

given the diversification effects of off-farm employment, it is expected that farm types with greater income volatility will increase the likelihood of off-farm employment for farms in those sectors and subsequently increase the variance in off-farm income ((Jetté-Nantel et al. 2010); Mishra and Goodwin 1997).

Farm size, regardless of farm type, will also affect the variability in farm and off-farm income. Increases in size can increase relative income due to production and pecuniary economies of size. Larger farms may also be more adept at coping with risk either due to greater management ability or to greater access to risk-management strategies ranging from credit reserves to hedging (Valendia *et al.* 2009, Goddard *et al.* 1993). However, this ability to cope with risk may induce larger farms to handle greater farm income variance and several studies have estimated a positive relationship between size and net farm income volatility (Dunn and Williams 2000; Schurle and Tholstrup 1987; and Pope and Prescott 1980). However, Barry, Escalante and Bard (2000) and Purdy, Langemeier and Featherstone (1997) found that farm size had no effect on the risk/return tradeoff.

The effect of farm size on the variance of off-farm income is also likely indeterminate. While the likelihood of off-employment decreases with farm size (Alasia *et al.* 2009), the variance may increase. Small farms are more likely to use off-farm employment as a permanent income source while larger farms are more likely to seek outside income in times of financial pressures within the agricultural sector. The self-insurance use of outside work for commercial producers suggests that the variance in off-farm income is likely to increase with farm size.

Specialization increases risk and therefore variability according to portfolio theory (O'Donoghue, Roberts, and Key 2009). Shurle and Tholstrup (1989) found that both specialization and variance in returns correlates with average net farm income implying

movement along the tradeoff curve between mean returns and business risk. However, the empirical evidence on the effect of diversification on farm income variance is mixed. Purdy, Langemeier, and Featherstone (1997) found that specialization increased volatility for crop operations, but not for livestock farms suggesting that there are differences in risk management strategies across farm types. The effect of diversification may not only depend on farm type but also location. Barry, Escalante and Bard (2000) found that diversification is only significantly related to reduction in volatility in areas with a low concentration of highly specialized farms.

Location will also affect the variability in farm returns in other manners. While it may not have as large an impact on the livestock sector, it is assumed that variability in crop returns will be higher in the Prairie provinces where greater fluctuations in weather patterns are observed. Regions will also vary in terms of the vibrancy and stability of the labour market and this will have effects on the variability in off-farm income (Alasia *et al.* 2009). The volatility in off-farm income is assumed to be directly correlated with the volatility in local employment conditions.

The theoretical model provides no testable hypotheses on the effect of age. Purdy, Langemeier, and Featherstone (1997) suggest using the operator's age as a proxy of experience, and more experienced operators are able to manage risk better leading to lower volatility. Rather than risk management ability, the inverse relationship between age and farm income variance may have been due to the length of planning horizon. Less risk-taking activities are likely to used the shorter the planning horizon. Schurle and Tholstrup (1989) find age to be positively related to the variance of net farm income and propose the result could be due to older operators being less flexible in adjusting to unusual circumstances and/or less risk averse due to higher wealth. Barry, Escalante, and Bard (2001) combine the two possibilities and find a quadratic

relationship between age and volatility implying experience reduces volatility up to a certain point in the operator's life cycle. The same non-linear relationship for age has also been found in many other empirical studies on off-farm labour supply. The relative returns to market employment are expected to increase with age but then decline suggesting that it will likely have a similar effect on the variance in off-farm income.

Government payments are intended to supplement farm income in times of need. The negative covariance effect thus suggests that these support payments reduce the volatility of farm income and several studies have estimated an inverse relationship (Jetté-Nantel *et al.* 2010; Purdy, Langemeier, and Featherstone 1997; and Schurle and Tholstrup 1989). However, several other studies have found that the reduction in risk associated with government payments may actually increase overall volatility by inducing risk averse producers to use higher levels of risk-increasing inputs (Serra *et al.* 2005; Hennessy 1998). This wealth effect of government policy suggests the impact of a support program on farm income volatility is indeterminate. The theoretical model suggests the wealth effect of higher government funds will decrease the likelihood of off-farm work and thus the variability in off-farm income. However, sectors with higher government payments may also be the ones requiring additional measures of risk mitigation such as off-farm employment, suggesting that government payments could be positively related to the variation in off-farm income.

Methods

We use a two-step approach to measure the impact of the factors affecting the variance of farm and off-farm income. The first step consists of ranking all farmers by the value of their coefficient of variation for each income source. Quintiles are established for each ranking. The

quintile cutoffs are based on the weighted sample so that each quintile will not necessarily have the same number of observations (20%) as would unweighted quintiles.

The quintiles are plotted for the whole data set, by production types and by the Agriculture and Agri-Food Canada (AAFC) farm typology that categorizes farms into seven types on the basis of farm revenue and household characteristics. The quintiles of income variation are determined and then the percentage of farm operators of a particular group, such as production type, within each quintile are examined. The resulting bivariate distribution reveals the 'spread' of volatility and illustrates whether operators in a specific farm typology category are concentrated into one volatility quintile or evenly spread between quintiles. Since an operator in one category can be placed in different quintiles depending on the volatility measure and income source, these graphs can also show the volatility relationships across groupings and income types.

The second step entails regressing the coefficient of variation for farm and off-farm income against a set of explanatory variables defined in the next section. Two sets of regression analysis were done: a 1-period OLS regression model and a 4-period panel regression model. For the 1-period model, each of the variables with 6 years of data is condensed to a single measure (this is described in the data section below). For example, the 6-year volatility for farm and off-farm income were measured by single CV observations, which are then regressed against independent variables that are also condensed into single observations. The second set of regressions condenses the 6-year longitudinal sample into four 3-year periods, and a fixed effects panel regression is applied. This maximizes the length of the panel given that 6 years are available and that each CV is computed with three years of data. The time trend in the panel regression is used to account for inter-temporal patterns common to all farms in the sample but

not captured by the explanatory variables. These patterns include price fluctuations, weather patterns, and other exogenous factors and conditions that change over time but cannot be effectively captured in the model.

Data

Data Source

The analysis uses the Farm Micro-Longitudinal Dataset, which contains the income tax files of approximately 38,000 Canadian farm operators or shareholders between the years of 2001 to 2006. However, only individuals associated with unincorporated farms plus their family members are included in the sample since the study requires information on the operator's off-farm income as well as farm income. Individuals involved with incorporated farms (31% of the records) were excluded from the analysis for two reasons: (1) it is impossible to distinguish between the operator's farm earnings and the operator's off-farm earnings as the incorporated farm flows earnings to its shareholders as wages or as dividends, and (2) there is no information on the operator's family income. Tax files with average gross farm revenue less than $10,000 (7% of unincorporated farms), as well as operators of farms with a non-farm label for any one-year (29% of unincorporated farms) were also excluded from the dataset.

Only one operator from each farm and each family is kept, so inferences can be made at the one-operator-per-farm-per-family level. Matching the Family Identification Number (FIN) and gross farm revenue of the tax records identifies operators in the same farm and family. For multiple operators with matching FIN and gross farm revenue, only the eldest operator with the largest share was kept in the sample. For 'duplicate' operators with the same age and farm share, one operator was picked and kept randomly. Duplicates represented 9% of unincorporated farms

in the sample. This leaves a final sample size of approximately 17,000 operators representing a population of 175,000 farms across Canada. This subset follows a contingent group of unincorporated, non-hobby farms within the longitudinal sample who have been active in agricultural production for all six years in sample.

Variable Definition

Dependent Variables

Farm income is calculated as gross farm operating revenues minus gross farm operating expenses. This is calculated before depreciation and it also includes government payments. Only records with positive average farming income over the six year period are included although negative net farm income in given sample years are possible. Off-farm income is non-negative and is defined as the sum of wages and salaries plus net unincorporated self-employment income from operating a non-farm enterprise. Off-farm income can also include investment income, pension income, and social transfers. Both income sources, along with all other monetary values, were adjusted to real 2001 dollars using the Consumer Price Index.

The volatility for each of the two income sources is measured in relative terms by the coefficient of variation (CV). A single CV measure is calculated for each income type over the six year period. The CV for each grouping of 3 successive time periods was also calculated, but the results did not differ significantly from the ones reported below. The CV measures are log-transformed in both sets of regressions in order to reduce heteroscedasticity issues in the regression analysis. The summary statistics for the CV measures are reported in Table 1 along with those for the explanatory variables below.

Explanatory Variables

Farm type and size are hypothesized to be major determinants of relative income variability. These variables are proxied in this study by the farm typologies developed by AAFC (2009). These typologies are used for aggregating farm level data to reveal patterns related to different types of operations for sector and policy analysis. Based on a combination of operator demographics and revenue classes, farms are sorted into seven mutually exclusive groups: four business-focused farms (small, medium, large and very large), and three non-business focused farms (pension farms, lifestyle farms, and low income farms).

The four business-focused categories are exclusively based on gross revenue as indicated in Table 1. The gross revenues used to classify the business-focus farms is the average between 2001 and 2006. Criteria for non-business-focused farm typologies are based on gross farm revenue as well as characteristics of the operator or the operator's family. Pension farms represent farmers approaching retirement and are downsizing their farms or in the process of exiting the industry. Operators of lifestyle farms rely on off-farm employment as their main source of income, and have a net farm income of less than $50,000. Low-income farms have a gross farm revenue of less than $250,000 and a family income below the poverty line. The poverty cut-off is Statistic's Canada's Low Income Measure (LIM), which is calculated as half of the median adjusted before-tax family income, with adjustments based on the number of adults and children in a household. For this analysis, we compare the 2001 family income to the 2001 LIM of $19,473 for a family of four in a rural area. Hobby farms (those with less than $10,000 in average gross farm revenue between 2001 and 2006) are excluded from the analysis due to limited data availability. Typologies are defined by in the OLS regression using 6-year averages of gross farm income and family income. For the panel regression, 3-year averages for each of the 4 periods are used. The 2001 observations for age and pension were used to

determine whether the farm is a pension farm or not. Dummy variables were defined for each typology, except the medium sized business-focused farm which defines our benchmark.

Farm operations are also distinguished by the major enterprise of focus. The initial two groupings are crops and livestock, but each are further sub-divided (grains and oilseeds, potatoes, other vegetables, fruit and treenut, greenhouses, and other crops for crop farms; beef, dairy, hog, poultry, and other animals for livestock farms). Farm types are identified as a specific farm type if one of the enterprises generates over 50% of the farm's gross revenue, and is predetermined in the dataset by Statistics Canada. Farm types also define dummy variables. The grain and oilseed sector defines our benchmark because it is the commodity group with the largest number of operators. For the OLS regression, farm type is determined by the farm type identified in 2001. For the panel regression, farm type is determined by the type identified in the first year of each period.

The degree of specialization across these enterprise types is calculated using the Herfindahl Index which is based on gross revenue generated from each enterprise (sum of squares of the share of the revenue generated by the enterprise over gross, $S=\sum[(Rev_{enterprise} / Rev_{gross})^2]$). The lower the value of the Herfindahl Index, the greater the diversification on the farm. We expect the degree of specialization to be directly related to the variability in farm income but its expected sign on off-farm income variability is ambiguous. The Herfindahl Index for the OLS regression is calculated using enterprise and gross revenue for all 6 years. For the panel regression, it is calculated using 3-year averages for enterprise and gross revenue. An alternative diversification measure is the family's reliance on farm income, which is calculated as the operator's average family income between 2001 and 2006, divided by the average farm

income over the same period. For the panel regression, reliance measures are based on 3-year average income divided by the average farming income over the same period.

Location effects are accounted for through identifying the province in which the farm operation is based. Dummy variables were created for each province, and Quebec, the province with the highest number of farms, was used for our benchmark. Farm locations are identified by their address reported in 2001 for the OLS regression model, and were determined by the address reported at the start of each 3-year period for the panel regression.

Age is measured as the age of the operator in 2001 in the OLS regression, and is measured at the beginning of each 3-year period for the panel regression. The square of the age variable is also included in both sets of regressions to capture any non-linear effects that age might have on income volatility due to life-cycle changes in management ability and planning horizon.

The final variable is government payments. It is measured as the amount of payment received through all government support programs, including crop insurance. Although some of the support payments are received a year after taxes are filed (e.g., the CAIS program requires tax data to calculate payment), others, such as crop insurance, are paid out in the year of need. Both types of payments are reported in the same tax year and combined into one variable in the longitudinal database. Because crop insurance are commodity-specific, the level of payment will be different between different types of operations. For the OLS regression, the 6-year average of the net program payment are used, and for the panel regression, 3-year averages of the net program payments are used. The government payment variable is logged transformed as well, as the magnitude of this variable is very large compared to the dummy variable.

Results

Graphical Quintile Analysis

The distribution of farm operators between the quintiles of farm income volatility for each of the seven AAFC farm typologies is illustrated in Figure 1. A CV of 0.51 delineates the 20% of the represented population (22% of operators in sample) with the lowest CV of farm income without government payments included while those in the highest quintile have a CV of 3.31 or higher. If government payments are included in farm income, the respective CV measures are 0.41 for the lowest quintile and 2.45 for the highest quintile. Government payments, thus, appear to lower the variability in farm income as desired.

When government payments are taken into account in farm income, approximately 20% of the small and very large commercial farmers fall into the lowest CV quintile while 35% of the medium sized commercial farmers are in the least volatile quintile. Similarly, approximately 20% of the smallest and very large commercial farmers are in the highest quintile with the highest volatility (CV>2.46) while only 10% of medium sized commercial farmers are in this quintile. One reason for the apparent lower farm income volatility experienced by operators of medium sized farms is that a relatively high proportion of farms in supply management fit in the medium sized farm category as will be discussed further below. In addition, the result conforms with previous studies that found larger farm operators tend to be less risk averse and take on more risky investments.

Operators in the three non-business focused farm types experience higher relative income variability than operators in the four business-focused farm types. For example, only 10% of the low-income and lifestyle farmers are in the lowest quintile of farm income variability while

approximately 30% of these types of farmers are in the highest volatility quintile. Pension farmers appear to have volatility measures that compare more to commercial farms than the other two non-business focused farm types.

Removal of government payments as part of revenue increased the relative volatility of farm income for commercial farmers as compared to non-business focused farmers. The effect of government support on stabilizing farm income was particularly notable for the large commercial farmers. For example, the percentage of the very large farms in the upper two volatility quintiles increased from approximately 42% with government payments included to over 50% without these stabilization funds. In contrast, the percentage of low-income and lifestyle farmers in the highest quintile categories fell if government payments were not included. Such farm operators are likely to receive few dollars from government programs and, subsequently would have little effect on farm income volatility.

The volatility of off-farm income for operators of the seven farm typologies, as well as for the overall sample, is illustrated in Figure 2. The CV of off-farm income is significantly lower than the CV for farm income. For example, the CV measure at the least (most) volatile quintile is 0.14 (1.03) for off-farm income and is 0.41 (2.45) for farm income with government payments. In contrast to the volatility of farm income, operators of business-focused farms tend to have a higher proportion of farms with relatively volatile off-farm income than non-business focused farm operators, and this proportion increases with farm size.

Approximately 50% of large and very large farms are in the most volatile off-farm income quintile (CV > 1.03) while less than 5% are in the lowest quintile. The result may be due to the lower level of off-farm earnings for larger operations (Chaplina *et al.* 2004). Bigger farms are unlikely to have surplus labour and tend to have a higher opportunity cost of spending labour

hours outside the farm operation. It may also suggest that off-farm income may be used to supplement family income during periods of low farm income. Off-farm employment may be a self-insurance mechanism for commercial farms.

In contrast to commercial farmers, pension and lifestyle operators tend to have higher and more stable off-farm income through either stable off-farm work or pension payments. Consequently, the proportion number of these farms in the low quintile bracket is higher than commercial farms. The operators of low-income farms have high farm income volatility as well as high off-farm income volatility. Because of the low revenues these farms generate, they receive lower amounts of stabilization payments as compared to farms with higher sales. These farms also suffer relatively high off-farm income volatility suggesting these operations are particularly vulnerable and may require special focus from rural policy programs.

Relative income volatility between commodity groups is illustrated in Figure 3a for the crop sectors and in Figure 3b for the livestock sectors. Note that the CV measures differentiating income volatility quintiles are the same as in Figure 1. Farm income variability is measured as before, but farms are categorized by commodity rather than by AAFC's farm typology.

The sector with the most stable farm income is dairy with over 50% of dairy operators in the least volatile farm income quintile. The result was expected because the mandate of supply management is to ensure stable and fair returns for its producers. The poultry sector is also under a quota system, but its operators do not benefit from the same level of farm income stability. Approximately one-third of its farmers are in the lowest quintile and its volatility distribution is very similar to the vegetables and the greenhouse sectors. The most volatile sector in terms of farm income is beef. Approximately half of beef operators are in the highest two quintiles of farm income volatility. The result reflects the price cycles normally faced by the

sector which were accentuated due to factors such as the BSE outbreak that closed export markets during this time period. The distribution of farm operators across the quintiles of farm income volatility is very similar for several commodity groups. The percentage of farmers in each quintile is approximately equally distributed for the following sectors: grains and oilseeds, potatoes, fruit, hogs, and other animals.

Excluding government payments from farm revenue increases income volatility (CV measures of the quintile groups increases). This is most noticeable for operators in the grains and oilseeds sector and the hog sector. Operators in these two sectors experience the biggest stability gain (in terms of the decrease in the proportion of operators in the highest quintiles) from government payments. Approximately one-third of farmers in these sectors were in the two most volatile quintiles of farm income when government payments are included but this percentage increased to 50% of farmers when government payment were not taken into account. The result reflects the relatively large amount of stabilization funds flowing to these two sectors either in the form of crop insurance and/or ad hoc income support.

The relative volatility of off-farm income across commodity groups, as illustrated in Figures 4a and 4b, depends on the likelihood of off-farm employment as it did across farm typologies as illustrated in Figure 2. The sectors with the largest relative variation in operator's off-farm income are potato and vegetable in the crop sectors and dairy and hogs in the livestock sectors. Approximately 60% of operators in these four sectors are categorized into the two most volatile quintiles. Operations specialized in these commodities are more labour-intensive throughout the year than other commodity groups; less surplus labour provides operators fewer opportunities for off-farm employment.

Commodity groups displaying less relative volatility in off-farm income tend to be either ones with a greater likelihood of surplus labour available for outside work and/or have faced significant financial pressures. Fruit and other crop farms may have time periods during the year that are suitable for off-farm employment. Given the part-time nature of many beef operations, this may also be a factor explaining the relatively stable levels of off-farm income for operators in this commodity group. Over 30% of beef farm operators are categorized into the two least volatile quintiles and this could also be due to these farmers seeking means to supplement their unstable and low farming income.

The distribution of operator's family income volatility for crop-related and livestock-related commodity groups is illustrated in Figures 4a and 4b respectively. The sectors with the most unstable operator's family income are the potato and hog sectors. Operators in both sectors had relatively high farm and off-farm volatility and the result is that over 55% of operators from these two sectors are in the two most volatile quintiles. Farms with relatively low variation in operator's family income tend to have either stable farm income (supply managed and greenhouse sectors) and/or stable off-farm earnings (fruit and other crops). Approximately 20% of greenhouse and dairy farm operators are categorized into the two most volatile quintiles. Although off-farm earnings were relatively unstable for dairy farmers, the level and stability of their farm earnings more than compensate. As a result, dairy operators have stable family income.

Government payments did little to stabilize operator's family income of most commodity groups. Government payments were most effective for the grain and oilseed sector and the hog sector. Operators in these sectors received a relatively large share of stabilization funds over this time period and tend to rely more on farm income for the operator's family income. In contrast,

the inclusion of government payment increased the relative volatility of operator's family income for the supply-managed sectors (dairy and poultry). Since government payments have a stabilizing effect on other commodity groups (i.e. grains and hogs) and the supply-managed farms receive relatively few dollars directly from government, the absolute volatility in family income for the dairy and poultry sectors does not change with the inclusion of government payments but in relative terms, a higher percentage of operators end up categorized into the most volatile quintile.

Regression Analysis

The OLS regression results over the six-year average are reported in Table 2. The results for both income variance equations have a relatively high explanatory power given the cross-sectional nature of the data with an R^2 of 0.61 for the coefficient of variation of farm income and 0.36 for coefficient of variation of off-farm income. In addition, the majority of the explanatory variables are statistically significant and the signs are consistent with expectations.

The volatility in farm income increases with decreases in average farm income and decreases in off-farm income. The result suggests that more efficient operators (i.e. those with a higher margin) are better at managing their volatility. Schurle and Thostrup (1989) found variance to increase with average farm income but the movement along the implied EV frontier was due to increases in specialization. The negative coefficient on average farm income estimated here suggests that the higher average is partially due to avoiding income falls which translates into lower farm income volatility. The positive effect on farm income variance estimated from average off-farm income suggests that the relative variability is greatest for non-business focused farm operations, which is consistent with the earlier descriptive analysis.

In terms of farm typologies, pension, lifestyle, and small business-focused operations all have significantly lower farm income volatility than medium-sized commercial farms. This result is opposite to the results from the descriptive analysis, which indicated that medium farms have the lowest relative farm income variance. The regression analysis controls for other factors and so the finding confirms our suspicion that the low income volatility of medium size farms found in the descriptive analysis is mainly attributed to the high proportion of dairy operations in this group. Large and very large farms, on the other hands, tend to have higher farm income volatility. This result supports the hypothesis that larger operations take on higher risk to generate a higher level of net farm income. The result is consistent with the findings of Dunn and Williams (2000) and Schurle and Tholstrup (1987) who conjecture that larger farms are less risk averse and/or have greater ability to manage higher volatility.

Farm income volatility for most crops is not significantly different than for the grain and oilseed sector. In contrast, the majority of livestock operations have significantly higher farm income volatility compared to grain and oilseed operations, with the exception of dairy operations. While random weather events may have a larger relative impact on crop farms, livestock farms, especially beef and hogs, may face even more uncertainty because of the length of the period separating production from marketing decisions (Larue, Gervais and Lapan, 2004). The results suggest that it is market rather than production volatility that is primarily causing the fluctuations in farm income over this period. The significantly higher variance of farm income for beef and potato producers reflect border closures that affected both farm types in the early 2000s. As expected, dairy operations have a significantly lower farm income volatility compared to grains and oilseeds farms when all other factors are held constant due to the stabilizing effect of supply management. However, poultry, which is also a supply-managed

sector, was found to have a significantly higher level of relative farm income variance than grain and oilseed farmers. The result may reflect the greater amount of labour time that poultry operations have in comparison to dairy which can be allocated to other farming activities that are more risky than the returns from their supply-managed enterprise, or it could also reflect the cost of production formula used for pricing which transmits feed cost volatility.

Relative farm income variance is lower in Quebec than all other provinces, which may reflect higher levels of government support for agriculture in addition to the actual payments received and the high relative concentration of supply-managed farms. The difference is greatest between Quebec and the Prairies, as Western Canada tends to have greater weather variability and be specialized in agricultural sectors more sensitive to world market shocks.

Farm enterprise diversity did not lower farm income volatility as expected which suggests that encouraging a wider mix of enterprises is not an effective strategy to reduce fluctuations in farm income. Diversity was also found to have mixed effects on farm income variance in previous studies, with the expected reduction in volatility occurring only in certain locations with high concentrations of certain farm types (Barry, Escalante and Bard 2000; Purdy, Langemier, and Featherstone 1987). Consistent with the finding on average off-farm income, an increase in the reliance on farm income reduces the coefficient of variation in farm income. It was expected that increases in age or management experience would lower the relative variability in farm income up to a certain point and then it would increase due to changes in abilities and planning horizon. The estimated coefficients on the two age variables suggest that the coefficient of variation on farm income declines until the mid-30s and then increases.

Finally, level of government payment increases farm income volatility, even though the effect is small. The result could suggest that government support encourage farmers to engage in

more risky activities (Serra *et al.* 2006, and Hennesy 1998). However, our result can also be due to the lag between the drop in farm income that triggers the program and the reception of the payment several months later.

The coefficient of variation in off-farm income was found to be inversely related to average farm and average off-farm income. Holding farm type constant, the negative effect of farm income suggests that increases in average farm returns reduce the need for supplemental revenue and thus the movement in and out of off-farm employment. The larger effect, and consistent with prior expectations, is from an increase in average off-farm income. The greater these revenue sources from either pension, investment returns or off-farm employment, the greater the likelihood that these income flows will be permanent and the lower their relative variability.

The relative permanence of off-farm income can also explain the signs on the farm typologies. Relative to medium-sized, commercial farms, the coefficient of variation of off-farm income is less for non-business-focused farms and greater for larger, business-focused farms. Off-farm income for low-income, pension, life-style, and small commercial farms is more likely to be relatively constant since it is the main source of total family income. In contrast, farm income is the main income generating activity for larger commercial operations and off-farm employment is more likely to be a temporary income supplement. The increase in the variability with the size of the operation suggests off-farm work is a self-insurance mechanism for commercial farms.

The ability to seek off-farm employment as a means to either counter changes in farm income or to supplement total family income will be greater for crop than livestock farms due to the greater likelihood of excess labour. The larger coefficient of variation of off-farm income

for crop producers compared to grain and oilseed producers, all other things being equal, suggests that these farms have greater opportunity to move in and out of off-farm employment. In contrast, the labour demands are greater for livestock farms compared to grain and oilseed operations and thus are expected to be less involved in off-farm work.

Producers located in provinces west of Quebec have significantly higher levels of off-farm income volatility. The result could be due to the lower level of farm income volatility noted for producers in Quebec and thus less of a need to supplement their family income with non-farm revenue. It may also be due to the reliance on dairy farming, which provides less surplus labour for off-farm employment. It could also be due to more opportunities for off-farm employment west of Quebec and thus the greater chance that farm family members are moving in an out of off-farm employment depending on their family income needs.

Farm enterprise diversity and reliance on farm income have a statistically significant positive effect on the off-farm income volatility. The result suggests that diversification is a substitute to off-farm employment as a risk-management strategy for total household income. It could also be due to having less time for off-farm employment as the increase in farming activities will reduce an operation's available surplus labour. Both reasons could lead to more diversified farms being less likely to seek off-farm employment and thus experience greater variations in its level. Similarly, as an operation's reliance on farm income increases, the likelihood of a stable, off-farm job decreases and the covariance of off-farm increases.

The increase in the covariance of off-farm income with age until approximately 50 years and then a decrease suggests that perhaps there is more movement in and out of off-farm employment when the operator is younger. This could be due to the greater need to supplement

the income of the farm business during certain period or due to the increase in investment or pension income as the operator gets older.

Finally, government payments increase the covariance of off-farm income. As with farm diversification, the need for alternative risk management options such as off-farm employment if government payments serve to reduce total family income fluctuations. Thus, the increases in government payments decrease the likelihood of full-time off-farm work and thus increase the variability in off-farm income.

Conclusion

The stabilization of farm income and family income is a major objective of agricultural and public policy. The purpose of this research was to examine the factors affecting the variability of the sources of income to the farm and the farm family. Little research has been done on the variability in either income source and attempts to look at both within the same framework have been limited by the lack of available data combining both farm and off-farm income levels for farm operations over time. Statistic Canada's Farm Micro-Longtidinal Dataset of 17,000 farm operators from 2001 to 2006 allowed such an analysis.

The coefficient of variation (CV) in farm income is significantly greater than that for off-farm income but both measures are inversely related to the permanence of the income source to the operation. The greater the reliance on farm income and the labour demands within the farm, the lower (greater) the relative variability in farm (off-farm) income. However, there are notable variations within the farm typologies. Larger commercial operations tend to experience larger farm income volatility either because they are less risk averse and/or have the ability to manage more risk. More profitable farms also have lower income variability since the average is higher

due to the avoidance of income drops. These larger farms also tend to have greater variability in off-farm income sources since it is not a permanent income source but rather a self-insurance mechanism against temporary reductions in farm income. Diversification and off-farm employment appear to be substitute risk management strategies for commercial operations. Pension and lifestyle farms have lower covariances for both farm and off-farm income compared to business-focused farms since these farms will be likely be more risk averse and have a permanent stream of off-farm revenue.

The results on relative variation in the two income sources across farm types raises questions about whether government programs should target specific farm types. Indeed some provincial programs such as Quebec's ASRA have put a cap on the number of productive units that are covered under the price support program, which is now based on the cost for the 75% most efficient producers. Although the CV measures in the descriptive analysis decline with the inclusion of government payments, there is a small positive effect in the regression results implying that government support leads farmers to take on more risky activities. Government payments also were found to increase the covariance of off-farm income suggesting that the need for alternative risk management options such as off-farm employment (or diversification) decrease if government payments serve to reduce total family income fluctuations. However, the results could also be due to the lag between the time of the income reduction and the time in which the aid is received. Further research is necessary to decipher the effects of government support on farm decisions and subsequently the distribution of farm and off-farm income.

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Table 1. Summary Statistics of Income Variation and Farm Characteristics for Canadian Farm Micro-Longitudinal Data, 2001-2006.

Variable	Unit	Mean	Std. Dev.
Dependent Variables			
CV of Farm Income(with govt payments)		3.816911	83.86133
CV of Off-farm Income		0.9430341	3.057287
Dependent Variables			
Farm Typology			
Business-Focused- Small (Revenue ≤$99,000)	#	3018	
Medium ($100,000<Revenue ≤$249,000)	#	3815	
Large ($249,000<Revenue ≤$499,000)	#	2040	
Very Large (Revenue >$500,000)	#	1080	
Non-Business Focused- Low Income	#	1524	
Pension	#	1775	
Lifestyle	#	725	
Farm Enterprise			
Crop	#	5996	
Grains and Oilseeds	#	4,152	
Potatoes	#	250	
Other Vegetables	#	228	
Fruit and Treenut	#	456	
Greenhouse	#	248	
Other Crops	#	662	
Livestock	#	7981	
Beef	#	3,751	
Dairy	#	2,587	
Hog	#	757	
Poultry	#	424	
Other Animals	#	462	
Diversity (Heiferndahl index)		0.2123876	0.202158
Reliance on Farm Income	%	.724469	1.188753
Age	Years	48.24683	12.09825
Government Payments	$	20536.43	36950.71
Location			
Newfoundland	#	61	
PEI	#	497	
Nova Scotia	#	386	
New Brunswick	#	323	
Quebec	#	2,729	
Ontario	#	1,973	
Manitoba	#	2,389	
Saskatchewan	#	2,099	
Alberta	#	2,235	
British Columbia	#	1,285	

Table 2. Regression Results of Factors Affecting Coefficient of Variation in Farm Income and Off-Farm Income for Unincorporated Canadian Farm Operators, 2001-2006.

Variable	CV of Farm Income		CV of Off-Farm Income	
	Coefficient	Std. Error	Coefficient	Std. Err.
Intercept	5.86 ***	0.123	-0.617 ***	0.135
Log of average farm income	-0.763 ***	0.0110	-0.0356 ***	0.0120
Log of average off-farm income	0.0567 ***	0.00718	-0.114 ***	0.00788
Farm Typology				
Non-Business Focused- Low Income	-0.0252	0.0253	-0.0320	0.0278
Pension	-0.184 ***	0.0326	-0.452 ***	0.0358
Lifestyle	-0.729 ***	0.0344	-0.495 ***	0.0378
Business-Focused- Small	-0.402 ***	0.0192	-0.0953 ***	0.0211
Medium				
Large	0.444 ***	0.0202	0.124 ***	0.0222
Very Large	0.994 ***	0.0269	0.170 ***	0.0296
Farm Enterprise				
Crop				
Grains and Oilseeds				
Potatoes	0.276 ***	0.0531	0.171 ***	0.0583
Other Vegetables	-0.0867 *	0.0565	0.177 ***	0.0620
Fruit and Treenut	0.0209	0.0414	0.146 ***	0.0454
Greenhouse	-0.0303	0.0554	0.136 ***	0.0608
Other Crops	0.0175	0.0328	0.0575 *	0.0360
Livestock				
Beef	0.207 ***	0.0176	-0.0352 **	0.0193
Dairy	-0.0531 ***	0.0239	-0.116 ***	0.0263
Hog	0.0764 ***	0.0307	0.0232	0.0337
Poultry	0.0933 ***	0.0406	-0.0803 **	0.0446
Other Animals	0.191 ***	0.0401	0.0703 *	0.0440
Location				
Newfoundland	0.0426	0.102	-0.00120	0.112
PEI	0.146 ***	0.0385	0.0595	0.0423
Nova Scotia	0.132 ***	0.0411	0.0705 **	0.0451
New Brunswick	0.0896 ***	0.0456	0.0152	0.0500
Quebec				
Ontario	0.107 ***	0.0227	0.177 ***	0.0249
Manitoba	0.294 ***	0.0232	0.237 ***	0.0254
Saskatchewan	0.302 ***	0.0247	0.240 ***	0.0271
Alberta	0.372 ***	0.0238	0.244 ***	0.0262
British Columbia	0.307 ***	0.0292	0.303 ***	0.0321
Diversity (Heiferndahl index)	0.134 ***	0.0324	0.330 ***	0.0355
Reliance on Farm Incom	-0.185 ***	0.0569	0.985 ***	0.0625
Age	0.00754 **	0.00389	0.0232 ***	0.00427
Age^2	-0.000114 ***	0.0000409	-0.000262 ***	0.0000449
Log of average Government Payments	0.0781 ***	0.00331	0.0243 ***	0.00363
Adjusted R^2	0.6127		0.3598	

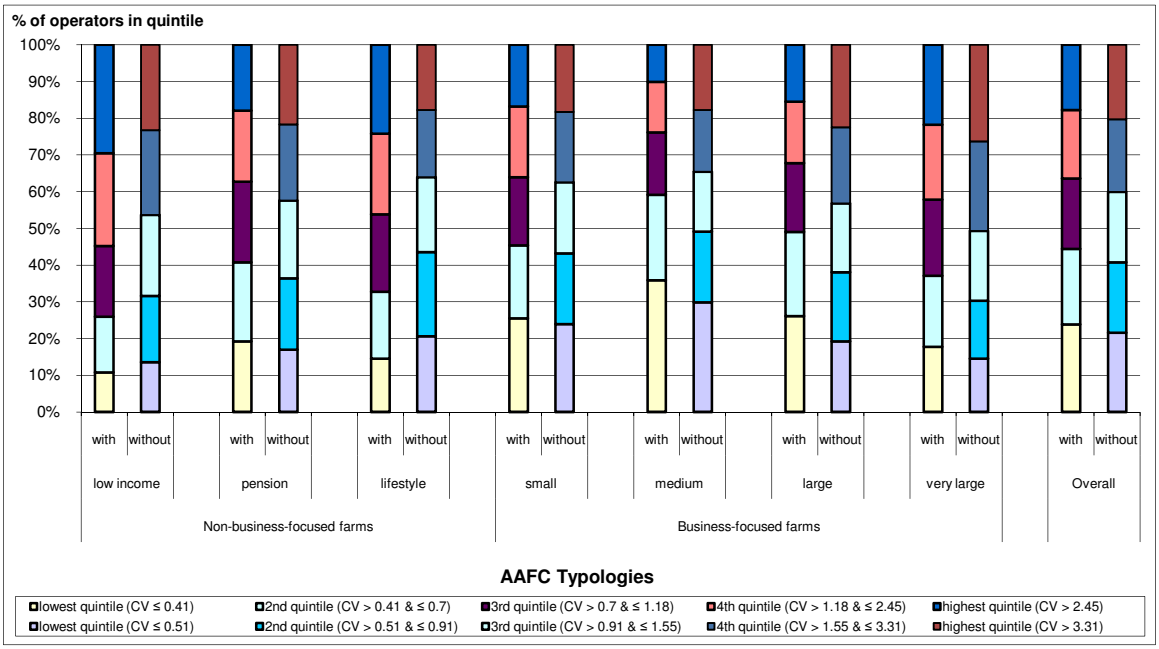

Figure 1 - Percentage of farm operators in AAFC typologies in each farming income volatility quintile, with and without government payment included in the income measure

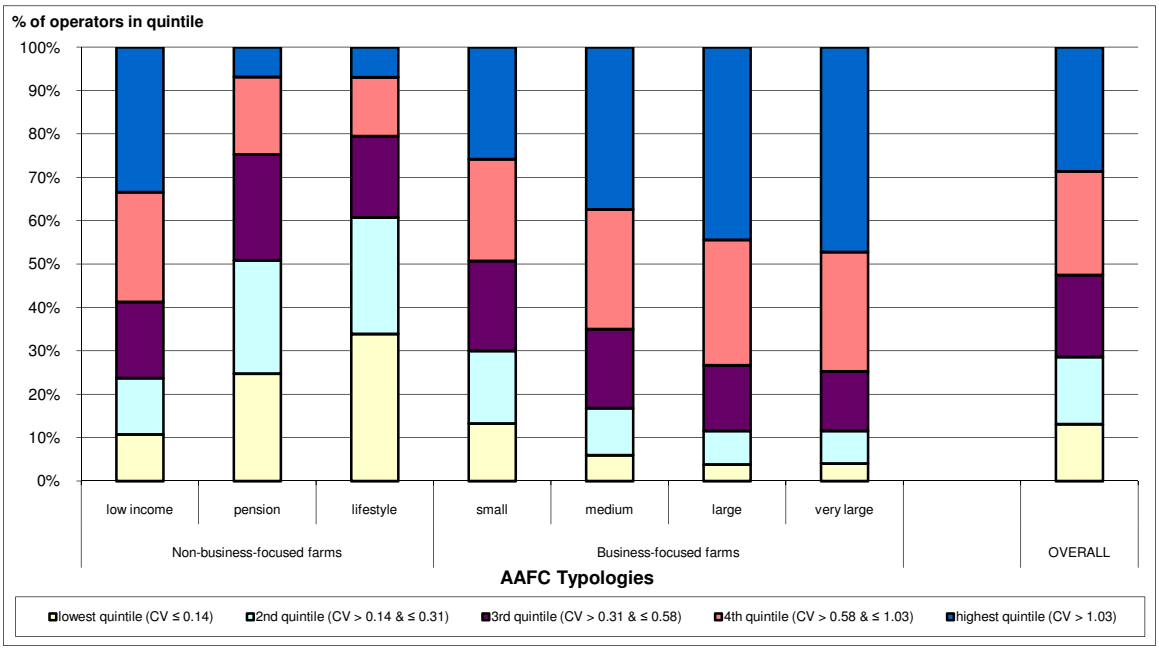

Figure 2 - Percentage of farm operators in AAFC typologies in each off-farming income volatility quintile

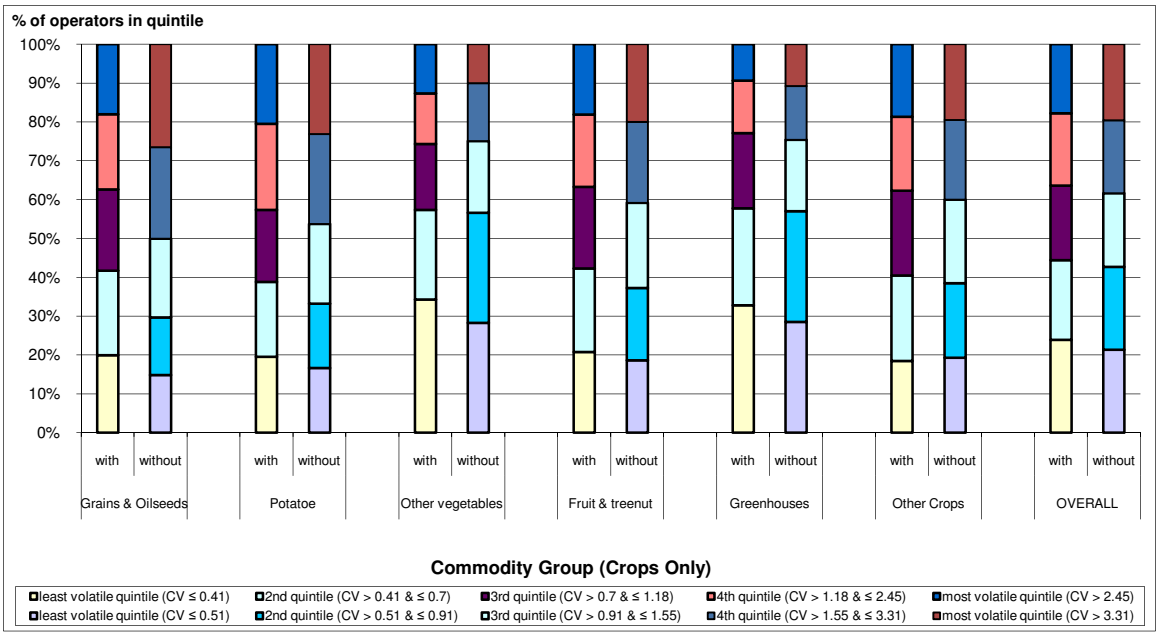

Figure 3a - Percentage of farm operators in crop-related commodity groups in each farming income volatility quintile, with and without government payment included in the income measure

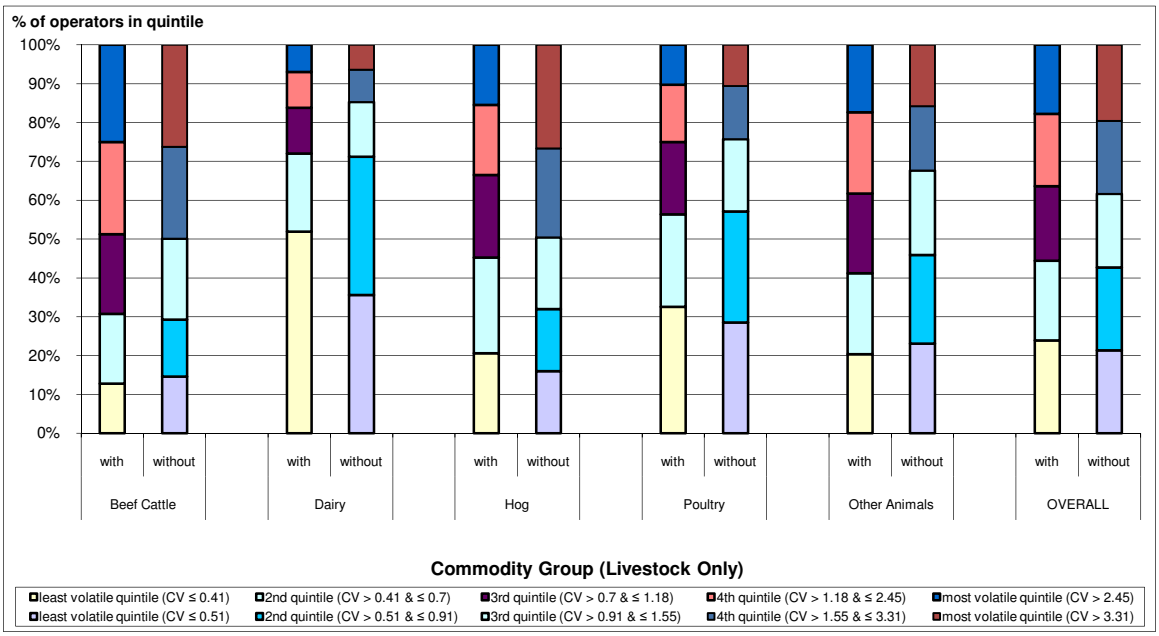

Figure 3b - Percentage of farm operators in livestock-related commodity groups in each farming income volatility quintile, with and without government payment included in the income measure

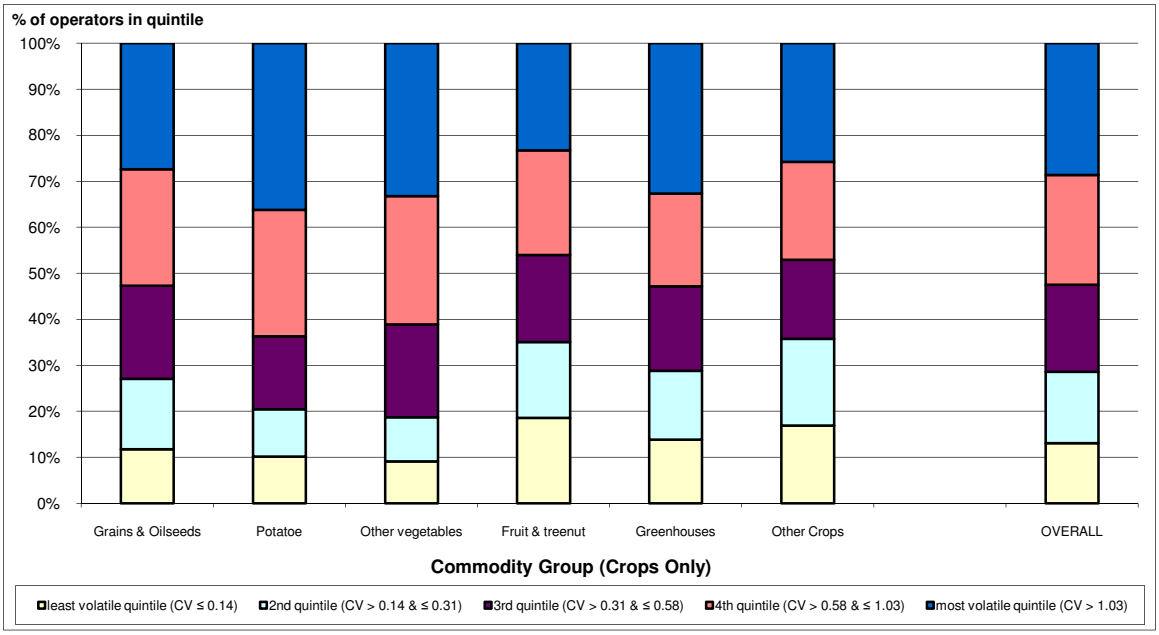

Figure 4a - Percentage of farm operators crop-related commodity groups in each off-farming income volatility quintile

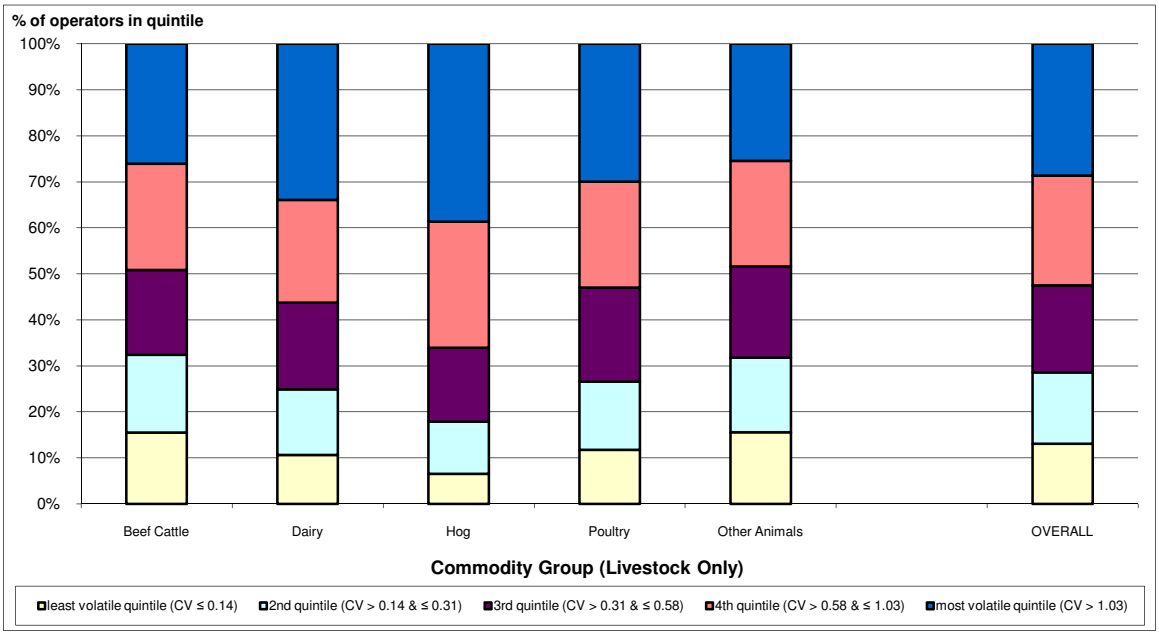

Figure 4b - Percentage of farm operators livestock-related commodity groups in each off-farming income volatility quintile