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Determinants of the Extension of Part-time Farming – Results from a Probit Approach

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DETERMINANTS OF THE EXTENSION OF PART-TIME FARMING – RESULTS FROM A PROBIT APPROACH

Abstract

This paper presents a Probit model explaining the employment decisions of farmers located in the German State of Hesse. The model is based on a cross-section analysis including data from 74 Hessian farmers. It indicates empirically a strong impact from wages on employment decisions of farmers. It also verifies the importance of the personal type of entrepreneur for their working behaviour. Finally, we can conclude that, regarding working behaviour, farmers react to signals from the labour market conditions as well as to the structural transformation process in the agricultural sector.

Keywords: Probit models, part-time farming, microeconomic household models, employment behaviour, labour markets

JEL classification: C25, D13, Q12, J22.

1. Introduction

During the last five decades the agricultural sector in the German Federal State of Hesse underwent a very intensive economic and social transformation which is still in process and manifests itself especially in both a significant reduction in the number of farms and a simultaneous increase in the average farm endowment with input factors such as arable land, pasture and livestock. Particularly, the number of farms in Hesse was reduced between 1963 and 2003 from 144,000 to 25,500. Meanwhile, the allocation of input factors in remaining farms grew significantly. For instance, the average cultivated land per farm went up from 6 hectares in 1963 to 30 hectares in 2003, while during the same period the average number of dairy cattle per dairy farm rose from 7 to 27. Correspondingly, yearly milk production per dairy cow increased from 3,700 kg to 6,400 kg and wheat yields per ha went up from 23 decitons to 70 decitons. In line with these developments, two further factors were incorporated in this structural change: the reduction of agricultural labour force on farms continuing production due to the increasing expansion of part-time farming and multiple-job holding. In this study we analyze the second element, namely multiple income-earning activities of farmers. Therefore, the aim of the present paper is to elaborate interdependencies between the local business conditions and the employment behaviour of farmers.

As in other Western European regions, part-time farming on small-scale farms in Hesse has a very long tradition. Particularly in the low mountain ranges covering about 60 percent of this State farmers have become accustomed over at least the last five hundred years to the combination of farming and other income sources. The main reasons for this are probably the rather low yields in agriculture because of natural conditions and job opportunities in other sectors (Harsche, 1998). Particularly in Southern and South-Western Hesse, the long-term economic development since World War II has, namely, created a diversified local economy offering people a wide range of job opportunities in several sectors such as chemical industry, banking, automotive industry and mechanical engineering. In the European perspective, similar agricultural structures can be observed in other regions partly characterized by low mountain ranges as well as general economic prosperity such as Luxembourg or Baden Württemberg. Consequently, results from this study could be in a way transferable to similar research topics.

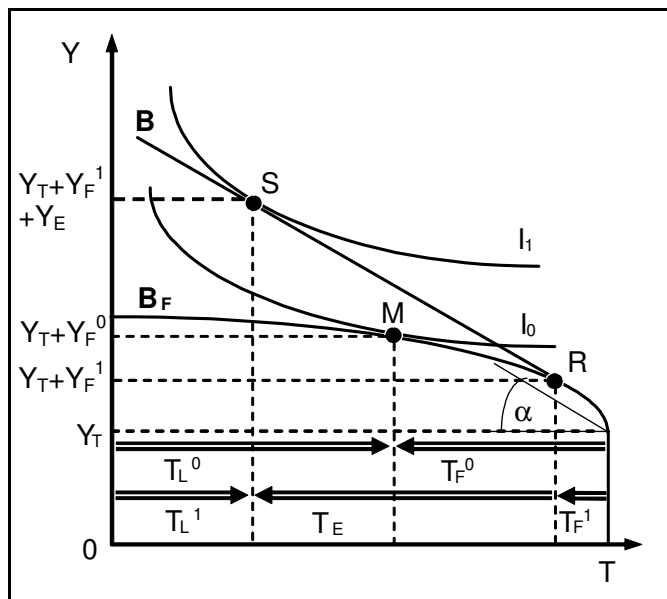
The last two decades have seen a lot of empirical work on the issue of part-time farming. For instance, Weiss (1997) performed a Probit model with three years' panel data from Upper Austrian farm households. On the one hand, he established that for these farmers wages have an impact on the probability of switching from full-time to part-time-farming. But on the other hand, according to this study there might be a significant relationship between wages and farmers' decisions to return from part-time farming to full-time farming. In another study based on cross-section data collected from farms

located in several North-Western German and Central German administrative districts Schulz-Greve (1994) came to the conclusion that there seems to be a negative interrelation between farm scale and off-farm employment. This paper is in some aspects similar to these studies. It also considers micro-economic issues by dealing with cross-section microcensus data at the single farm household level in combination with theoretical farm household models. We focus here on household cross-section data resulting from 74 farms located in the German Federal State of Hesse. With regard to this, the present paper illuminates the impacts of several variables on farmers' decision to practise part-time farming.

The present paper continues in Section 2 with a presentation of a theoretical household model, followed in Section 3 by an analysis of the extension of part-time farming in the State of Hesse. Section 4 reports the results of an analytical empirical model, while finally Section 5 gives some concluding comments.

2. The microtheoretical model

The theoretical approach presented here explains the time allocation of a farm household (Gebauer, 1988, Nakajima, 1986, Schulz-Greve, 1994). According to such a model, two budget lines are indicated in Figure 1: one budget line B_F , describing the income restriction for households working only on the farm, and another budget line B , illustrating the restriction for households being engaged in part-farming. In addition to this, there exists a group of indifference curves I_0, I_1 etc. representing the household's preferences with regard to leisure and working time.



- | | | | |
|------------|--|---------------|--|
| T | = Total time | T_L | = Leisure time |
| T_F | = Working time on farm | T_E | = External working hours off farm |
| I^0, I^1 | = Indifference curves | $\tan \alpha$ | = Wage |
| B_F | = Budget line resulting from farm work | | |
| B | = Budgetline resulting from combination of on-farm and off-farm work | | |
| Y | = Income | Y_T | = income resulting from transfers or capital |
| Y_F | = income resulting from farm work | | |
| Y_E | = income resulting from external off-farm work | | |

Figure 1: The Time Allocation of a Farm Household

The multiple-activity time-allocation equilibrium determines a total household income, which represents an income combination resulting from several sources, namely a fixed capital investment or transfer income (Y_T) in addition to external off-farm (Y_E) and on-farm (Y_F) earning activities respectively off-farm working time plus on-farm working time. If household members have only the oppor-

tunity to earn farm-based income, $Y_T + Y_F^0$ indicates the optimal income. It is determined by point **M**, which is the tangential point where the marginal rate of substitution between income Y and leisure time T_L corresponds to the marginal product of on-farm working hours T_F . The marginal product of on-farm working hours equals the inverse marginal utility relation between leisure time and income ($-dU/dL$) : (dU/dY):

$$-\frac{dY}{dT_L} = -\frac{\frac{dU}{dT_L}}{\frac{dU}{dY}} = \frac{dY}{dT_F} \quad (1)$$

Point **M** implies a time allocation which results in the magnitude T_L^0 illustrating leisure time and in the time T_F^0 indicating working hours on the farm.

But if household members have the opportunity to do on-farm work as well as off-farm work, the algebraic solution generates a new equilibrium and results in an income $Y_T + Y_F^1 + Y_E$, which is determined by point **S** where the marginal rate of substitution between income Y and leisure time L respectively the inverse marginal utility relation between leisure time and income $-dU/dL:dU/dY$ equals the off-farm employment wage $\tan \alpha$:

$$-\frac{dY}{dT_L} = -\frac{\frac{dU}{dT_L}}{\frac{dU}{dY}} = \tan \alpha \quad (2)$$

Finally, the optimal time allocation in the household results from point **S** as well as point **R** where the marginal product of on-farm work corresponds to the wage $\tan \alpha$ in off-farm employment:

$$-\frac{dY}{dT_F} = \tan \alpha \quad (3)$$

Consequently, the farming household's time allocation is divided into three activities: line T_L^1 represents leisure time, line T_F^1 determines on-farm working time and line T_E indicates the external employment hours. The optimal time allocation results in a total income that contains the fixed income Y_T , on-farm work income, indicated by Y_F^1 , and off-farm employment income, determined by Y_E . As a result from this theoretical approach we can conclude that many external and internal variables, such as reference wages, factor intensities, number of persons living in the household or agricultural production systems, may influence the aggregate employment decisions of household members.

With regard to enlargement of the model, it is also suitable to transform it into a comparative static model by changing the constellation of exogenous parameters determining the allocation of time. Variations of wages as well as policy instruments such as price support and direct transfers or introduction of transaction costs seem to be convenient examples for such an approach.

3. The expansion of part-time-farming in the State of Hesse

In context to the analytical framework in Section 2, the following results presented from a cross-section and times series analysis are intended to describe the real expansion and importance of part-time farming in several regions located in the German State of Hesse.

With regard to part-time farming, we illustrate here two interrelated agricultural structure variables: the percentage share of part-time farms in utilized agricultural area (UAA) and, second, the percentage share of number of part-time farms in total of farms. Figure 2 and 3 show us that due to structural change in agriculture these two indicators increased significantly 1979 through 1995. However, from the middle of the 90^{ies} there were reduced slightly. Results show also that particularly in *Southern Hesse (Regierungsbezirk Darmstadt)* the share of part-time farms in UAA is comparatively

small, and also that proportion of part-time farms in total of farms is rather low. Correspondingly, in *Southern Hesse* proportion of UAA amounts to 20 to 30 percent, whereas proportion of farms is shown to be between 40 and 65 percent.

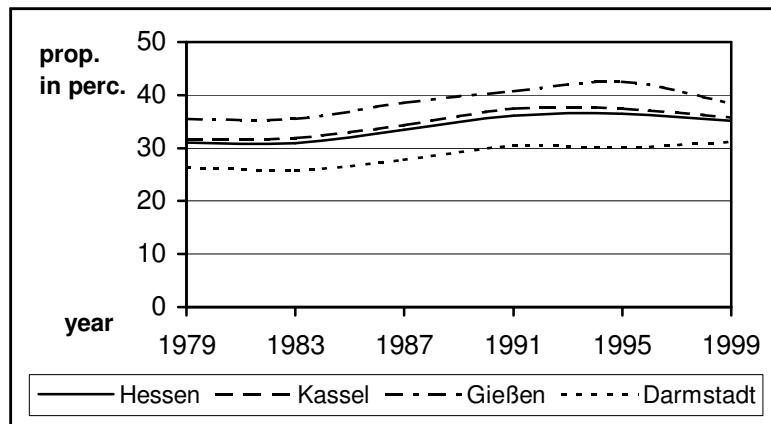


Figure 2. The share of part-time farms in utilized agricultural area in the *State of Hesse*
 source: calculations and graphics by the author, HSL (various issues), Kreiszahlen.

However, in several areas in *Northern Hesse (Regierungsbezirk Kassel)*, in addition to some in *Central Hesse (Regierungsbezirk Gießen)*, results show a very significant dominance of part-time farming in terms of number of farms. In these regions, proportion of part-time farms comes to between 70 and 90 percent. But, the share of the area cultivated in part-time farms is also rather low in these areas, namely between 40 and 55 percent. These figures lead us to the conclusion that there must be a high concentration of cultivated land in full-time farms.

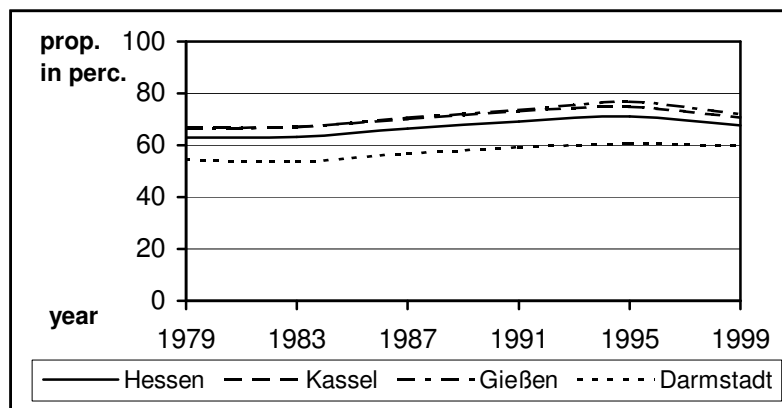


Figure 3. Proportion of part-time farms in total number of farms in the *State of Hesse*
 source: calculations and graphics by the author, HSL (various issues), Kreiszahlen.

Looking at the whole picture, we can conclude that across different regions in the *State of Hesse* the agricultural sector reveals a wide structural variety in terms of farm management type. First of all, interregional disparities in economic prosperity give rise to interregional structural differences in agribusiness (Herrmann/Harsche/Pfaff, 1999). Due to the general economic and social development across different regions, the agricultural structural change is at different stages.

4. Determinants explaining the extension of part-time farming

After explaining the importance of part-time farming in Hesse, we perform a probit model to work out interrelations between the extension of part-time farming and various independent variables. The data

base used includes cross-section data across 74 farm households located in the Lahn Dill Region which is in the western part of Hesse and characterized by low mountain areas and a high magnitude of industry in the regional economy. Data results from interviews (Stahr, 2001).

In the model we analyse as a dependent variable farmers' decisions to operate a part-time farm instead of a full-time farm. In relation to this, we focus on several household variables considering agricultural as well as non-agricultural aspects which are listed in table 1. Concerning the personality of the farmer, two several types of entrepreneur are distinguished: first, a type I who is risk willing, innovative, optimistic and socially integrated, and, second, a type II being rather risk averse, pessimistic and not very integrated. These two categories are derived by a cluster analysis in combination with a factor analysis based on data collected from answers to questions concerning personal characteristics of the farmers (Harsche, 2002). Being a parameter of the theoretical model, the type of entrepreneur may affect indifference curves as well as labour productivity. Numbers of adults respectively children living in the family give additional insights into social structure and labour capacity of the household which is also an essential theoretical component.

Variables concerning farm structure, namely endowment with land and size of land parcels, are also considered. According to the theoretical model presented above, these parameters have implications for labour productivity and, therefore, for the budget lines in figure 1. Share of leased land gives information on mobility of land. Namely, due to German law selling of land is much more complicated than to let on lease. Furthermore, proportion of grassland in total UAA combines several aspects. As a proxy variable it indicates, particularly, natural conditions in a region as well as implications from different instruments of agricultural policy related especially to grassland farming or arable farming. Policy issues are also considered by including the participation of farmers in agricultural policy programs implemented by the government of the State of Hesse. These programs are intended to give farmers additional incentives to extensification of farming.

Table 1. Descriptive Statistics of the Model Variables

Exogene Variable	Explanation	Unit	Mean	St.dev.	C. of var. (%)
<i>PART-TIME</i>	Part-time farming, 1=„yes“, 0=„no“	absolute	0,649	0,481	74,11
<i>ENTREPRENEUR</i>	Type of entrepreneur, 1=“Type 1“, 0=“Type 2“	absolute	0,554	0,501	90,43
<i>WAGE</i>	Non-agricultural wage	DM/h	20,833	3,560	17,09
<i>UNEMPLOYMENT</i>	Local unemployment rate, average quartal value of March 1995 until June 1997	percentage	9,66	0,33	3,42
<i>ADULTS</i>	Number of adults (at least 18 years old) living in household	persons	2,635	1,016	38,56
<i>CHILDREN</i>	Number of children (less than 18 years old) living in household	persons	0,770	1,340	174,03
<i>UAA</i>	UAA per worker	ha/worker	6,324	9,610	151,96
<i>LEASED LAND</i>	Share of leased land in total UAA	percentage	54,964	77,046	140,18
<i>GRASSLAND</i>	Share of grassland in total UAA	percentage	66,906	29,740	44,45
<i>FREERANGE</i>	Freerange farming, 1=“yes“, 0=“no“	absolute	0,162	0,371	229,01
<i>PARCEL</i>	Ø-size of agricultural parcel	ha	1,312	1,565	119,28
<i>POLICY</i>	Participation in regional agricultural policy programs HELP or HEKUL, 1=“yes“, 0=“no“	absolute	0,527	0,503	95,45
<i>DIETZHÖLZETAL</i>	Region Dietzhölzetal, 1=“yes“, 0=“no“	absolute	0,257	0,410	159,53

Source: calculations by the author, Stahr (2001), Landesarbeitsamt Hessen (various issues), Arbeitslose nach Gemeinden.

Variables relating to the local labour market are incorporated, as well. Particularly, reference wages paid in non-agricultural sectors may be an indicator for incentives to quit agriculture or to operate a part-time farm and are also an important parameter in the theoretical model. Data base of reference wages results from a wage function which was performed by considering several education characteristics of farmers such as school enrollment, working experience, training etc. (Harsche, 2002). Additionally, reference wages are weighted by local employment rates in order to regard job availability. Descriptive statistics and explanations are shown in Table 1. Particularly, variables concerning land endowment, share of leased land as well number of children living in the household are characterized by comparatively high coefficients of variation.

Many previous cross-section studies, such as the work of Weiss (1997), Schulz-Greve (1994) or Gebauer (1988), concentrate on part-time farming issues and focus on Logit or Probit models to explain the influence of variables on part-time farming at the farm household level. In line with this work, this paper applies a Probit model explaining farmers' employment decisions which can directly be linked to the theoretical household model presented in chapter 2.

Regarding the framework of the model presented in table 2, the Likelihood Ratio test which is common for non-linear models and comparable with F-test in linear models indicates an interrelation between the dependent variable and at least one of the independent variables (Pindyck/ Rubinfeld, 1998, p. 276). The regression model is characterized by a R-squared of 63 percent and, additionally, 85 percent of values of endogenous variable are assigned to the right category. Furthermore, with regard to T-values, majority of exogenous variables are significant at least at the 90 %-level. Exceptions are *LEASED LAND* and *FREERANGE*. However, because of methodological issues the parameter values are not suitable to be generally interpreted as "marginal effects". In the case of probit models such effects depend, namely, on the level of exogenous variables. A solution of this problem consists of performing "reaction coefficients" which are derived from average impulse probabilities across the whole sample.

First of all, we consider the type of *ENTREPRENEUR* and the size of household. The parameter value indicates that farmers of type 1 are less willing to operate a part-time farm than farmers of type II. Farmers who are rather innovative, risk willing and socially integrated in the local community prefer, apparently, full-time farming instead of part-time farming. This might be the case because personal characteristics of these farmers are comparatively more convenient to run an own full-time business. Numbers of *ADULTS* respectively *CHILDREN* living in the household show positive impacts on the preference for part-time farming. This finding is based on a working capacity argument: on the one hand, the more members belong to the family the more labour capacity can be allocated to pluri-active employment. On the other hand, due to the positive parameter the fact that education of children takes time seems to be not very essential.

Farm structure is characterized by heterogeneous influences on household's employment decisions. Land endowment, defined as hectares UAA per agricultural worker, shows a positive regression parameter. A small labour intensity is suitable for being engaged in an additional employment besides farming. Share of *GRASSLAND* in total UAA has a negative impact on the decision to operate a part-time farm. Additionally, the proportion of grassland is an indirect indicator for impacts from agricultural policy because, due to the corresponding production systems, grassland farming and arable land farming are politically affected in different ways. The average size of *PARCELS* cultivated by the farmer shows also negative implications. Although there does not exist an "optimal" size of land parcels, in general, up to some level of parcel size labour productivity increases. Consequently, high labour productivity provides an incentive to operate a full-time farm.

Particularly, we focus on the labour market. Obviously, wages in other sectors have a strong impact on farmers' working decisions. Due to a shift of the budget line in our household model we can conclude an ambiguous finding from microeconomic theory which includes an income as well as a substitution effect. Due to the empirical model, a plus in *WAGE* yields a significant positive impact on farmers' decision for part-time farming. Attractive wages in other sectors may give, in general, an incentive to practise a combination of on-farm and off-farm work.

Table 2. Estimation results of the probit model

Exogene variable	Parameter value	T value	coefficient of reaction ^{b)}
Konstante	-16,060	-2,697***	-2,544
<i>ENTREPRENEUR</i>	-1,350	-1,775*	-0,197
<i>ln WAGE</i> ^{a)}	4,773	2,636***	0,698
<i>ADULTS</i>	0,922	2,280**	0,135
<i>CHILDREN</i>	2,045	2,939***	0,299
<i>ln UAA</i>	1,352	2,916***	0,198
<i>TENANT LAND</i>	-0,453*10 ⁻²	-1,382	-0,001
<i>GRASSLAND</i>	-0,039	-3,282***	-0,006
<i>ln PARCEL</i>	-1,233	-2,370**	-0,180
<i>FREERANGE</i>	-1,226	-1,276	-0,179
<i>POLICY</i>	1,171	1,666*	0,171
<i>DIETZHÖLZETAL</i>	1,230	1,702*	0,180

R²=0,63 scal. R²=0,69 N=74 n=48 Correct assigned: 85,1 percentage LR-Test =57,289***

***(**, *) significant on 99% (95%, 90%) level.

^{a)} wages are weighted by local employment rate (= 1 – *UNEMPLOYMENT* rate), average quarterly values from March 1995 until June 1997).

^{b)} Reaction coefficients are calculated as sample means of impulse probabilities.

Source: calculations by the author, Stahr (2001), Landesarbeitsamt Hessen (various issues), Arbeitslose nach Gemeinden.

Concerning issues of agricultural *POLICY*, we recognize that participation of farmers in regional extensification programs maintains their tendency to prefer part-time farming instead of full-time farming. However, some farmers may be in favour of political transfer payments, although they anyway tend to extensify their production systems because of other reasons.

Finally, we discuss aspects of regional economic structure. According to model results, farmers located in the *DIETZHÖLZETAL* region show a preference for running a part-time farm. In the sense of a job availability argument, this region is particularly characterized by a comparatively strong economic prosperity offering a wide range of employment opportunities, especially in the industrial sector.

If we consider these results in context to other work carried out on part-time farming, we see that some authors conclude remarkable as well as comparable findings. For instance, using a Probit model, Weiss (1997) comes to the conclusion that high wages in other sectors attract farmers to switch into part-time farming by a strongly significant parameter coefficient. The results of Huffman's (1980) regional cross-section study show also a significant positive interdependence between the proportion of part-time farms and external wages, indicating a wage elasticity of 0.34 for male farmers and 0.33 for female farmers. Sumner (1982) analyses farmer's working hours in non-agricultural jobs by means of a household cross-section model. He comes to the conclusion that a one percent increase in wages results in a 1.13 percent increase in the number of non-agricultural working hours. Using a Logit model, Gebauer (1988) worked out that a farm income higher than DM 30,000 reduces significantly the incentive to practise part-time farming. The results of all those studies are comparable with the results of this research because in most cases the authors analyzed similar topics, but used a different range of independent variables from the variables included in this study.

5. Concluding remarks

After an introduction into the topic, we analysed in Section 2 the theoretical microeconomic calculus explaining part-time farming as a phenomenon in household's time allocation. In this context we derived a model equilibrium which results in three types of time utilisation: on-farm working hours, off-farm working hours and leisure time.

Illustrating the real expansion and importance of part-time farming in Section 3, the cross-section analysis of several regions (*Regierungsbezirke*) of the State of Hesse leads us to the conclusion that from 1979 until 1995 the extension of part-time increased significantly, whereas it was reduced since 1995. Additionally, in several districts in Southern Hesse the proportion of part-time farm land, as well as the proportionate number of part-time farms in relation to all farms, is rather low. In contrast to this, we notice the considerable importance of part-time farming in Central and Northern Hesse in terms of the proportion of part-time farms. However, the share of the area cultivated in part-time farms in these regions is rather low, indicating a concentration of land in full-time farms. Obviously, interregional differences according to the expansion of part-time farming correlate with interregional disparities in economic development.

The econometric analysis produces significant results on how various agricultural as well as non-agricultural parameters affect part-time farming on the household level. In particular, a growth in wages results in a tendency to operate a part-time farm. High numbers of adults respectively children living in the household are also convenient for part-time farming. In contrast to this, farmers prefer full-time farming if they are innovative and optimistic entrepreneurs.

Further research activities considering part-time farming topics could place more emphasis on analysing variables concerning agricultural parameters such as climatic conditions and bequeathing of farm capital.

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