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Farm household risk balancing: implications for policy from an EU perspective

Erwin Wauters
Social Sciences Unit, Institute for Agricultural and Fisheries Research, Merelbeke, Belgium and
Department of Veterinary Sciences, University of Antwerp, Antwerp, Belgium
Yann de Mey
Business Economics Group, Wageningen University, Wageningen, The Netherlands and
Division of Bioeconomics, KU Leuven, Heverlee, Belgium
Frankwin van Winsen
Animal Sciences Unit, Institute for Agricultural and Fisheries Research, Merelbeke, Belgium
Steven Van Passel
Department of Engineering Management, University of Antwerp, Antwerp, Belgium and
Centre for Environmental Sciences, Hasselt University, Diepenbeek, Belgium
Mark Vancauteren
Department of Econometrics, Hasselt University, Diepenbeek, Belgium, and
Ludwig Lauwers
Social Sciences Unit, Institute for Agricultural and Fisheries Research, Merelbeke, Belgium and
Department of Agricultural Economics, Ghent University, Gent, Belgium

Abstract

Purpose – Building on the risk balancing theory and on recent discussions the appropriateness of using farm income maximization as behavioural assumption, this paper extends the risk balancing framework by accounting for business-household interactions. The purpose of this paper is to theoretically introduce the concept of farm household risk balancing, a theoretical framework in which the farm household sets a constraint on the total household-level risk and balances farm-level and off-farm-level risk.

Design/methodology/approach – The paper argues that the risk behaviour of farmers is better understood by considering risk at the household level. Using an analytical framework, equations are derived linking the farm activities, off-farm activities, consumption and business and private liquidity.

Findings – The framework shows that a farm household that wants to minimize the risk that total household cash flow falls below consumption needs, may exhibit a wide variety of behavioural responses to changes in the policy and economic environment.

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Social implications – The framework suggests multiple ways for policy makers and individual farmers to support risk management.

Originality/value – Risk management is at the core of the agricultural policy and it is of paramount importance to be able to understand behavioural responses to market and policy instruments. This paper contributes to that by suggesting that the focus of current risk analysis and management studies may be too narrowly focused at the farm level.

Keywords Business risk, Business-household interactions, Financial risk, Off-farm income

Paper type Conceptual paper

Introduction

Acknowledging that many farm households in the EU attract a substantial part of their income from non-agricultural sources, this paper theoretically introduces the concept of farm household risk balancing. As a theory, risk balancing suggests that changes in the farm policy and/or economic environment can lead to unanticipated behavioural responses at the farm household level. The paper further describes the implications of this novel concept for policy makers and researchers. Risk analysis and risk management are important issues that have sparked considerable interest among agricultural economists and policy makers. Only relatively recently, the importance of risk management has entered policy and extension debates in the EU (Tangermann, 2011). With the phasing out of guarantees provided by the Common Agricultural Policy (CAP) of the EU, the issue of risk management is gradually acquiring an ever more important role, which is reflected in a series of innovations that first appeared in the 2009 Health Check, and later in the proposed commission regulation for rural development policy 2014-2020 (Capitanio *et al.*, 2013). Researchers, on the other hand, have long since recognized that risk management at the individual farm level is one of the greater challenges for the farming community (e.g. Just, 2003; Richardson *et al.*, 2000). However, several authors assert that there is a strong case that the handling of risk in policymaking in the agricultural and resource sectors leaves scope for improvement (e.g. Hardaker and Lien, 2010; Just, 2003).

One of the most important areas in this respect relates to the behavioural response of farmers in reaction to changes in the economic and policy environment. Farming systems theory views a farm as a unique, goal-setting purposeful system (Dillon, 1991). Farmers are active decision makers and changes in the environmental, policy and economic situation induce them to change certain aspects of their farming business. Depending on the behavioural response policy measures aimed at obtaining one particular goal (e.g. income stabilization) may have adverse effects on alternative goals.

How these adverse effects may appear depends on how the objective (income) is targeted and measured, the assumed behavioural objectives of farmers and the focus of agricultural policy. Increasingly, scholars acknowledge that the focus of agricultural policy and research on a measure of farm income goes beyond what is really going on in the majority of farm households, even in developed countries (Freshwater, 2007). In those countries where an adequate measurement of income at the household level exists, such as the USA, evidence shows that only a minority of farm households earn the majority of their income from agricultural sources, so that the use of a measure of farm income to assess farmers' well-being is flawed (United Nations, 2007). While these issues are gaining considerable agreement, the majority of agricultural economics research is still focusing on a measure of farm income as its target variable and risk research in agriculture is no exception to this case. Yet, in farm households where a significant proportion of the overall household income is coming from non-agricultural sources, an interaction may exist between both the level and riskiness of the agricultural and the non-agricultural income.

This paper presents a novel theoretical framework in which the farm household sets a constraint on the total household-level risk and balances farm and off-farm risk. We argue that the risk behaviour of farmers is better understood by considering risk at the household level. By taking farm household income and not just farm income as the focal point of our behavioural assumptions, we consider a much wider variety of behavioural responses to changes in the policy and economic environment. The original risk balancing framework (Gabriel and Baker, 1980) describes how financial risk (FR) and business risk (BR) are trade-offs in the risk behaviour of farmers. Our model shows that changes affecting the BR at the farm level might just as well induce changes at the household level (e.g. changes in off-farm employment or non-farm investments) and not just changes in the farm financial position.

Our frame of reference is targeted towards industrialized country agriculture, but with specific reference to the European research community and policy making arena. In the EU, the questionable relevance of a measure of farm income for analysing farmers' policy responses and for evaluating the contribution of policy to farm households' well-being, is particularly neglected. This may in part be explained by a disconnect between data collection on the one hand, and research and policy making on the other. As a result, there is no incentive to make changes to the current data collection systems, which reinforces the lack of research efforts. This phenomenon has already been described in the context of rural planning policy, by, amongst others, Bomans *et al.* (2010). It is also related to Van der Ploeg's (2003) concept of the virtual farmer, namely a farmer as seen by the CAP, which is often very remote from the realities of the daily life of a real farmer. Our paper addresses this disconnect, by developing a stylized model of risk balancing behaviour that explains farm-household interactions with risk optimization behaviour. Due to the lack of data resulting from the vicious circle, we have to rely largely on indirect evidence to support our case. Nevertheless, we also provide brief empirical evidence of farm-household interactions, based on farm and household data from a sample of Swiss farms.

The main contributions of this paper are presenting a novel theoretical framework describing a farm household's risk behaviour, thus advancing the argument that the farm household is the preferred level of analysis for risk (management) research, extending the original risk balancing framework to the household level and highlighting the need to adapt data collection systems in the EU if research is to adequately inform agricultural policy design. Important implications for policy makers and researchers are discussed. Focusing on the role of liquidity in agricultural household risk management, our model presents a link between liquidity reserves and agricultural risk management policies which is very important, yet largely ignored in the literature (Pedersen and Olsen, 2013).

This paper is structured as follows. The second section reviews the existing literature on risk management policies and on the measurement of farm household income, demonstrating the importance of considering the household level in risk (management) analysis. The third section introduces the conceptual and operational measures for household risk and its constituents. In the fourth section we show that, for a farm household with income from and an investment portfolio both within and outside agriculture that is optimizing household income risk, risk behaviour may involve a trade-off between total farm risk and household-level risk and provide a behavioural equation with important implications. The fifth section provides evidence from our own analysis on Swiss farm households, and briefly summarizes the available literature in support of our model. A more detailed paper with greater empirical depth that complements the theoretical model that follows can be found in de Mey *et al.* (2015). The next section discusses the implications for this in terms of agricultural policy. The last section summarizes and concludes.

Household-level policy and risk (management) analysis in agriculture

Risk management policies

Farm support policies in the EU have long been in place in several member states to provide income support for individual farmers depending on their size, production practices, output orientation and levels of market prices. Recently, risk management and income stabilization in agriculture have become a central point of European and national agricultural policies, induced by a growing consensus that the agricultural sector will face increased price and production volatility (OECD, 2011). Accordingly, the focus of farm support policies has recently shifted towards more specific risk mitigation policies (Cafiero *et al.*, 2007), in addition to a remaining focus on farm-level support. Recent estimates show that this support is again on the rise in 2012, after a historically low in 2011 (OECD, 2013). Also recently, the European Commission has suggested in its new proposed CAP reform a risk management toolkit as part of the Pillar 2 rural development measures that allow member states the opportunity to develop a mix of instruments (insurance, mutual funds, income stabilization tools) consistent with their current national insurance systems and laws (Tangermann, 2011).

In order to improve new policy measures directed towards risk and risk management, policy makers and researchers need to be able to predict how farmers will respond to changes in the institutional environment. Policy makers and researchers should look beyond intended effects and be especially concerned with unanticipated effects. As Freshwater (2002, p. 465) puts it "It is not appropriate to conclude that a program is successful if it has met its stated goals but has created significant harm in other areas".

Several unanticipated responses with regards to risk management policies have already been identified. Previous studies reveal that risk-reducing or income stabilizing government programs could induce risk-taking behaviour for farmers, e.g., growing more risky crops (Turvey, 2012), have adverse environmental externalities, e.g., reduced biodiversity (Di Falco and Perrings, 2005), or crowd-out other instruments, e.g., subsidized insurance schemes potentially reduce farmers' participation in forward contracting opportunities to hedge prices (Coble *et al.*, 2000). Another unanticipated effect is risk balancing, originally postulated by Gabriel and Baker (1980). Risk balancing refers to the fact that farmers strategically adjust the level of FR in response to exogenous changes in BR. On the one hand risk balancing entails a rational risk management strategy when farmers lower FR in response to an increase in BR; when on the other hand more FR is taken when the BR position improves, it involves an unanticipated entrepreneurship strategy to restore the original total risk level (de Mey *et al.*, 2014). The latter case led several authors to the notion of the paradox of risk balancing or the fact that when income-enhancing or BR-reducing policies (e.g. price stabilization policies) induce farmers to increase their FR, their overall risk position is left unchanged or even worse off (Featherstone *et al.*, 1988). The occurrence of risk balancing supports the policy goal of stimulating innovation and entrepreneurship, but the purpose of providing the farming population with a stable farm income, however, could be jeopardized by off-setting increases in the FR position.

Farm income as the focal point of agricultural policy

Initially, the focus of income support policy and research was the farm household, but in the 1970s it changed to the farm enterprise (Freshwater, 2007). As a result, the implicit assumption became that a farm household maximizes farm income. However, sufficient evidence exists that shows that the majority of farm households in the USA and Canada, attract a significant part of their income from non-agricultural sources (Freshwater, 2007; Mishra *et al.*, 2002). It is estimated that also in the EU many farm households attract a significant portion of their total household income from off-farm sources (OECD, 2003). For instance, a recent survey in the Flanders region in Belgium showed that only 34 per cent of the farming population had only agricultural income, the remaining 66 per cent attracting on average 35 per cent of their household income from elsewhere (Wauters *et al.*, 2014). A survey among farmers in Ireland showed that 25 per cent of the population attracted income from non-agricultural sources (Hennessy and Rehman, 2008). Earlier data from Austria (McNamara and Weiss, 2005) and France (Benjamin and Kimhi, 2006) also showed that many farmers spent a significant share of their time working time on non-agricultural activities. In Austria, about half of the farm households spent 50 per cent or more of their available working time off the farm. In France, 33 per cent of the male farmers and 42 per cent of the spouses reported working off the farm.

Farmers are known to be able to adapt to unanticipated changes in farm income, by cutting down household expenses, or by using household liquidities and/or capitalizing household/farm assets. Hence, Freshwater (2007) argued that the behavioural assumption of farmers maximizing farm income is no longer tenable and that to assess the impact of income support policies on welfare, the focus should return to the farm household. Already Gasson's (1973), seminal paper showed that farmers have a broad range of goals and values and that farm income maximization is only one of them. The relative priorities that are attached to each value explains farmers' economic behaviour when confronted with a choice (Gasson *et al.*, 1988). More recently, Lien *et al.* (2006) found that profit maximization as a goal was ranked rather low by both full-time and part-time crop and dairy farmers. Having a reliable and stable income, however, was ranked among the most important goals. Wallace and Moss (2002) also consider a series of alternative goals aside from conventional profit maximization and quantify the trade-off between family and farm goals. Profit maximization might be sound behavioural assumption for corporate/commercial farms, yet in 2010, 97 per cent of all farms in the EU were considered family farms (European Commission, 2013). Their importance in the agricultural chain might increase over time (Brookfield, 2008; Schmitt, 1991) and they are found to remain operational according to the notion of the disappearing middle in the size distribution of farms (Weiss, 1999). In her Agricultural and Applied Economics Association presidential address, Offutt (2002) also emphasized the importance of understanding the microeconomic behaviour at the household level in order to succeed in effective design and implementation of farm policies.

Risk analysis and management in agriculture: a new focus on the household level

Combining the findings of the two preceding sections, we advance the argument that the analysis of risk and risk management in agriculture should consider the farm household as the preferred level of analysis rather than focusing solely on the farm. This implies that measures of off-farm and total household-level risk are needed. The interdependence between the farm household and the farm is strong as they are intertwined both in terms of physical location and labour supply. There is also a financial dependency as farm and family accounts frequently coincide or are used for both purposes. The strong interaction between the farm and the farm household permits farm operational decisions to be influenced by, and to have influence on, a much broader range of alternative household-related factors than is assumed under the behavioural assumption of profit-maximization. For example, Jetté-Nantel *et al.* (2011) found that Canadian farmers' operational (production) decisions are influenced by off-farm income.

There is also a policy-related reason to start focusing more on household-level risk. The Agenda 2000 reform of the CAP still listed ensuring a fair standard of living for the agricultural community as an objective and further explicitly acknowledged the stability of farm incomes and the creation of abundant alternative income opportunities for farmers and their families as goals of the CAP. These objectives are clearly formulated with the farm household as the social unit in mind and hence in order to assess to what extent risk management policies succeed in realizing these objectives, a measure of household risk is warranted.

Whereas in the past, risk research mainly used aggregate data sets (Just, 2003), research and policy analysis on risk (management) is increasingly focusing on farm-level analyses (e.g. Kimura *et al.*, 2010), which is important as averaging may substantially misrepresent the risk farmers are facing at the individual level (Just and Weninger, 1999). We argue, however, that a final step towards better risk research and policy analysis is considering the farm household as the decision making unit[1], not ignoring the household layer of risk. Although the notion that farm household risk exposure and management is not limited to simply farm-level aspects and thus the household-level should be considered has been previously discussed in US/Canada-based research (e.g. Barnett and Coble, 2009; Freshwater and Jette-Nantel, 2011), EU-based research (e.g. Cafiero *et al.*, 2007; Vrolijk *et al.*, 2009) and has been pointed out by the OECD (2009, 2011), the fact that this notion has yet to permeate the agricultural risk management discipline in practice is quite surprising.

Conceptualizing and operationalizing household risk

This section will introduce the different risk concepts used in our extended risk balancing framework and present specifications to operationalize these concepts.

BR

BR is the risk inherent in the farming operation and is independent of the way the operation is financed (Gabriel and Baker, 1980; Barry *et al.*, 1981). BR is generally operationalized using a measure of farm return that is not influenced by the financing decision (such as Earnings Before Interest, Taxes, Depreciation and Amortization, operational cash flow or the rate of return on assets). From a probability distribution of any of these result parameters, several measures of risk may be derived, such as the coefficient of variation, the value-at-risk or the probability of a predefined disastrous outcome. Each measurement concept results in an alternative, yet identical representation of BR that leads up to analogous versions of the risk balancing model. For the remainder of this paper we will work with cash-based definitions as this definition allows the transition to the household level (United Nations, 2007). Following Gabriel and Baker (1980), we define BR in terms of a coefficient of variation:

$$BR = \frac{\sigma_{CF_o}}{\overline{CF_o}} \tag{1}$$

where $\overline{CF_o}$ represents expected operational cash flow and σ_{CFo} its standard deviation. The two major causes of BR in the farm are unexpected variability in production and in the prices of inputs and outputs. Whereas the level of BR is mainly influenced by external sources (e.g. market conditions, policy changes, environmental circumstances, the weather, pests and diseases), internal factors such as productive efficiency and general management skills might also play a role.

FR

FR is defined as the added variability on the return for owners of equity that results from the cash obligations associated with debt financing (Gabriel and Baker, 1980). Primarily, this risk results from the use of debt as leverage, which multiplies the potential BR that will be generated (Boehlje, 2002). Of course, there are other risks involved in the use of debt, most notably risks arising from uncertainties in the cost (interest rate) and availability of debt (Boehlje, 2002). FR can be specified as (Gabriel and Baker, 1980):

$$FR = \frac{\sigma_{CF_o^*}}{\overline{CF_o} - I_f} - \frac{\sigma_{CF_o}}{\overline{CF_o}} \tag{2}$$

where $\sigma_{CF_o^*}$ represents the standard deviation of operational cash flow with debt financing, but before the deduction of fixed debt servicing payments of the farm I_f. When working in cash flow terms, I_f involves both interest paid and principal, but only interest when using income-based definitions. Rewriting this expression and assuming no leverage-induced changes in the variability of cash flows yields[2]:

$$FR = \frac{\sigma_{CF_o}}{\overline{CF_o}} \frac{I_f}{\overline{CF_o} - I_f} \tag{3}$$

This equation demonstrates that FR can be regarded as a multiple of BR with the right-hand multiplier term reflecting the finance decision. When I_f equals 0, FR is 0, and total risk comprises only BR.

Total farm risk

Analogous to the definition of BR, the total risk of the farm (TR_f) is generally reflected in the variability of farm cash flow (defined as operational cash flow after debt financing deductions: $CF_f = CF_o - I_f$) or alternatively using accounting definitions in the rate of return to equity. More formally:

$$TR_f = \frac{\sigma_{(CF_o - I_f)}}{\overline{CF_o} - I_f} = \frac{\sigma_{CF_o}}{\overline{CF_o} - I_f} \tag{4}$$

where the second equation removes I_f from the standard deviation as it is assumed to be a fixed amount (an assumption made throughout this section).

Off-farm risk

Analogous to FR, we define off-farm risk (OFR) as the difference between the variability of household cash flow(defined as operational cash flow minus fixed debt servicing obligations plus off-farm cash flow: $CF_h = CF_o - I_f + CF_{of}$) and the variability of operational cash flow after debt financing deductions (*i.e.* TR_f):

$$OFR = \frac{\sigma_{CF_h}}{\overline{CF_h}} - \frac{\sigma_{CF_o}}{\overline{CF_o} - I_f} \tag{5}$$

where $\overline{CF_h}$ represents expected household cash flow and σ_{CF_h} its standard deviation. Rearranging Equation (5) as follows:

$$OFR = \frac{\sigma_{CF_o}}{\overline{CF_o} - I_f}\left(\frac{\sigma_{CF_h}}{\sigma_{CF_o}}\frac{CF_f}{CF_h} - 1\right) \tag{6}$$

which demonstrates that – analogous to FR – OFR can be regarded as a multiple of TR_f, where the multiplier now depends on both the share of farm cash flow in household cash flow and their relative variability.

Total household risk

Total household risk (TR_h) is the variability of household cash flow from all sources and is defined as[3]:

$$TR_h = \frac{\sigma_{CF_h}}{\overline{CF_h}} = \frac{\sqrt{\sigma^2_{CF_o} + \sigma^2_{CF_{of}} + 2Cov(CF_o, CF_{of})}}{\overline{CF_o} - I_f + \overline{CF_{of}}} \tag{7}$$

TR_h thus depends positively on: the variability of operational cash flow; the variability of off-farm cash flow; the interdependency of operational and off-farm cash flow; the fixed debt servicing obligation and depends negatively on expected operational cash flow and expected off-farm cash flow. An important implication of the interdependency of operational and off-farm cash flow is that when operational cash flow and off-farm cash-flow are countercyclical, i.e. regarding correlated in the covariance term, total household risk decreases, but increases when they are procyclical.

A first special case of Equation (7) is when there is no off-farm cash flow, i.e., a farm focuses entirely on agricultural production. In this case $\overline{CF_{of}}$, $\sigma^2_{CF_{of}}$ and $Cov(CF_o, CF_{of})$ are equal to zero, and expression (7) reduces to:

$$TR_h = \frac{\sigma_{CF_o}}{\overline{CF_o} - I_f} = TR_f \tag{8}$$

This special case amounts to the Gabriel and Baker (1980) framework, and suggests that when a decision maker can identify a constraint on TR_h, risk balancing between BR and FR may occur. Consider, for instance, that the decision maker identifies β as the maximum bearable level of TR_h[4]. Then Equation (8) can be rewritten as:

$$TR_h = \frac{\sigma_{CF_o}}{\overline{CF_o}}\frac{\overline{CF_o}}{\overline{CF_o} - I_f} \leqslant \beta \tag{9}$$

A shock in for instance price variability, causing σ_{CF_o} and hence BR to lower, can lead to an adjustment in the financing decision, with an equivalent increase in I_f. This decision may be a pure financing decision, an investment decision or both.

A second special case is when off-farm cash flow is non-zero but fixed, e.g., when a farmer family member has a steady extra off-farm job. In that case, the variability of off-farm cash flow and its covariance with operational cash flow equals zero:

$$TR_h = \frac{\sigma_{CF_o}}{\overline{CF_o} - I_f + \overline{CF_{of}}} \tag{10}$$

Rewriting this equation and considering an equivalent risk constraint β yields:

$$TR_h = \frac{\sigma_{CF_o}}{\overline{CF_o}} \frac{\overline{CF_o}}{\overline{CF_o} - I_f} \frac{\overline{CF_o} - I_f}{\overline{CF_o} - I_f + \overline{CF_{of}}} \leqslant \beta \tag{11}$$

This equation shows that a decision maker that sets a constraint on TR_h can assume more BR and/or FR when off-farm cash flow is positive and less when it is negative. This equation further shows that, in reaction to an exogenous shock that decreases σ_{CF_o} and hence BR, a decision maker with the objective of stabilizing household cash flow does not necessarily take on more FR (by changing I_f), he may also lower the household buffer he/she maintains by changing CF_{of}.

A third case is when off-farm cash flow is non-zero, stochastic but uncorrelated with operational cash flow, e.g., when a farmer receives a variable return from financial investments or he/his spouse has a flexible extra job. This is likely the most prevailing situation, as farmers are motivated to seek uncorrelated income streams when looking for off-farm opportunities (OECD, 2009). In this case, TR_h can be expressed as:

$$TR_h = \frac{\sigma_{CF_h}}{\overline{CF_h}} = \frac{\sqrt{\sigma^2_{CF_o} + \sigma^2_{CF_{of}}}}{\overline{CF_o} - I_f + \overline{CF_{of}}} \leqslant \beta \tag{12}$$

which increases with the riskiness of off-farm cash-flow, but decreases with expected off-farm cash-flow.

Risk balancing and liquidity management: the role of household components

In order to gain a better insight into the role of BR, FR and OFR in the determination of TR_h, we move away from operationalizing risk in variability terms and now look at risk in a probabilistic sense. This will also shed light on one of the merits of considering total household income and the risk thereof as determinants of farm household risk behaviour. We now define TR_h in terms of the probability that household cash flow is equal or falls below a certain critical level z:

$$TR_h = P(CF_h \leqslant z) \tag{13}$$

Using Chebyshev's theorem, an upper bound can be placed on this probability:

$$P(CF_h \leqslant z) \leqslant \frac{\sigma^2_{CF_h}}{\left(\overline{CF_h} - z\right)^2} \tag{14}$$

We can now identify α as the maximum tolerable level of TR_h a farm household is willing to accept, leading to the following risk constraint equation:

$$P(CF_h \leqslant z) \leqslant \frac{\sigma^2_{CF_h}}{\left(\overline{CF_h} - z\right)^2} \leqslant \alpha \tag{15}$$

As previously defined, household cash flow is equal to operational cash flow minus fixed debt servicing obligation of the farm plus off-farm cash flow. We now further expand this definition by introducing the role of liquidity reserves, both belonging to the farm (R_f) and to the household (R_h). One might think of liquidity reserves in terms of cash deposits on a bank account, but also in terms of liquid assets (Barry *et al.*, 1981). Further, we introduce the role of new loans, both for the farm business (L_f) and household (L_h). New loans also represent, in a way, a liquidity reserve and are dependent on the borrowing capacity of the farm household. New loans may be used to refinance existing loans and may also be used to reinvest in new farm or non-farm assets. We also introduce household debt servicing obligations (I_h), corresponding to the household loans. Hence, the total expression for household cash flow becomes:

$$CF_h = CF_o - I_f + R_f + L_f + CF_{of} - I_h + R_h + L_h \tag{16}$$

Introducing this expression into the risk constraint Equation (15) and assuming that operational cash flow and off-farm cash flow are the only two stochastic yet, by assumption, uncorrelated elements in this equation we obtain:

$$\sqrt{\sigma^2_{CF_o} + \sigma^2_{CF_{of}}} \leqslant \sqrt{\alpha}\left(CF_o - I_f + R_f + L_f + CF_{of} - I_h + R_h + L_h - z\right) \tag{17}$$

Dividing each side by CF_o and rearranging yields:

$$\frac{\sqrt{\sigma^2_{CF_o} + \sigma^2_{CF_{of}}}}{CF_o} + \sqrt{\alpha}\left(\frac{I_f}{CF_o} - \frac{R_f}{CF_o} - \frac{L_f}{CF_o} - \frac{CF_{of}}{CF_o} + \frac{I_h}{CF_o} - \frac{R_h}{CF_o} - \frac{L_h}{CF_o} + \frac{z}{CF_o}\right) \leqslant \sqrt{\alpha} \tag{18}$$

The conclusions from this equation are that a farm household can take a certain amount of BR and OFR, which are reflected in the first term on the left-hand side, and this tolerable amount of risk is increased by private and business liquidity reserves, private and business additional loans and off-farm cash flow and decreased by the amount of business and private debt servicing obligations and the size of the tolerable amount of TR_h. A farm household that wants to minimize the probability that household cash flow falls below a certain threshold, will have to adjust any of the elements in the numerators of the second element on the left-hand side equation.

Empirical evidence

Our conceptual model shows that the original Gabriel and Baker (1980) farm-level risk balancing hypothesis may be extended to include a trade-off between total farm risk and off-farm risk. Empirically validating the conceptual model, however, might prove difficult in practice as data on off-farm activities of farm households are typically unavailable to researchers or do not match the available farm-level accounting data sets. While off-farm information is available in the USA (Mishra *et al.*, 2002) and Canada (Jetté-Nantel *et al.*, 2011), off-farm information collection is not mandatory in the European Farm Accountancy Data Network (FADN) and accordingly only selected member states such as The Netherlands and the UK do collect some household variables.

An empirical verification of our household risk balancing model is provided in de Mey *et al.* (2015) for Swiss farm households in the period 2003-2012. The authors test an adapted version of our conceptual model that focuses on three household risk balancing components: first, farm FR; second, the share of off-farm income; and third, relative consumption. Switzerland is an interesting case study area; not only because the Swiss FADN data set contains the required detailed farm household information, but also because off-farm employment opportunities have been readily available to Swiss farmers in the study period. Estimating a fixed effects seemingly unrelated regression model, the authors find evidence of household risk balancing behaviour: an increase of 10 percentage points in BR levels leads Swiss farm households to lower farm FR with 0.286 percentage points, increase the share of off-farm income in total household income with 0.151 percentage points and lower the share of total household income spent on consumption with 9.01 percentage points. A sub-sample analysis further reveals heterogeneous household risk balancing effects according to farm size (defined based on on-farm family labour usage) which corroborates the findings of Uzea *et al.* (2014). Small farms appear to make most use of household-level risk balancing strategies (altering off-farm income and consumption) whereas large farms make more use of the original farm-level risk balancing strategy (altering farm FR).

Although not a formal proof of our model, the remainder of this section presents several stylized findings in the literature that provide some further empirical underpinning of our model. A well-covered topic in literature is that of off-farm employment. Our model suggests that an increase in BR may induce farmers to spend more time on off-farm work (given the other components in Equation 18). Conversely, their engagement in an off-farm activity may explain why certain farmers pursue rather risky farm activities. Particularly in North-America (Canada and the USA), this has been an extensively studied topic in the agricultural economics profession. Gardner (2005) writes that small farms are flourishing to an extent no one would have guessed 30 or 40 years ago, and that the main contributor to this finding is off-farm income which has reduced the riskiness of the on-farm income stream. There have been many empirical studies confirming the existence of a relationship between the level of farm income and off-farm income (e.g. Weersink *et al.*, 1998; Woldehanna *et al.*, 2000; Mishra *et al.*, 2002, Lien *et al.*, 2010).

More importantly, many papers confirm the existence of a link between the variability of farm income and off-farm employment in the USA and Canada (e.g. Jetté-Nantel *et al.*, 2011; Kyle, 1993; Mishra and El-Osta, 2001; Mishra and Goodwin, 1997; Mishra and Sandretto, 2002; Poon and Weersink, 2011). The main consensus in the USA and Canada is that for risk averse farmers off-farm employment increases in response to greater farm income variability and has helped to lower the variability of total farm household income variability. In the EU, less studies have been conducted – or reported – on this topic. In Ireland, Hennessy and Rehman (2008) showed that decoupling, which has consequences for the level and variability of farm returns, is likely to increase both the probability and the amount of time spent on off-farm labour. In Austria, McNamara and Weiss (2005) showed that on-farm diversification, a strategy to reduce BR from farming, had a negative impact on the probability of pursuing in part-time farming. The broader issue of pluriactivity of farm households has also been a topic well-covered in the sociological and rural development literature, both in the North Americas (e.g. Bessant, 2006) and especially in the EU, such as in the UK (Shucksmith and Smith, 1991), Norway (Blakesaune, 1996), Greece (Barlas *et al.*, 2001) and Ireland (Kinsella *et al.*, 2000). Pluriactivity refers to the diversification of activities of farm households (both farm-centred and off-farm) where a potential motivator to start new non-agricultural businesses was found to be reducing risk (Hansson *et al.*, 2013).

Another link suggested by our model is that between off-farm employment and farm FR. The existence of this link has empirically been shown in several studies looking at the determinants of debt usage (e.g. Collins and Karp, 1993, 1995; Katchova, 2005) and the results of Mishra and Goodwin (1997) also suggest that highly leveraged farms work more hours off-farm.

A final link related to off-farm employment is that with farm investments. The direction and sign of this interaction has been shown to be context specific, for instance depending on farm type, size, location and other factors (Andersson *et al.*, 2005). Hennessy and O'Brien (2008) found that the probability of investing in the farm decreased in Ireland when the farm manager engaged in off-farm employment whereas the effect of off-farm employment by the spouse was less clear.

Our model also suggests a link between off-farm investments and the components of total farm risk: BR and FR. Serra *et al.* (2004) found that higher fluctuations in farm income (i.e. BR) increase the share of non-farm assets in the farm household portfolio. Mishra and Morehart (2001) found that leverage (i.e. FR) and farm diversification decreased the possibility of off-farm investments, whereas non-farm aspects such as off-farm income and the household's net worth along with a farm operator's age, educational level, management skills increased the probability. Off-farm investments (e.g. in financial assets) can be an effective farm household income risk management tool similar to off-farm employment when the correlation between on-farm and off-farm investments is low (Nartea and Webster, 2008; Serra *et al.*, 2004).

As any other non-agricultural household, farm households will smooth their consumption to some extent in function of total household income variability (Langemeier and Patrick, 1990; Mishra *et al.*, 2002). The smoothing response can also be linked to BR, as most variability of total household income can be attributed to farm income variability (Mishra and El-Osta, 2001). The consumption changes also differ with regards to the source of income variability, as the marginal propensity to consume from off-farm income and government payments was found to be significantly greater than the propensity to consume from farm income (Carriker *et al.*, 1993; Sand, 2002).

A final link suggested by our model is that between farm-level risk and liquidity reserves; farm families will also maintain liquidity reserves/savings as a risk management strategy (Remble *et al.*, 2013). Facing higher future income uncertainty, farm households will – besides smoothing future income – accumulate more savings, called precautionary savings (Mishra and Chang, 2009). These savings were found to constitute about 8 per cent of total household wealth for farm households (Mishra *et al.*, 2013).

Discussion

With ample empirical support for the different possible interactions suggested by our model, the household risk balancing hypothesis suggests some important implications for the future of agricultural policy and research.

First, we advocate a micro-level, farm household approach to policy analysis (Offutt, 2002). In the EU, this is particularly important, given the ongoing CAP reform discussions and challenging, given the continuing resistance to broaden the agricultural statistics collection with household income data (Hill, 2002; United Nations, 2007). There is a need for better data to analyse at a minimum the effects of changes in agricultural policy and the general economic conditions on the well-being and behaviour of farm households, ideally a panel data set of farm households is constructed that allows looking at volatility and robust analyses (Boisvert, 2002). Policy analyses that are only focused on the farm level ignore potentially important farm household responses that affect the achievement of the intended policy effects. The assumptions that underlie most of the agricultural policy measures are very much targeted towards those farm families with a small household buffer or low possibilities to increase this buffer. Empirical evidence shows that this is in many countries not the majority of farm households. As such, expectations about responses of farmers to agricultural policy instruments, remain unfulfilled.

Second, our model suggests that current EU risk management policy, which is gradually moving towards the World Bank approach (Freshwater, 2007), allowing for subsidies on insurance premiums, should encompass a more broad view on agricultural risk management. Currently, the focus of agricultural policy is on just one of the elements of the household risk balancing equation, BR, since it is guided by a policy analysis framework that is focused at the farm level. Farm households, however, have created a new reality, one in which pluriactivity or part-time farming is the norm, rather than a marginal phenomenon restricted to small and less efficient farmers. In this new reality, farm households in the EU internalize the risks inherent in farming, by adjustments in off-farm risk stemming from consumption, off-farm employment, private liquidity reserves and private loans. Policies that aim to reallocate resources to more risky activities that provide larger benefits to society, in terms of resource efficiency and value creation, might consider targeting the other way around. More specifically, rural development policies that encourage multiple job holdings, or enable farm families to easily attract cash flow from non-agricultural sources may just as well induce them to engage in more risky farming activities, because it increases their total risk bearing capacity. In this respect, policies that enable farm households to maintain or even increase their household buffer, may be able to assume more BR, thereby allocating resources to more efficient activities and increasing their resilience (Jetté-Nantel *et al.*, 2011).

Third, the model also shows why, in certain sectors, some farm families persist even against all economic rationality, while others go bankrupt, or at least are in serious problems. Some farm families have built up a considerable household buffer or assume very low FR. These households are much less affected by variability in price and production than others. We believe that especially for such farm households, our model provides a valuable extension to the original Gabriel and Baker (1980) model. Our model suggests that the overreliance on price support policies in the past might have pushed farmers towards more FR and very low household buffers (Turvey and Baker, 1990; Kostov and Lingard, 2003; Woldehanna *et al.*, 2000; Ifft *et al.*, 2015). Recently, with the shift towards less distortive policies, coinciding with increased international trade, BR may have increased well above the constraint set by financial and household risk. More specifically, the expectation that farmers may alter the allocation of resources, in response to price stabilization policies, to more efficient production systems might be jeopardized. Gabriel and Baker (1980) assert that as a reaction, farmers may assume more FR. Our model shows that farmers may also change their household strategies, increasing their off-farm risk.

Conclusions

In this paper, we extend the original Gabriel and Baker (1980) risk balancing framework to the household level. We analytically show that, confronted with an exogenous change in BR, farm households may also respond by a change in household buffering strategies and not only by a change in their financial position, as posited by Gabriel and Baker (1980). Empirical evidence from previous literature regarding elements of our model is presented and important implications for policy makers and researchers are discussed. Future research could empirically validate our model for countries were data on both on-farm and off-farm activities of farm households are available. In the EU, however, this might prove difficult as only a few EU member states (e.g. The Netherlands (Vrolijk *et al.*, 2009)) meet these data requirements; comparable data across EU member states is non-existent ruling out a cross-country analysis. Acknowledging that the farm household is the preferred level of analysis for risk (management) research, our model advocates broadening agricultural statistics collection with household income data. Another important implication of our model is that EU policy makers have an extended set of policy instruments at hand to ensure a stable income and enhance the well-being of farm households by also considering rural development programs that facilitate off-farm opportunities. Future policies should account for the increasing heterogeneity of the agricultural sector and acknowledge the multiple dimensions of farm households. As the household situation will influence a farmers' decision to diversify their farm, studies are needed in order to understand future farm sector developments as this a highly prioritized themes in EU rural development policy (Hansson *et al.*, 2013).

Notes

1. Considering the farm household as the decision making unit is accomplished in household models that explicitly acknowledge that farm-level and household-level choices are endogenous and inseparable (Chayanov, 1966; Singh *et al.*, 1986). Farm household models are commonly based on the behavioural assumption of the maximization of subjective expected household utility. In our framework, we further identify that farm households are risk-constrained by aiming for an optimal level of household-level risk (see Section 4).
2. Gabriel and Baker (1980) assume, for most of their reasoning, that the standard deviation of cash flows with debt financing equals that without debt financing. This assumption may hold in practice, as debt financing is most often used to increase the scale of current operations, rather than removing some of the uncertainty inherent in current operations. Some farmers, however, take on additional new loans, thereby increasing debt to asset ratio, in order to decrease business risk. Indeed, many investments to decrease the risk inherent in normal farm operations require large funds, which most farmers can only acquire though debt financing. For these farmers, this assumption will be flawed.
3. Note that $\sqrt{}$ represents the principal (positive) square root throughout the manuscript.
4. The size of β depends on personal characteristics (e.g. the level of risk aversion of the farm operator), farm-level factors (e.g. profitability) and exogenous factors (e.g. general economic conditions).

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Corresponding author
Professor Erwin Wauters can be contacted at: erwin.wauters@ilvo.vlaanderen.be