Farm household risk balancing: empirical evidence from Switzerland

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Abstract

This paper presents the first empirical evidence on household risk balancing behavior, *i.e.*, strategic off-farm decisions in response to changes in expected business risk. Using Swiss FADN data, we estimate a fixed effects seemingly unrelated regression model to analyze how farm households jointly alter their levels of debt, off-farm income and consumption. Evidence suggests that in response to changes in expected business risk, farm households make strategic off-farm decisions. Our study demonstrates that part of the behavioral risk response of farm households is ignored when focusing solely on farm-level analyses and illustrates the relevance of the household risk balancing framework.

Keywords: Farm risk, off-farm risk, financial risk, off-farm income, consumption

1. Introduction

This paper presents the first empirical evidence on farm household risk balancing behavior, *i.e.* farm households making strategic off-farm decisions in response to exogenous changes in expected business risk (Wauters, *et al.*, 2014). The observed unanticipated behavioral responses demonstrate the relevance of the household extension to the original risk balancing framework by Gabriel and Baker (1980).

The original risk balancing framework describes a farmer's strategic choice of the level of financial risk in response to exogenous changes in expected business risk. Business risk comprises any risk that can be experienced (and managed) at the operational level (e.g., price risk, production risk, institutional risk) and is considered independent from the way the farm is financed. The financial structure of the farm implies additional financial risk stemming from the fixed financial debt obligations. The sum or product of business risk and financial risk constitutes the total farm-level risk.

The original risk balancing framework has had several theoretical extensions—most notably the utility-centric model by Collins (1985)—and empirical applications in predominantly US-based research. Recently, Wauters, *et al.* (2014) extended the risk balancing framework to the household level by analytically showing that exogenous changes in the farm's business risk position might just as well induce changes in household buffering strategies aside from changes in the level of farm financial risk. It is widely recognized that farm households have several buffering strategies at their disposal that smooth the variation in total household income, including earning off-farm income (e.g. Jetté-Nantel, *et al.*, 2011), smoothing consumption levels (e.g. Mishra, *et al.*, 2002), seeking off-farm investments (e.g. Serra, *et al.*, 2004) or maintaining liquidity buffers (e.g. Remble, *et al.*, 2013). Household risk balancing thus involves strategic changes in any of these buffering strategies in response to exogenous changes in expected business risk while aiming to stabilize total household risk.

This paper will present the first empirical application of the household risk balancing framework using Swiss farm accountancy data network (FADN) data. Although many papers have acknowledged the importance of farm household risk exposure and management in European agricultural economics research (e.g. Cafiero, *et al.*, 2007, Vrolijk, *et al.*, 2009), empirical applications explicitly recognizing the possibility of simultaneous adoption and the potential correlation between different on- and off-farm responses are limited which is not surprising given that only a few of the countries in the FADN network have the required data on both on-farm and off-farm activities of farm households. Switzerland is a very interesting case study because off-farm employment opportunities have been readily available to Swiss farmers in recent years and currently off-farm income thus constitutes nearly a third of total household income (FOAG, 2013).

2. Swiss Agricultural Production, Risk Exposure and Policies

Although the relative economic importance of agriculture is low in Switzerland—0.7% of Switzerland's GDP and below 4% of the employment rate was provided by agriculture in 2011—it is of great importance for the country's rural landscape as farming takes up nearly a quarter of the surface area (OECD, 2013). The dominant farm structure is the small family farm and dairy farms constitute the most prevalent farm typology. Intensive forms of farming are present in the valley region, compared to more extensive systems in the hills and mountain regions.

Swiss agriculture is highly protected, due to several agricultural policy measures in place (e.g. market price support and border protection). Although Switzerland has progressively reduced its support to farmers over time, overall government support remains high. This can be reflected in the high OECD producer support estimates (PSE) at 55% in 2011, which is almost three times the OECD (19%) or EU (17%) average (OECD, 2013).

A consequence of the high level of government protection and support is that Swiss farmers are less exposed to market price risk than their colleagues in neighboring countries and also makes them less vulnerable to climate volatility. Accordingly, Swiss agricultural gross revenues and household incomes are rather stable (El Benni, *et al.*, 2012). Regardless of the high level of income support, however, Swiss farmers do earn a lower income compared to other industries. For the 2010-2012 period, agricultural incomes reached between 41% (mountainous region) to 66% (plain region) of the comparable income earned in the industry or service sectors (Schmid and Roesch, 2013). Lips, *et al.* (2013) show for Swiss dairy farms that farmer's family members earn double the on-farm income per full-time employee when they work off-farm. The income composition of Swiss farm households has also changed over the last years: between 2003/04 and 2010/10 the agricultural income was almost stable at CHF 57,500, yet at the same time the off-farm income increased by 34% reaching CHF 20,000 (Lips and Schmid, 2013). The question arises, however, whether this increased reliance on off-farm income involves a risk-reduction strategy.

3. Methodology

3.1. Model Rationale

Risk balancing behavior entails strategic decisions in response to exogenous changes in the expected level of business risk. The original Gabriel and Baker (1980) risk balancing framework focusses solely on financial responses (*i.e.*, changes in the level of debt), whereas the extended household risk balancing framework goes beyond the original framework by also considering strategic off-farm responses (Wauters, *et al.*, 2014). These responses include changes in off-farm income, consumption levels, off-farm investments or liquidity buffers that determine the level of off-farm risk. Given the unavailability of data for the latter two responses, we will focus on off-farm income and consumption. We further assume that farmers form their expectations of future business risk based on past exposure to business risk.

Our overall regression rationale to analyze household risk balancing is thus regressing changes in past levels of business risk on three strategic decisions made by the farm household: (i) the level of financial risk, (ii) the amount of off-farm income earned and (iii) farm household consumption. We expect to find a negative relationship for financial risk in line with the original risk balancing hypothesis (increased expected business risk results in lowered financial risk).

Consistent with household risk balancing, we would expect farm households to lower off-farm risk in response to an increase in expected business risk by acquiring more off-farm income (positive relationship) and smoothing consumption levels (negative relationship). We further control for several additional risk balancing, farm(er) and household related characteristics based on literature. The definitions and expected signs of these regressors will be discussed in section 4.2.

3.2. Econometric Specification

First, we look at the original risk balancing hypothesis and estimate the following two-way fixed effects model (de Mey, *et al.*, 2014):

$$\boldsymbol{FR_{i,t} = \beta_{BR}(BR)_{i,t-1} + \beta x_{i,t} + \mu_i + \lambda_t + \varepsilon_{i,t}} \qquad \textbf{(1)}$$

where *i* and *t* are indexing farm and year, *FR* represents our dependent variable financial risk, *BR* characterizes our main variable of interest business risk and its β_{BR} associated coefficient, β represents the coefficient vector of the explanatory variables *x* elaborated above and μ, λ and ε symbolize the farm-specific, year-specific and idiosyncratic error terms respectively. By estimating a fixed effects regression model, we make use of the panel structure of our dataset to account for unobserved heterogeneity that varies across farms but does not change over time and vice versa. Note that due to using lagged values of business risk (to represent expectations) it is considered purely exogenous.

Next, we look at household risk balancing by considering the three following equations that reflect strategic responses to exogenous changes in business risk:

$$\boldsymbol{FR_{i,t} = \beta^1_{BR}(BR)_{i,t-1} + \beta^1 x_{i,t} + \mu^1_i + \lambda^1_t + \varepsilon^1_{i,t}} \qquad \textbf{(2)}$$

$$\boldsymbol{OFI_{i,t} = \beta^2_{BR}(BR)_{i,t-1} + \beta^2 x_{i,t} + \mu^2_i + \lambda^2_t + \varepsilon^2_{i,t}} \qquad \textbf{(3)}$$

$$\boldsymbol{CONS_{i,t} = \beta^3_{BR}(BR)_{i,t-1} + \beta^3 x_{i,t} + \mu^3_i + \lambda^3_t + \varepsilon^3_{i,t}} \qquad \textbf{(4)}$$

where *OFI* and *CONS* represent our dependent variables off-farm income and consumption, all other symbols are defined as before and the superscripts 1, 2 and 3 are introduced to refer to the financial risk, off-farm income and consumption equations respectively.

We will estimate equations 2 to 4 in a system of seemingly unrelated regressions (SUR) (Zellner, 1962) which captures the efficiency of modeling the correlation of the disturbances across equations. As our three equations represent decisions made by the same entity (the farm household), they cannot be considered to be autonomous and hence 3SLS estimates are not appropriate (Wooldridge, 2010: 239). As household risk balancing prescribes that a farm household simultaneously changes financial risk, off-farm income and consumption levels, we have no reason to hold any of the other two household responses fixed as would be the case in a 3SLS model. We account for the panel structure of the dataset by manually applying a within transformation to the data (*i.e.*, subtracting the within-farm mean from each variable).

One potential problem when following a SUR approach is heteroskedasticity, which leads to inconsistent estimates. Therefore, we will also estimate our system of SUR equations using generalized method of moments (GMM) with a weight matrix that specifically controls for heteroskedasticity and using the explanatory variables as instruments.

4. Data

4.1. Sample Description

Our empirical analysis makes use of the Swiss farm accountancy data network (FADN) dataset, which is collected and analyzed by Agroscope Reckenholz–Tänikon Research Station ART (Schmid and Roesch, 2013). The comprehensive database includes detailed information based on cost accounting and covers 10 years from 2003 to 2012. An unbalanced panel dataset is compiled from this source by selecting those farms that (i) do not have missing values for the key variables needed for estimation (ii) are present in the dataset at least four consecutive years (to calculate the lagged value of business risk, which in turn is calculated over 3 years), (iii) have a positive farm income (given the problematic calculation of the coefficient of variation of negative values) and (iv) do not present outlying values. The following observations were considered as outliers: financial risk measures greater than one, implausible consumption levels, negative values of interest paid or ROA and extreme level of farm income. Our final regression sample contains 12,827 observations covering 3,184 farms over 7 years, 23.4% of which are present the entire period.

4.2. Variables Definition and Expected Signs

The three main dependent variables in this study are financial risk, off-farm income and consumption. In line with Gabriel and Baker (1980), *Financial risk* is measured as the ratio of interest paid over farm income. Farm income represents the remuneration of family owned capital, labor and land and is calculated by subtracting intermediate costs, depreciation, wages paid, rent paid for land and interest paid from gross revenue including subsidies and taxes. *Off-farm income* comprises all income sources earned off-farm that are actively chosen by the farm household: wages earned by self-employment, wages earned by employment and income from investments. These income sources account for 60% of total reported off-farm income on average and exclude sources such as social transfers, pensions or inheritances that farm households do not actively choose themselves. *Consumption* measures the total monetary level of consumption of the family members living on the farm (it includes the categories insurance costs, car costs, housing costs, social contributions and other consumption including food expenditures).

Our main independent variable of interest, *business risk* (BR), is represented by the coefficient of variation of farm income before interest payments. We thus define risk in terms of the variability of outcomes and assume that farmers form their expectations of future business risk based on past levels of variation in income. Note that observed past level of variation only represent part of the potential risk that farmers faced. The coefficient of variation is calculated over a moving 3-year window. The 3-year period was chosen because business risk measures calculated over 4-year and 5-year periods were highly correlated (80%) with the 3-year measure. Hence, in order to retain as much observations as possible (recall that our dataset is unbalanced), we only considered 3-year measures. For our descriptive results in section 5.1, we additionally calculated *total farm risk* (TR_f) as the 3-year coefficient of variation of farm income and total household risk (TR_{hh}) as the 3-year coefficient of variation of household income, which is simply the sum of farm income and off-farm income.

The original risk balancing related independent variables are past values of the cost of debt, profitability and liquidity. The cost of debt is represented by the *interest percentage* paid on loans (interest paid over total outstanding debt). Profitability is measured by the rate of return on assets (ROA), calculated as the ratio of farm income over total assets. Liquidity is characterized by the monetary value of *current assets*. In our financial risk equation, we expect to find a negative relationship with past levels of profitability and a positive relationship with past levels of debt costs and liquidity (Gabriel and Baker, 1980).

The off-farm elements considered in this study are the existence of extra off-farm income, the units of consumption, the amount of children and the educational level of the farm operator. *OFI incomplete* is a dummy variable indicating whether additional off-farm income earned by the farm household was not completely reported under off-farm income. This variable mainly acts as a control variable, it should clearly be positively related to off-farm income and consumption. The amount of *consumption units* (UC) represents the standardized number of family members in the farm household. The householder accounts for one UC, other family members of 14 years or older account for 0.5 UC and 0.3 UC for children below the age of 14. Aside from an obvious positive influence on consumption, we would also expect a positive influence of household size on off-farm income as larger farm families can more easily share the on-farm work—making more time available for off-farm work—and potentially have some family members willing to fully work off-farm (Mishra and Goodwin, 1997, Goodwin and Mishra, 2004). The variable *children -16* additionally counts the number of children below the age of 16 that are part of the farm household. This variable captures the effect of having a higher composition of children in the household as we also control for the amount of UC. Accordingly, we expect a negative influence on off-farm income as children below the age of 16 are considered too young to work and a positive influence on consumption as having more children tends to increase the required household budget. An educational dummy represents whether the farm operator has had some form of household-related or nonagricultural *education* (e.g. an apprenticeship, a professional training, a mastercraftship or training at a technical college or university) or is currently in education. Having a formal education increases the amount of off-farm jobs available and hence potentially increases the amount of off-farm income that can be earned (Woldehanna, *et al.*, 2000, Alasia, *et al.*, 2009).

The farm(er) related variables considered in this study are direct payments, farm size, land tenure, age, farm income, liquidity and equity. In our financial risk model, *% Direct payments* represents the share of direct payments received in total gross revenue. This alternative formulation was chosen to prevent multicollinearity problems with farm size as direct payments are tied to farm area. This form of government support can be considered as a stable and thus low-risk income source. In that sense, they would allow farmers to increase debt usage in line with the original risk balancing hypothesis. In the off-farm income and consumption regression, *direct payments* simply represent the monetary amount of direct payments received. Previous research has suggested that government subsidies (coupled or decoupled) reduce off-farm labor participation (Ahearn, *et al.*, 2006). Therefore we would expect a negative influence of direct payments on off-farm income obtained in addition to a logical positive influence on consumption levels. Farm size measures the total *area* of the farm used for production in hectares. Previous research has suggested a positive relationship with debt usage (de Mey, *et al.*, 2014) and negative with off-farm income (Fernandez-Cornejo, 2007, Alasia, *et al.*, 2009). Larger farms potentially have higher consumption levels due to economies of scale allowing for increased income per family member. Land *tenure* represents the percentage of land under tenure of the farm household and is measured as the ratio of owned land over total farm size. As agricultural land prices are generally high in Switzerland (e.g. Giuliani and Rieder, 2003), we expect farm households who own a larger percentage of their land to have higher debt usage and would be motivated to gain more off-farm income. *Age* is the age of the farm operator, age^2 was also included in our models to account for potential second-order effects. We expect farmers prefer to decrease investments and pay off their debts as they become older and hence a negative relationship with financial risk. The relation with off-farm income is less clear to predict a-priori, however, as older farmers might have more difficulties finding an off-farm job (Goodwin and Mishra, 2004), but this potential decrease in hours worked off-farm might be compensated by increased hours worked on-farm and therefore complemented with off-farm income gained by the other household members. We anticipate that farm households with low amounts of *farm income* compensate by gaining more off-farm income (and vice-versa) and that getting more farm income has a positive influence on consumption levels. To take the typical consumption-saving tradeoff into account, we include the monetary amount of current assets as a proxy for savings in absence of more detailed information regarding the savings behavior of the farm households (assuming that part of the yearly amount saved ends up under current assets in the balance sheet as cash on a checking or savings account). Finally, we include equity as a proxy measure to take differences regarding household wealth into account. *Equity* represents the monetary amount of assets owned privately by the farm household (note that no clear distinction is made in the dataset between farm equity and farm household equity) and is expected to have a positive influence on consumption levels.

Table 1. Summary statistics

Variable	Mean	Std. Dev.	Unit
Dependent variables			
Financial risk (FR)	0.13	0.15	Ratio
Off-farm income (OFI)	1.42	2.26	10^4 CHF
Consumption (CONS)	7.34	2.64	10^4 CHF
Risk balancing			
Business risk (BR)	0.21	0.15	Coefficient of variation
Interest%	1.93	2.18	%
Return on Assets (ROA)	0.09	0.07	Ratio
Current Assets	1.22	0.93	10^5 CHF
Off-farm elements			
OFI Incomplete	0.25	0.43	Dummy
Consumption Units (UC)	3.52	1.46	UC
Children -16	1.05	1.35	Children
Education	0.10	0.30	Dummy
Farm(er) related			
Direct Payments	6.06	2.76	10^4 CHF
% Direct Payments	0.26	0.13	Ratio
Area	25.61	12.83	Ha
Tenure	0.64	0.28	Ratio
Age	48.21	8.37	Years
Farm Income	6.91	4.03	10^4 CHF
Equity	5.33	3.51	10^5 CHF

Notes: All monetary values deflated to 2012 values using the Swiss Federal Statistical Office CPI (http://www.bfs.admin.ch), N = 12,827

5. Results and discussion

5.1. Risk Exposure in Swiss Agriculture over Time, Region and Farm Typology

Figure 1 presents the volatility of the average levels of total farm risk, business risk and total household risk over the period 2005–2012. The general risk exposure—as measured by coefficients of variation between 0.20 and 0.25—in Swiss agriculture is low compared to other countries. de Mey, *et al.* (2014) report the EU-15 average farm-level business risk at 0.33 (1995–2008), while Poon and Weersink (2011) report average levels of total farm risk of as high as 3.8 for Canada (2001–2006). Overall, there is little year-to-year variation in the average levels of risk, barring a small surge in the year 2010. The later can be explained by recalling that we calculate risk over three-year periods, hence the 2010 risk measure spans the years 2008–2010, a period characterized by elevated prices for arable crops and milk, followed by a marked drop (Schmid and Roesch, 2013). The difference between business risk and total farm risk represents financial risk and the difference between total farm risk and total household risk represents off-farm risk. Whereas financial risk increases total farm risk relative to business by definition, off-farm risk can either stabilize or increase total household risk compared to total farm risk. On average, the relationship is a stabilizing one (average total household risk is lower than total farm risk), yet for 24% of the observations household-level risk is higher than farm-level risk.

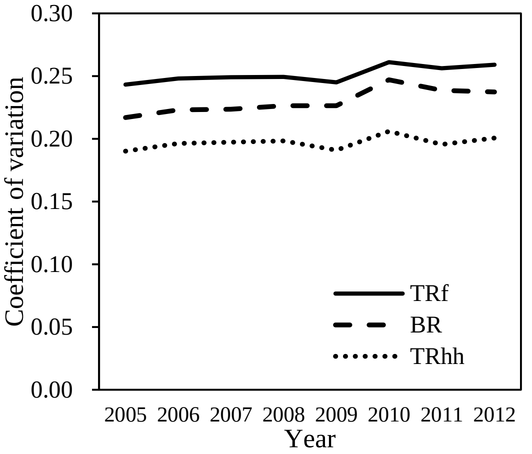

Figure 1. Comparison over time of average total risk at the farm level (TR_f), business risk (BR) and total risk at the household level (TR_{hh})

Table 2. Comparison over farm typology and region of average total risk at the farm level (TR_f), business risk (BR) and total risk at the household level (TR_{hh})

	TR_f	BR	TR_{hh}	N
Farm Type				
Dairy	0.217	0.193	0.168	5,109
Mixed	0.247	0.221	0.199	5,008
Crops	0.268	0.234	0.190	1,784
Animals	0.253	0.234	0.200	926
Region				
Valley	0.244	0.219	0.199	5,639
Hill	0.232	0.205	0.178	3,985
Mountain	0.237	0.210	0.171	3,203
Total	0.239	0.213	0.185	12,827

Notes: The Swiss FADN distinguishes 11 types of farms (Hoop and Schmid, 2013). These types were classified as follows: dairy (21), mixed (51 to 54), crops (11 and 12) and animal (22, 23, 31 and 41)

Table 2 compares the same risk measures from Figure 1 over farm typology and across the three distinct production regions in Switzerland. Four typologies were considered; dairy farms as these constitute the predominant farm type in Switzerland, and three general classes: mixed farms, crop based and animal based farms (other than dairy). We observe that the crop and animal based production types have above average levels of risk. A closer inspection of the data revealed that this is mainly accounted for by arable farms and pig farms, which are particularly susceptible to production risk (weather influences) and price risk (the hog cycle), respectively. Conversely, dairy farms have below average risk levels, which could be attributed to relatively stable milk prices—compared to the price volatility for crops and pork—and a higher share of direct payments. Differences across the production regions are less pronounced. One noticeable results is that the valley region has above average risk levels, as this is the region with most arable and pig farms and furthermore the share of direct payments in the farm's turnover increases with the altitude.

5.2. Regression Model Results on Farm-Level and Household-Level Risk Balancing Behavior

Table 3 presents the parameter estimates of our fixed effects (FE), seemingly unrelated regression (SUR) and generalized method of moments (GMM) models. All econometric models were estimated using the statistical package Stata. There is no indication of multicollinearity problems in the data, the variance inflation factors (VIF) of all regressors are between 1 and 2. We have reason to assume heteroskedasticity is present, as a modified Wald test for groupwise heteroskedasticity in fixed effects models (Greene, 2003: 598) for each individual equation indicated the presence of farm-specific error variances ($\alpha = 0.01$). We therefore clustered our standard errors by farm in the FE model and will compare our SUR model results with the heteroskedasticity robust GMM model results.

The first column in Table 3 presents the results of our original risk balancing FE regression model based on equation (1). We find no significant evidence that *ceteris paribus* Swiss farmers made strategic changes in financial risk in response to changes in expected business risk. A potential explanation for this finding is that interest rates have been low and stable in

Switzerland over the period under consideration (1.93% on average, Table 1). Debt was therefore easily available to Swiss farmers and hence the decision to change the level of financial risk was less driven by changes in business risk as it was not constrained. In line with our expectations from section 4.2, we find a negative relationship with past levels of profitability and a positive relationship with the share of direct payments, land tenure and past levels of liquidity. For area we find a significant negative yet small effect, where we would have expected a positive relationship as larger farmers generally have more access to credit. For age we would expect a negative relationship, yet obtain a positive coefficient that is only significant at 10% and is very low.

Table 3. Parameter estimates for the determinants of the financial risk (FR), off-farm income (OFI) and consumption (CONS) decisions made by Swiss farm households for the period 2006–2012 using fixed effects (FE), seemingly unrelated regression (SUR) and generalized method of moments (GMM) models

	FE	SUR			GMM		
	FR	FR	OFI	CONS	FR	OFI	CONS
Risk balancing							
BR_{t-1}	-0.0131	-0.0133**	0.2184***	-0.2107**	-0.0130	0.2191***	-0.2083**
	(0.0103)	(0.0061)	(0.0674)	(0.0913)	(0.0085)	(0.0689)	(0.0991)
Interest% $_{t-1}$	-0.0314	-0.0003			-0.0003		
	(0.0231)	(0.0004)			(0.0002)		
ROA $_{t-1}$	-0.1897***	-0.1964***			-0.1897***		
	(0.0307)	(0.0242)			(0.0247)		
Current Assets $_{t-1}$	0.0060*	0.0055***			0.0060**		
	(0.0031)	(0.0017)			(0.0024)		
Off-farm elements							
OFI Incomplete			0.2161**	0.2294*		0.2159***	0.2236**
			(0.0885)	(0.1198)		(0.0816)	(0.1015)
UC			0.0143	0.1720***		0.0143	0.1725***
			(0.0152)	(0.0205)		(0.0135)	(0.0230)
Children -16			-0.0719***	0.0494**		-0.0718***	0.0502**
			(0.0162)	(0.0219)		(0.0194)	(0.0228)
Education			-0.1087			-0.1277	
			(0.1201)			(0.1236)	
Farm(er) related							
% Direct Payments	0.5055***	0.5128***			0.5055***		
	(0.0435)	(0.0252)			(0.0336)		
Area	-0.0012**	-0.0012***			-0.0012**		
	(0.0006)	(0.0004)			(0.0005)		
Tenure	0.1305***	0.1303***	0.1882	0.2035	0.1305***	0.1876	0.1937
	(0.0211)	(0.0137)	(0.1491)	(0.2020)	(0.0160)	(0.1249)	(0.2314)
Age	0.0056*	0.0055**	0.1161***	0.2262***	0.0056**	0.1161***	0.2272***
	(0.0034)	(0.0024)	(0.0278)	(0.0376)	(0.0025)	(0.0312)	(0.0445)
Age^2	-0.0001	-0.0001**	-0.0013***	-0.0023***	-0.0001**	-0.0013***	-0.0024***
	(0.0000)	(0.0000)	(0.0003)	(0.0004)	(0.0000)	(0.0003)	(0.0004)
Direct Payments			-0.0623***	0.0673***		-0.0625***	0.0657***
			(0.0133)	(0.0180)		(0.0158)	(0.0236)
Farm Income			-0.0268***	0.0874***		-0.0275***	0.0818***
			(0.0040)	(0.0054)		(0.0051)	(0.0088)
Current Assets			0.1083***	-0.0708***		0.1083***	-0.0710*
			(0.0185)	(0.0250)		(0.0284)	(0.0417)
Equity			0.0082	0.0183		0.0081	0.0179
			(0.0099)	(0.0134)		(0.0148)	(0.0190)
Constant	-0.1643*	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000
	(0.0921)	(0.0006)	(0.0066)	(0.0089)	(0.0006)	(0.0066)	(0.0089)
F/Chi² test statistic	19.3***	674***	398***	548***			
R^2	0.0489	0.0489	0.0303	0.0383			
Wald test BR_{t-1}= 0		$\chi^2(3) = 21.46^{***}$			$\chi^2(3) = 18.2^{***}$		

Notes: Year dummies were included in each model but not reported for brevity, Standard errors in parentheses (clustered by farm for the FE model and robust for the GMM model), * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$, N = 12,827

The second column in Table 3 presents the results of our SUR regression models from equation (2) to (4). The correlation coefficients between the regression errors are low (0.0036, 0.0223 and 0.0702), yet the Breusch-Pagan Lagrange Multiplier test of independence rejects the H_0 that the disturbance covariance matrix is diagonal ($\chi^2(3) = 69.8^{***}$). Hence, our three equations cannot be considered independent and our SUR approach is appropriate as opposed to single equation estimation. Estimating the three equations in a system of regressions offers us a gain in efficiency and accordingly, we observe smaller standard errors in the FR equation compared to the estimates of the FE model. We find that expected business risk has a significant influence of the expected direction in each of the three equations and a joint Wald test furthermore confirms that the effect is also jointly significant ($\alpha = 0.01$) across the three equations. However, as we have indications of the presence of heteroskedasticity, we will not further discuss our SUR results and turn to our heteroskedasticity robust GMM estimation results.

The coefficient estimates of our robust GMM model—presented in the last column of Table 3—are nearly identical to the SUR model estimates (as they should be, the slight differences are due to the different estimation approach of the SUR and GMM methods) yet the standard errors differ as we now take heteroskedasticity into account. A joint Wald test indicates that expected business risk still has a significant ($\alpha = 0.01$) influence across all three equations. However, our robust results now indicate that expected business risk does not significantly influence financial risk decisions. We do find a significant positive influence on the level of off-farm income attained and a negative influence on consumption levels. The effects are small, however, as the model coefficients suggest that for an increase of 0.10 in expected business risk (a change of one within standard deviation), *ceteris paribus*, off-farm income increases with CHF 219 and consumption decreases with CHF 208.

Although the other explanatory variables in our model are mainly added as control variables and are of secondary interest, we will briefly discuss their role in explaining changes in the dependent variables. In the financial risk equation, we obtain the same coefficients for the additional control variables compared to the FE. In the off-farm income equation we find that having a greater proportion of children in the household decreases off-farm income as hypothesized. In the category of farm(er) related control variables, we observe that farm households that have an older farm operator and that have more liquid assets have greater levels of off-farm income. Conversely, farms receiving more direct payments and that have greater levels of farm income attract lower levels of off-farm income, which is in line with literature (Ahearn, *et al.*, 2006). Consumption levels are evidently greater in larger farm families and when the proportion of children below the age of 16 is higher. The farm operator's age, the level of farm income earned and the amount of direct payments received are furthermore found to have a positive impact on changes in consumption.

6. Conclusions

Farm households have several off-farm buffering strategies at their disposal that allow them to influence the variation in total household income, such as earning off-farm income, smoothing consumption levels, seeking off-farm investments or maintaining liquidity buffers. In this light, household risk balancing behavior refers to strategic changes in household buffering in response to exogenous changes in the expected business risk of the farm (Wauters, *et al.*, 2014). This household-level behavior complements original risk balancing behavior which comprises strategic changes in farm-level financial risk in response to the same exogenous changes in business risk (Gabriel and Baker, 1980).

The main objective of this paper is presenting the first empirical evidence on farm household risk balancing behavior. Using Swiss FADN data, we estimate a robust fixed effects seemingly unrelated regression (SUR) model to analyze how farm households jointly alter their levels of financial risk, off-farm income and consumption. The evidence supports the notion that farm households make strategic farm and off-farm decisions in response to the exogenous changes in expected business risk. Our model coefficients suggest that for an increase of 0.10 in expected business risk (a change of one within standard deviation), *ceteris paribus*, off-farm income increases with CHF 219 and consumption decreases with CHF 208.

The results of our study demonstrate that when focusing solely on farm-level analyses, an interesting part of the behavioral risk response of farm households is largely ignored. As important farm household responses are not revealed, the full impact of risk-related policies in the European region (e.g. price stabilization or subsidized insurance schemes) cannot be assessed. Therefore, a farm household approach to policy analysis is of great importance (Offutt, 2002), and calls for a broadening of the agricultural statistics collection with household income data. Future research could analyze household risk balancing behavior in those member states of the EU that collect reliable information on off-farm aspects (e.g. The Netherlands, Vrolijk, *et al.*, 2009). It would be valuable to compare results across countries as there surely are marked differences in off-farm opportunities, risk exposure and government support levels.

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