On- and Off-Farm Diversification

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1. Introduction

One striking feature of the post war prosperity in industrialised countries has been the reallocation of labor from agricultural to non-agricultural activities. This transition process is the result of two interrelated elements: restructuring in agriculture that has seen increasing specialization and concentration in agriculture production, and increased agricultural labor productivity that has resulted in a dramatic decline in the sector's labor requirements. As farm households adjust to these changes, part-time farming and multiple job holding (off-farm income diversification) have become strategies to support and stablize income, and for households that wish to transition into or out of agriculture.

Following Huffman's (1980) pioneering empirical work on farm household off-farm employment participation, the last two centuries have seen a considerable volume of empirical research on farm household labor allocation. However, as Mishra and Goodwin (1997) stress, limited attention has been devoted to the role of farm income in total farm household income variability. Referring to a U.S. farmer attitudes survey, they point out farmers reported the primary reason they worked off-farm was the variability, risk, and uncertainty associated with their farm income. In an econometric analysis of Kansas farmers' off-farm labor supply decisions, Mishra and Goodwin (1997) found a positive relationship between the coefficient of variation for farm income and off-farm work. That is, the greater the variability of farm income, the higher farmers' off-farm labor participation rate.

Off-farm employment (off-farm income diversification), however, is only one strategy to deal with income fluctuations and risk associated with agriculture. Another important means of reducing to farm household income variability and risk is diversification of on-farm production activities, or farm enterprises. Although the importance of this strategy has long been recognised (Heady, 1952), only a few econometric studies examining the relationship between farm enterprise diversification and farm household income variability have been conducted using micro-data (White and Irwin, 1972; Pope and Prescott, 1980; Sun, Jinkins and El-Osta, 1995). And, none of these studies incorporated the impact of off-farm income.

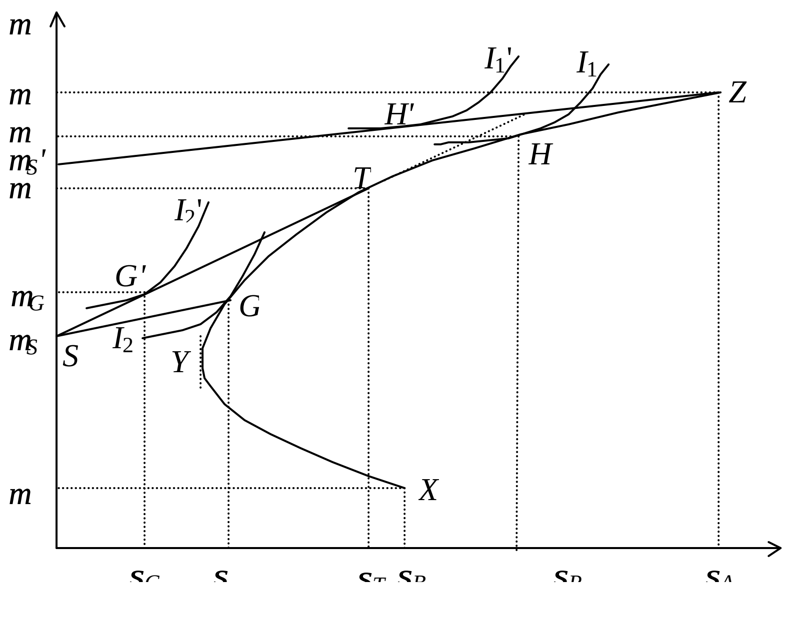
This paper brings together the two strands of literature by analysing the interrelationship between on-farm enterprise diversification and off-farm labor as farm household strategies to stabilize household income. Section 2 briefly describes the relationship between on-farm enterprise diversification and off-farm labor allocation as a household income stabilization strategy in a mean-variance approach. The data and the econometric results are presented in Section 3. A discussion of the results and conclusions are presented in Section 4.

2. The relationship between enterprise diversification and off-farm employment

Different arguments concerning the relationship between farm enterprise diversification and off-farm employment as strategies for income stabilization have been raised. In the following, we focus on the joint role of both activities as strategies to reduce farm household income risk.

Assume a farmer can devote labor and other resources to two farm production activities, *A* and *B* (Figure 1). Specialisation in one of these activities would yield income m_A or m_B , respectively, with (m_A > m_B). Weather conditions, market fluctuations, and other factors influence the actual income associated with m_A and m_B. Standard deviations of m_A and m_B are s_A and s_B , respectively, with (s_A > s_B). The correlation of income between the two activities is not perfect. By devoting different shares of resources to the production activities *A* and *B*, the farmer can realize all points on the efficiency frontier *XYZ* (Figure 1). Which she actually sellects on her income and risk preferences, described by indifference curves I_A and I_B. A risk averse farmer 2 prefers point *G* (with a low level of risk but also a lower level of average income). A less risk adverse farmer 1, on the other hand, would specialize in production of the more risky alternative (activity *A*) and choose point *H* in the diagram.

<u>Diagram 1</u>: Diversification and Part-time Farming in the mean-variance model



In addition to the two agricultural activities *A* and *B*, now assume that the farmer also can allocate some of her resources to off-farm income activities (employment). Allocation of all her time to off-farm employment would yield an income of m_S. While this income is associated with uncertainty related to broad economic conditions, it not associated the same degree of risk and uncertainty faced by agricultural production activities. For simplicity, the standard deviation of this off-farm employment income is set equal to zero. By allocating different shares of total working time across the two on-farm activities and off-farm employment, a farmer can realize linear combinations of point *S* with points on the efficiency frontier (*XYZ*). The relevant efficiency frontier for the farmer therefore becomes *STZ*. If the non-farm job were offered to farmer 2, the risk adverse farmer, she would choose point *G'* in Figure 1, devoting time to both on-farm and off-farm income activities.

What influence does allocating time to off-farm activity have on farm enterprise diversification? Point *G'*, representing an allocation decision that includes both off-farm and on-farm activity, is on the efficiency frontier *STZ*. Point *T* is the point on *STZ* below which the farmer allocated no labor to off-farm activity. Comparing point *G'* to point *G* (the optimal diversification decision for an otherwise identical farmer without the opportunity to work off-farm) indicates that the full-time farmer (point *G*) would be more diversified than the farmer at point *T* (since, according to Tobin's separability theorem, diversification on the farm in *T* and *G'* is identical). Thus we expect to find full-time farmers to be more diversified than part-time farmers.

Farmers' time allocation across farm enterprise options and off-farm labor choice is a signal of their risk aversion. Comparing farmer 1 (indifference curves I_1 and I_1') with a more risk adverse farmer 2 (indifference curves I_2 and I_2'), we find that farmer 2 chooses to allocate time to off-farm work, while farmer 1 does not. Thus, we expect the farmer with more on-farm enterprise diversification would have a higher probability of participating off-farm employment activity, ceteris paribus. As Figure 1 illustrates, we expect to find that (a) on-farm enterprise diversification is lower for part-time farms (defined as those who allocated more than half their time to off-farm activities), and (b) the likelihood of allocating labor off-farm employment is higher for farmers with diversified farms. Empirical test for both hypotheses are presented and discussed in the following section.

3. Data and empirical method

The empirical test of our analysis used panel data from 39,235 farm households in the Upper Austria. The data were collected by the census bureau in Upper Austria in 1980, 1985 and 1990 as part of the farm census. The farm census collects information on farm operations and farm household characteristics, (such as, age, sex, and schooling of various family members, the off-farm employment status).

Given the importance of dairy farming in Upper Austria, we sellected a size and diversification measure based on the number and type of livestock (measured in "median large animal units"). This aggregate measure of farm size can is broken down into nine sub-categories (calves, fattened cattle, cattle, piglets, sheep and goats, chicken, cows, fattened pigs, and brood sow). Indices based on these nine farm production enterprises were used to measure the degree of on-farm enterprise diversification.

Three indices are commonly used to measure diversification:

(1) a modified concentration ratio $D_C = \frac{Q - q^{\max}}{Q}$,

(2) the Berry-index (Berry, 1971) $D_B = [1 - \sum_{j=1}^{n} s_j^2]$, and

(3) the entropy measure (Jacquemin and Berry, 1979) $D_E = \sum_{j=1}^{n} s_j \log(\frac{1}{s_j})$,

where $s_j = \frac{q_j}{Q}$. Here, q_j denotes the quantity of product j with $Q = \sum_{j=1}^{n} q_j$, $q^{\max}$ is the quantity of the most important product in the group of all 9 products ($q^{\max} = \max(q_1, q_2, \ldots, q_n)$) and n is the number of products ($n = 9$). Note that complete specialisation implies $D_C = D_B = D_E = 0$, whereas the maximum level of diversification is given by $D_C = D_B = 1$ and $D_E = \log(n)$. The properties of these diversification measures are discussed in Gollop and Monahan (1991).

The census data report how farm households allocate time to off-farm work activities as one of three groups: (a) more than 90 % on-farm, (b) less than 90 % but more than 50 % on-farm, or (c) less than 50 % on-farm. Using these data, we classified groups (a) and (b) as “full-time farmers” ($PT = 0$) and group (c) as “part-time farmers” ($PT = 1$) for our analysis.

To guarantee a homogenous data base we restricted the analysis to farms included in each of the three census years and having all relevant data. A total of 39,621 farm households satisfied this criteria. Descriptions and summary statistics for each variables used are reported in Table 1.

A simultanious bivariate probit model was used to estimate the relationship between farm enterprise diversification and farm household off-farm labor allocation. The dependent variable for the on-farm diversification model was the diversity measure, *DB*, which has a 0-1 range. The dependent variables from the off-farm diversification model was part time farmer, a binary (0, 1) variable.

4. Results

Estimation results are presented in Table 2. Both the estimated coefficients for on-farm diversification (enterprise diversity) and off-farm diversity (part-time farming/working off-farm) are reported.

Farm size, as measured by the number of large animals on the farm, had a significant, non-linear relationship to income diversification. The probability of both on-farm and off-farm diversification, first increased with farm size, and then decreased. At the mean value, the effect of the size measure was negative in both the on-farm (enterprise diversity) and part-time farming (off-farm work) models. Larger farms tend to be more specialised and require more operator labor time. Consequently, they are less likely to be operated as a part-time farm.

The farm operator's age variable was not significantly related to the diversity measure, but had a significant non-linear impact effect on the probability of part-time farming. The parameter estimates suggest a negative but diminishing impact of age on farm operator's off-farm work participation.

The size of the farm family is another important factor determining diversification on the farm as well as off-farm labor market behaviour. An increase in the number of family members living on the farm was associated with a lower farm enterprise diversification. While family size was not significantly associated with part-time farming, marital status was. Married farmers were more likely to be part-time farmers.

Education, often associated with off-farm working participation in other studies, was not associated with farm diversification or part-time farming in our analysis. This suggests that wage rates are not influenced by the education measure we used, completion of general education.

PT and *DBERRY*, the on-farm and off-farm diversity measures used in the estimated models, were not significant in the respective models. However, the results suggest on-farm and off-farm diversification decisions are closely related. The degree of diversification was significantly lower for farms where the farm operator was working off-the farm in the previous period. On the other hand, the probability of entering into the off-farm labor market declined as the farm enterprise mix became more diversified. On-farm and off-farm diversification, thus seem to be close substitutes as strategies to reduce farm household income risk.

The degree of on-farm diversification, as well as the probability of off-farm diversification, was significantly related to farm characteristics (farm size and past farm growth), operator characteristics (age and schooling), and regional economic characteristics.

These results have important policy implications. Historically, government market intervention has sheltered domestic prices from international market price fluctuation. In the new economy of the European Union, domestic prices will be more closely tied to international price signals. Our results imply that these changes will result in more off-farm diversification and/or more on-farm diversification. Which of the two strategies actually is chosen by the farm operators will not only have important consequences for the performance of their individual farm but will also influence the structure of the farm sector in the future.

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Table 1: Definition and descriptive statistics of all variables used.

Variable	Symbol	Part-time Farms Mean (Std. Dev.)	Full-time Farms Mean (Std. Dev.)	All Farms Mean (Std. Dev.)
Number of Observations	N	20,999	18,622	39,621
Berry Index of Diversification1990	DB_{90}	0.374 (0.231)	0.526 (0.187)	0.445 (0.225)
Berry Index of Diversification 1985	DB_{85}	0.410 (0.212)	0.545 (0.170)	0.474 (0.205)
Part-time farming: married couple spends more than 50% of total working time on off-farm employment.	$PT_{i,90}$	1.000 (0.000)	0.000 (0.000)	0.530 (0.499)
Part-time farming: married couple spends more than 50% of total working time on off-farm employment.	$PT_{i,85}$	0.748 (0.434)	0.136 (0.343)	0.460 (0.498)
Farm size in 1985 is the Log of Livestock (measured in Median Large Animal Units)	$\ln(S)_i$	6.300 (1.329)	7.475 (0.848)	6.852 (1.272)
Farm operators age in years in 1985 devided by 40	$AGE_{i,85}$	1.199 (0.292)	1.097 (0.260)	1.152 (0.282)
Dummy for "general" Schooling: (=1 for degree from high school or university; = 0 else)	$EDU_{i,85}$	0.193 (0.394)	0.233 (0.423)	0.212 (0.408)
Dummy for farm operators married state (1=married; 0=unmarried)	$MARR_{i,85}$	0.871 (0.335)	0.810 (0.392)	0.842 (0.364)
Number of family members	$\#FAM_{i,85}$	4.9369 (1.8684)	5.0822 (2.0980)	5.0058 (1.9744)
Farm operators sex: (0 = male, 1 = female)	$GENDER_{i,85}$	0.1817	0.1033	0.1464
Region 1	$R1$	0.021 (0.144)	0.035 (0.183)	0.027 (0.164)
Region 2	$R2$	0.136 (0.343)	0.157 (0.365)	0.146 (0.354)
Region 3	$R3$	0.102 (0.302)	0.091 (0.288)	0.096 (0.296)

Region 4	*R*4	0.189 (0.392)	0.246 (0.431)	0.216 (0.411)
Region 5	*R*5	0.261 (0.439)	0.244 (0.429)	0.253 (0.435)
Hardshipzone 1	*HZ*1	0.256 (0.437)	0.237 (0.425)	0.247 (0.432)
Hardshipzone 2	*HZ*2	0.149 (0.356)	0.113 (0.317)	0.132 (0.338)
Hardshipzone 3	*HZ*3	0.133 (0.340)	0.098 (0.297)	0.117 (0.322)
Hardshipzone 4	*HZ*4	0.004 (0.065)	0.001 (0.034)	0.003 (0.053)

Table 2: Results of estimation models on diversification and part-time farming

Independent Variables		Dependent Variables DB_{90} Parameter	(t-value)	Dependent Variable PT_{90} Parameter	(t-value)
Constant		-0.926	(2.22)	1.211	(10.17)
Farm Size	$\ln(S)_{85}$	0.314	(4.03)	0.937	(34.05)
Farms Size^2	$\ln(S)_{85}^2$	-0.060	(-7.55)	-0.136	(-56.42)
Farm Operators Age	AGE_{85}	-1.039	(-1.62)	-3.045	(-19.64)
Farm Operators Age^2	AGE_{85}^2	0.275	(1.02)	1.598	(24.27)
Schooling	EDU_{85}	-0.028	(-0.37)	-0.083	(-4.58)
Number of Family Members	$\#FAM_{85}$	-0.055	(-3.10)	-0.034	(-0.01)
Marrital Status	$MARR_{85}$	0.132	(1.57)	0.543	(24.65)
Part-time farming	PT_{85}	-0.149	(-1.69)		
Diversification	DB_{85}			-0.014	(-0.32)
regional dummy variables					
Rho	RHO		0.071	(1.46)	