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Stefan MANN, Laure LATRUFFE, Werner HEDIGER

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Stefan MANN

Research Station Agroscope Reckenholz Tänikon, 8356 Ettenhausen, Switzerland

Laure LATRUFFE

INRA, UMR1302 SMART, F-35000 Rennes, France
Agrocampus Ouest, UMR1302 SMART, F-35000 Rennes, France

Werner HEDIGER

Bern University of Applied Sciences, Swiss College of Agriculture SHL, Zollikofen, Switzerland

Auteur pour la correspondance / Corresponding author

Laure LATRUFFE
INRA, UMR SMART
4 allée Adolphe Bobierre, CS 61103
35011 Rennes cedex, France
Email: Laure.Latruffe@rennes.inra.fr
Téléphone / Phone: +33 (0)2 23 48 53 93
Fax: +33 (0)2 23 48 53 80

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Abstract

Differences between part-time farmers and full-time farmers are examined both theoretically and empirically. We develop the hypotheses that capital to labour ratio, labour productivity in the provision of both private and public goods, and agri-environmental payments received are higher for part-time farmers. FADN data for Swiss dairy farms in 2004 confirm the higher capital to labour ratio as well as higher agri-environmental payments for part-time farms, albeit no differences for the labour productivity of milk production

Keywords: farm labour, off-farm income, public goods, agri-environmental payments, Switzerland

JEL classifications: Q12, Q18, J22, Q57

Productivité du travail agricole et fourniture de biens privés et publics – L'influence du revenu hors exploitation

Résumé

Les différences entre exploitants agricoles pluriactifs et exploitants à plein temps sur leur exploitation sont analysées théoriquement et empiriquement. Nous développons l'hypothèse que le ratio capital sur travail, la productivité du travail pour la fourniture des biens privés et publics, et les aides agri-environnementales, sont plus élevés pour les agriculteurs pluriactifs. L'analyse empirique sur données d'exploitations laitières issues du RICA suisse pour l'année 2004 confirme un ratio capital-travail supérieur ainsi que des aides agri-environnementales plus élevées pour les exploitations pluriactives, mais aucune différence significative concernant la productivité du travail pour la production de lait.

Mots-clefs : travail agricole, revenu hors exploitation, biens publics, aides agri-environnementales, Suisse

Classifications JEL : Q12, Q18, J22, Q57

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1. Introduction

Since Fuller (1990) stated that the characteristics of full-time farms would not differ systematically from the characteristics of part-time farms, some agricultural economists have revealed such differences. One difference with particular importance to the environment is the intensity of production. Phimister and Roberts (2002; 2006) have shown repeatedly that the general intensity is lower for part-time farmers, even if the latter tend to use more pesticides than full-time farmers. Accordingly, Ellis et al. (1999) show that the biodiversity of grassland on part-time farms tends to be higher than that on full-time farms. In fact, for the provision of public goods at least, part-time farms appear to have some advantages over full-time farms.

Agricultural Policy has been transformed in recent decades in a way that the delivery of public goods is increasingly encouraged by direct payments from the government to the farmer. Both the switch from market support to direct payments (Gelauff et al., 2006), the increasing share of payments under cross-compliance (Mann, 2005) and the large number of agri-environmental schemes (Hodge, 2000) were intended to decrease the intensity of production. Extensive agricultural production is a mode of production which, at least in the Northern hemisphere, maximizes the potential for biodiversity and for resource quality (Ostermann, 1998; Caraveli, 2000).

Does this mean that part-time farming can deliver more efficiently these public goods that are required by society? Would the opportunity costs to extensify production be lower if there is a significant off-farm income? These are the questions which this paper aims to answer with the example of Swiss farmers. The example of Switzerland is particularly suitable for our question because the Swiss government actively follows the strategy of a multifunctional agriculture (Mann, 2003) and it represents a broad range of cultures (Losa and Origoni, 2005). It provides direct payments for its farmers for a large number of public goods, resulting in one of the highest subsidy levels in the world (OECD, 2006).

We proceed as follows: Section 2 theoretically develops our hypotheses. Section 3 uses the case of Swiss farm-level data to verify these hypotheses empirically. Section 4 presents the results and Section 5 concludes.

2. Theoretical hypotheses

Three hypotheses are developed and tested in this paper. The first hypothesis is that the capital to labour ratio for part-time (PT) farms is greater than that of full-time (FT) farms. The second hypothesis is that the labour productivity on PT farms is higher than on FT farms. Finally, the third hypothesis is that PT farmers receive more direct payments from agri-environmental programmes per labour unit than full-time farmers do.

Following the theoretical setup of Fall and Magnac (2004) for investigating the value of on-farm work to farmers, we assume here that farmers maximise instantaneous utility U derived from consumption C and leisure time X, and from being a farmer and enjoying on-farm work L_{on}. Accordingly, an individual farmer's utility function can be written as $U = U(C, X, L_{on})$. The farmer's decision problem is then to maximise his/her utility subject to his/her time and income constraints. The farmer's time allocated to leisure X, on-farm labour L_{on} and off-farm labour L_{off} cannot exceed his/her time endowment T:

$$T = X + L_{on} + L_{off} \tag{1}$$

The monetary budget constraint encompasses both on-farm and off-farm incomes restricting the farmer's consumption opportunities and payment of capital costs, with p denoting the farmer's product price, w_{off} the wage rate for off-farm employment and q the unit cost of capital:

$$pf(L_{on}, K) + w_{off} L_{off} \geq C + qK \tag{2}$$

For simplicity, we assume a single output Y that is produced with only labour and capital input, $Y = f(L_{on}, K)$.

Altogether, the above optimisation problem can be represented by the following Lagrangean that is to be maximised with respect to C, X, L_{on}, L_{off} and K:

$$\Im = U(C, X, L_{on}) + \lambda\left[pf(L_{on}, K) + w_{off} L_{off} - C - qK\right] + \mu\left[T - X - L_{on} - L_{off}\right] \tag{3}$$

2.1. No off-farm employment option

First, we investigate the case that no options for off-farm employment exist. This is the case with L_{off} = 0 and C, K, X, L_{on} > 0. The first-order optimality conditions of this allocation problem are:

$$\frac{\partial \Im}{\partial C} = \frac{\partial U}{\partial C} - \lambda = 0 \tag{4a}$$

$$\frac{\partial \Im}{\partial K} = \lambda \left[p \frac{\partial f}{\partial K} - q \right] = 0 \tag{4b}$$

$$\frac{\partial \Im}{\partial X} = \frac{\partial U}{\partial X} - \mu = 0 \tag{4c}$$

$$\frac{\partial \Im}{\partial L_{on}} = \frac{\partial U}{\partial L_{on}} + \lambda p \frac{\partial f}{\partial L_{on}} - \mu = 0 \tag{4d}$$

From these equations we get the following efficiency conditions:

$$\lambda = \frac{\partial U}{\partial C} > 0 \tag{5a}$$

$$pf_K = q > 0 \tag{5b}$$

$$\mu = \frac{\partial U}{\partial X} = \frac{\partial U}{\partial L_{on}} + \lambda pf_{L_{on}} > 0 \tag{5c}$$

with $f_{L_{on}} = \dfrac{\partial f}{\partial L_{on}} > 0$ and $f_K = \dfrac{\partial f}{\partial K} > 0$.

The shadow price of the monetary budget constraint, λ, is equal to the marginal utility of the farmer's total consumption; i.e., his/her marginal utility of income (5a). Capital must be engaged in the production process such that it is reimbursed according to its marginal value product $q = pf_K$ (5b). Finally, time allocation to labour and leisure must be such that the marginal utility of leisure $\partial U / \partial X$ is equal to the marginal benefit the farmer gets from allocating labour on the farm (5c); that is, the marginal on-farm labour income $\lambda pf_{L_{on}}$ plus the marginal benefit $\partial U / \partial L_{on}$ from enjoying farm work.

Using equations (5a) and (5c) we get:

$$\frac{\mu}{\lambda} = pf_{L_{on}} + \frac{\partial C}{\partial L_{on}} = \frac{\partial C}{\partial X} \tag{6}$$

Equation (6) shows that the farmer's opportunity cost of leisure, $pf_{Lon} + \partial C / \partial L_{on}$, includes besides the value of the marginal product of on-farm labour, $pf_{L_{on}}$ a surplus that he/she receives from enjoying farming activities. This makes the farmer sacrifice income (consumption) and leisure in favour of more labour time spent on the farm.

Moreover, by simple transformation, we get:

$$pf_{L_{on}} = \zeta - \psi = \frac{\partial U/\partial X - \partial U/\partial L_{on}}{\partial U/\partial C} \tag{7}$$

with ζ denoting the marginal rate of substitution between consumption and leisure, $\zeta = \partial C/\partial X$, and ψ the marginal rate of substitution between consumption and on-farm labour, $\psi = \partial C/\partial L_{on}$.

Equation (7) shows that the marginal product of on-farm labour, $pf_{L_{on}}$, is determined by the difference between these two marginal rates of substitution. It is smaller the larger the farmer's marginal enjoyment (marginal utility) of on-farm labour is. This is particularly relevant when it comes to the comparison with wage rates for off-farm employment, such as investigated in the following.

2.2. With off-farm employment option

Next, we extend the above analysis and include the option of off-farm labour. Thus, the first-order optimality conditions in (4a) to (4d) must be formally completed with the subsequent Kuhn-Tucker conditions that allow for the fact that a farmer's decision can be either to allocate some time for income generating off-farm activities L_{off} and become a PT farmer, or to remain a FT farmer without off-farm labour:[1]

$$\frac{\partial \Im}{\partial L_{off}} = \lambda w_{off} - \mu \le 0 \quad , \quad \frac{\partial \Im}{\partial L_{off}} L_{off} = 0 \quad , \quad L_{off} \ge 0 \tag{8}$$

From this we get:

$$\frac{\mu}{\lambda} \ge w_{off} > 0 \tag{9}$$

And we can conclude:

a) As long as $\frac{\mu}{\lambda} = pf_{L_{on}} + \psi = \zeta > w_{off}$, optimal allocation requires $L_{off} = 0$. This corresponds to the above equation (6) and implies that the marginal rate of substitution between

[1] This allows for both an interior solution with $L_{off} > 0$ and $\lambda w_{off} - \mu = 0$ as well as a boundary solution with $L_{off} = 0$ and $\lambda w_{off} - \mu \le 0$. In the case with $\partial \Im / \partial L_{off} < 0$, a farmer would be reasonably advised to remain a FT farmer and not to take any off-farm employment and become a PT farmer, since this would reduce his/her utility level compared to the FT situation.

consumption and leisure, ζ , can be above the off-farm wage rate. This is the case of full-time farming being optimal even if off-farm engagement would be an option.

b) For part-time farming with $L_{off} > 0$ being optimal, the following relationship must be valid: $\frac{\mu}{\lambda} = pf_{L_{on}} + \psi = \zeta = w_{off}$. In this case, the farmer's marginal product of on-farm labour $pf_{L_{on}}$ is lower than the alternative off-farm wage rate w_{off}, which can be explained with the words of Fall and Magnac (2004): "Because farmers like working on-farm, they accept lower marginal returns on this activity".

In sum, we have:

$$\zeta^{(FT)} = pf_{L_{on}}^{(FT)} + \psi^{(FT)} > w_{off} = pf_{L_{on}}^{(PT)} + \psi^{(PT)} = \zeta^{(PT)} > 0 \quad (10)$$

This reveals that, for optimal allocation of time, a FT farmer's marginal rate of substitution between consumption and leisure must be larger than the one he/she would have as a PT farmer: $\zeta^{(FT)} > \zeta^{(PT)}$. Accordingly, a farmer's opportunity cost of on-farm labour is larger if he/she is a FT farmer than it would be if he/she would take some off-farm employment; i.e., being a PT farmer. This opportunity cost is the farmer's own perception and an expression of his/her own values which drive his/her decisions.

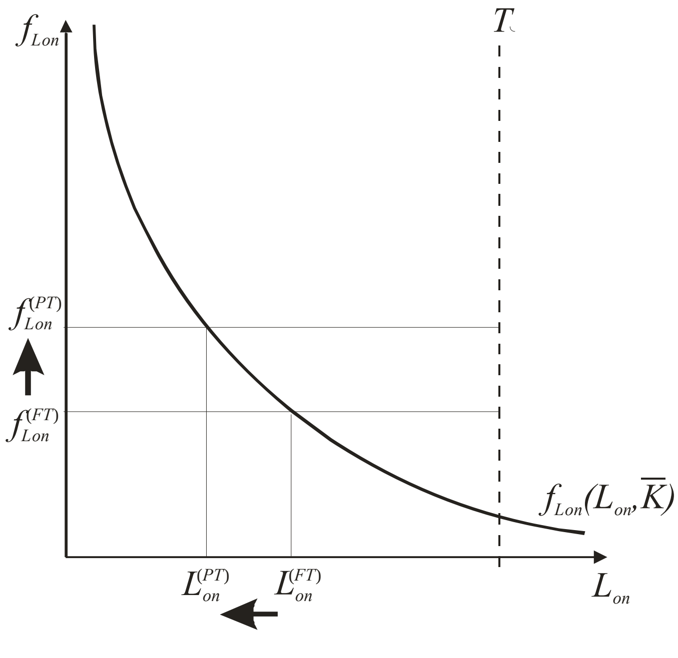
Exploring on cost and choice, Buchanan (1969, 1981) points out that observed money outlays need not reflect choice-influencing costs, the genuine opportunity cost that the decision-maker considers: "Cost is that which the decision-maker sacrifices or gives up when he selects on alternative rather than the other. Cost consists therefore in his own evaluation of enjoyment or utility that he anticipates having to forgo as a result of choice itself" (Buchanan, 1981: 14). This theoretical perspective is particularly relevant with regard to the opportunity cost of on-farm labour. Properly defined, the latter includes the farmer's marginal utility of consumption and his/her marginal utility of leisure time, rather than a value that is exogenously chosen by the analyst:

$$\zeta^{(FT)} = \frac{\partial U^{(FT)} / \partial X^{(FT)}}{\partial U^{(FT)} / \partial C^{(FT)}} > \frac{\partial U^{(PT)} / \partial X^{(PT)}}{\partial U^{(PT)} / \partial C^{(PT)}} = \zeta^{(PT)} \quad (11)$$

Moreover, equation (10) implies that a FT farmer's total marginal value of on-farm labour, $pf_{Lon}^{(FT)} + \psi^{(FT)}$, is larger than the wage rate for off-farm labour, w_{off}, and larger than the marginal value of on-farm labour on a PT farm, $pf_{L_{on}}^{(PT)} + \psi^{(PT)}$. For efficient allocation, the latter expression must be equal to off-farm wage rate w_{off}, while implying $pf_{Lon}^{(PT)} > w_{off}$ due to the farmer's joy of working on the farm.

Coming now to the comparison of the marginal labour productivities in FT and PT situations, we first assume that a PT farmer's stock of capital, K, is the same as the one held by a FT farmer.[2] In this case, Figure 1 reveals that $f_{L_{on}}^{(PT)} > f_{L_{on}}^{(FT)}$, with $f_{Lon}^{(PT)} = \left[\zeta^{(PT)} - \psi^{(PT)}\right]/p = \left[w_{off} - \psi^{(PT)}\right]/p$ and $f_{Lon}^{(FT)} = \left[\zeta^{(FT)} - \psi^{(FT)}\right]/p > \left[w_{off} - \psi^{(FT)}\right]/p$. This provides a theoretical framework that supports the first two hypotheses as formulated above.

Figure 1: Marginal labour productivity and optimal amounts of on-farm labour for the case of full-time (FT) and part-time (PT) farming and constant capital



Yet, in general, a transition from FT to PT farming will not only affect on-farm labour. It will also alter the use of other production factors that are employed on the farm, such as capital K in our simple model. As shown in equation (5b), the marginal productivity of capital, f_K, is determined by the relative price of capital, q/p, and is thus formally the same for FT and PT

[2] In the sense of a "putty-clay model" this assumption can be maintained at least in the short-run after a farmer switches from FT to PT farming. In the longer run, this may change, such as discussed below.

farmers: $f_K = q/p$. Apparently, this equality cannot be maintained if capital is kept constant in a transition from FT to PT farming. Rather, to compensate for less on-farm labour the use of capital (or other inputs) must increase. This results in a downward shift of the marginal labour productivity curve $f_{L_{on}}$ in Figure 1 when moving from FT to PT farming.[3] As a consequence, the marginal productivity of on-farm labour can be higher for a FT than PT farming, despite the fact of declining marginal productivity. However, the outcome is ambiguous with respect to the relative values of the marginal labour productivity for FT and PT farmers. The result depends on the relative values of the marginal rates of substitution, ζ and ψ , for FT and PT farmers, such as depicted in equation (10). Ultimately, this is an empirical question which will be addressed in the subsequent sections.

2.3. Direct payments

What remains to be investigated on a theoretical basis is the issue of public goods provision, or, more precisely, that of undepletable externalities (Baumol and Oates, 1988; Hediger and Lehmann, 2007), as theses additional services are a by-product of food and fibre production. We accordingly extend the above model by including a public good *Z* that is jointly produced with the primary agricultural output: *Z* = *Z*(*Y*). Assuming that the farmers receive a direct payment σ for the provision of *Z*, we can extend the Lagrangean of our original model as follows:

$$\begin{aligned} \Im = U(C, X, L_{on}) + \lambda\left[pf(L_{on}, K) + \sigma Z(f(L_{on}, K)) + w_{off} L_{off} - qK - C\right] \\ + \mu\left[T - X - L_{on} - L_{off}\right] \end{aligned} \tag{12}$$

Compared with our original model, this results in modified optimality conditions with respect to capital and on-farm labour, while the other conditions remain formally the same:

$$\frac{\partial \Im}{\partial K} = \lambda\left[\left(p + \sigma Z'\right)\frac{\partial f}{\partial K} - q\right] = 0 \tag{13a}$$

$$\frac{\partial \Im}{\partial L_{on}} = \frac{\partial U}{\partial L_{on}} + \lambda\left(p + \sigma Z'\right)\frac{\partial f}{\partial L_{on}} - \mu = 0 \tag{13b}$$

[3] Notice that capital and on-farm labour are treated as substitutes here. Alternatively, one may consider other variable inputs, such as fertilizers and pesticides, being substitutes for on-farm labour input while keeping capital constant, at least in the short-term after switching from FT to PT farming. However, this would solely complicate our model and formal analysis, without giving additional insight regarding the above specified hypotheses.

with Z' the first order derivative of Z with respect to f.

Using $f_K = \partial f / \partial K$, $f_L = \partial f / \partial L_{on}$, $\psi = \partial C / \partial L_{on}$ and $\zeta = \partial C / \partial X$ as well as equation (9), we get:

$$f_K = \frac{q}{p + \sigma Z'} \tag{14a}$$

$$\frac{\mu}{\lambda} = \left(p + \sigma Z'\right) f_L + \psi = \zeta \geq w_{off} \tag{14b}$$

If Z is a positive externality with $Z' > 0$ the marginal rate of substitution, ζ is larger than in the above case without direct payments. Accordingly, both FT and PT farmers are given an incentive to allocate more time to working on the farm than in a situation without payments for the provision of these public goods. But farmers also receive an incentive to employ more capital, which in turn reduces the incentive for more labour-intensive production. Thus, we can assume that the marginal labour productivity is higher on PT farms than on FT farms, for both agricultural outputs and the public good externality that are jointly produced. However, the net effect of government payments for the provision of public good externalities on on-farm labour and on capital input is ambiguous and can only be analysed on empirical grounds.

If jointness in production is such that one input (e.g. land) is joint to the agricultural activity but additional input (e.g. specific labour) is required for the provision of the public good, a higher reimbursement of total on-farm labour and for the cultivated land would be required for efficient resource allocation. With adequate government payments, this results in an incentive to allocate more labour to on-farm activities. As a consequence, the incentive for taking off-farm employment is reduced. But, at the same time, there is an incentive for providing more public goods and producing traditional agricultural outputs (food and fibre), which goes along with a lower intensity in agricultural production on the cultivated land and a tendency to have more land set aside for ecological reasons. About the same effect with regard to the intensity of cultivation and set-aside land could also be a consequence of farmers switching from FT to PT farming, suggesting that the marginal productivity of labour in both private and public good production is higher on PT farms than on FT farms. As long as this also results in lower labour input per hectare on PT farms than on FT farms and the vast amount of direct payments is provided on an area basis, such as in Switzerland, we come to our third hypothesis that PT farmers receive more direct payments from agri-environmental programmes per labour unit than FT farmers do. This is empirically tested together with the other two hypotheses in the remainder of the paper.

3. Methodology to test the hypotheses

In order to test the propositions that PT farming differs from FT farming regarding their capital to labour ratio and their labour productivity, data from the Swiss Farm Accountancy Data Network (FADN) in 2004 were used. Within the FADN, each year around 3,200 farms report their bookkeeping data in Switzerland. Certain minimum size criteria apply in order for farms to be included into the sample, but they are small enough in order not to create a sample bias.

The three above hypotheses are tested with the help of regressions, carried out with the method of ordinary least squares. Dependent variables (according to the hypothesis tested) and explanatory variables are described below.

3.1. Dependent variables

The three hypotheses necessitate three different dependent variables which are to be explained, *inter alia*, by a proxy of PT character. Two of these variables are rather straightforward, as depicted in Table 1. For testing the first hypothesis, the capital to labour ratio of the farm was specified as the farm total assets in relation to full-time labour units, including both hired and family labour. The third hypothesis was tested with direct payments to labour, computed as the value of all direct payments received by farmers, set into relation to labour units on the farm.

The second hypothesis necessitated estimating the productivity of farms in single production activities. For this, a more complicated methodology was applied. While partial productivities are most easily estimated for one-product-farms, this excludes diversified farms whose productivity may well differ substantially from that of specialized farms. Therefore, figures from the “Labour Economics” Research Group from the Swiss Federal Research Station ART were used. This group has detailed labour requirements for almost all farm products under typical Swiss conditions available (Schick and Stark, 2007). With these figures, Standard Labour Requirements for each farm were calculated based on the farm’s production portfolio, both for single products (Single products Labour Requirements, *SLR*) and for the total farm (total Farm Labour Requirements, *FLR*). The latter figure was compared to the total labour requirement of the farm as documented in its books (Reported Labour Requirements, *RLR*) by computing the ratio of *RLR* to *FLR*. Then, real labour requirements for single product lines (*R*) were subsequently calculated:

$$R = \left(\frac{RLR}{FLR} \right) SLR \,. \tag{15}$$

SLR, *FLR*, *RLR* and *R* are all in full working persons. Monetary labour productivity on a single-farm-level was then calculated by monetary produced amounts, divided by *R*. This figure for milk was then used as the dependent variable to test the second hypothesis. Only milk production was considered in this paper, as it represents the major output in Switzerland; moreover, dairy farms are often part-time, due to the reduced labour requirements in winter.

3.2. Explanatory variables

For our purpose, the most central independent variable was the part-time character of the farm. In order to avoid an arbitrary categorisation which farm would be a PT farm and which would not, the share of off-farm income in total farm household income was used as an explanatory variable representing the farms' part-time character. According to the hypotheses defined above, this share is expected to influence positively the capital to labour ratio, the labour productivity and the direct payments per labour unit.

A number of other variables had to be chosen in order to control for influencing factors that were obvious or at least plausible. Farm size, for example, has repeatedly shown to influence productivity in Swiss agriculture since it is almost always far below the economic optimum (Ferjani and Köhler, 2007; Lips and Eggimann, 2007). It is expected that farm size weakens the position of PT farms with respect to productivity, because they are smaller, on average, than FT farms.

Direct payments in Switzerland are grouped in general and ecological payments (Mann, 2003). For the hypothesis developed above, only ecological payments are of interest. Both types of direct payments are paid proportionally to land endowments. Therefore, the land per full-time-worker is believed to be one explaining variable. For farmers with a lot of animals, it may be less easy to produce extensively on their land since feed requirements may then not be met. Animals per hectare, on the other hand, are expected to contribute to explain the capital to labour ratio, since animal production is more capital-intensive than crop production.

Mountain farming suffers from a lower degree of productivity than lowland farming (Grasseni, 2007). However, mountain farmers enjoy higher general subsidies, but lower agri-environmental payments than farmers in lower production zones. Therefore, it is important to account for the production zone when explaining our dependent variables. Likewise, while the vast majority of Swiss farmers follow integrated production, some payments are eligible for organic farmers only, whereas conventional farmers do not receive direct payments at all. This is therefore another important explaining variable for direct payments.

It is also well-known that the farmer him/herself has a considerable influence on the farm's financial situation, although the sign of the effect is ambiguous. It is often acknowledged that the farmer's education has the potential of increasing the productivity of the farm (Lockheed et al., 1980). More recently (Wilson, 1996), education has also been shown to influence the uptake of agri-environmental programmes positively. However, *vice versa*, the farmer's age has also been shown to decrease both productivity and programme uptake (Kazenwadel et al., 1998; Lobley and Potter, 1998; Wynn et al., 2001).

Table 1 presents descriptive statistics of the variables used in the regression. Swiss dairy farms do not present a strong part-time character, as only 18% of their total income on average is derived from off-farm work.

Table 1: Descriptive statistics of the variables used

Variable	Definition and unit	Average	Standard Deviation	Minimum	Maximum
Capital to labour ratio	Assets (Fr.)/real labour unit	508,421	332,588	53,439	7,252,322
Productivity in dairy farming	Turnover (Fr.)/ real labour unit	101,956	54,671	5,575	973,662
Ecological direct payments	Fr./real labour unit	1,869	1,927	0	26,250
Part-time character	Off-farm income as share of total income	0.18	0.48	0	1
Farm size	Standardized Labour units	0.99	0.56	0.0021	6.75
Land per worker	Hectares per real labour unit	13.61	7.60	0	135.6
Animals per worker	Livestock Units per real labour unit	13.57	7.99	0	358.8
Animals per hectare	Livestock Units per hectare	1.41	0.92	0	14.3
Region	1-valley, 2-hills, 3-mountains	1.81	0.82	1	3
Environmental system	1-conventional, 2-integrated, 3-organic	2.15	0.38	1	3
Farmer's education	1-without education, 2-in education, 3-basic education completed, 4-higher education completed, 5-university education completed	3.22	0.80	1	5
Farmer's age	In years	45.5	9.21	18	73

Fr.: Swiss Francs

4. Empirical results

The results of the three regressions are presented in Table 2. In two of three cases, our hypothesis can be confirmed. In the case of the capital to labour ratio, the relation between the part-time character and the dependent variable is an exponential relation, so that the less income was earned on the farm, the greater the effect of off-farm income. Apparently, farms which are only run on the margin need a lot of capital per person.

Contrary to our theoretical results, part-time farming does not influence labour productivity in dairy production in Switzerland. The size of the farm seems to be much more influential than the question of an external income.

The other explaining variables partly confirm what has been developed in Section 2. Much land and few animals enable farmers to participate in agri-environmental programmes and maximize ecological direct payments. It is also confirmed that lower opportunity costs have led to a policy design that grants less ecological direct payments for farmers in mountain regions than in the lowland. However, the effect of the farm's environmental system and the farmers' age could not be confirmed in an unambiguous way.

The age of the farmer, however, influences labour productivity in dairy production to a stronger degree than it influences the level of direct payments. Aged farmers are considerably less productive than their younger colleagues, confirming the cited results from other countries. Contrary to other literature results, however, better educated farmers are not significantly more productive than others. Size and age remain the only potent predictors for labour productivity in Swiss dairy farming.

The regression explaining the ratio between capital and labour on the farm presents a low goodness-of-fit (small R-square), indicating that there are a lot of factors responsible for this balance that either have barely been omitted or that can be subsumed under "soft" factors. However, a number of variables, in addition to the part-time character of farmers, apparently influences this ratio. It can be seen that animal production is more capital-intensive than crop production, whereas mountain farming seems to be distinctly more labour-intensive than lowland farming. From the latter fact, there may be a connection between the lower average income of mountain farms compared to lowland farms, which deserves further attention.

The only measurable significant impact of farmers' education of the farmer in our analysis is that better educated farmers have a higher capital to labour ratio than others. From an economical point of view, this is fully rational because the opportunity costs of labour are, of course, higher if farmers are well-educated. Apparently, younger farmers prefer, on average, to work more capital-intensively than others.

Table 2: Results of the regressions

Variable	Capital to labour ratio	Labour productivity in dairy farming	Ecological direct payments per labour unit
Number of observations	3,164	2,277	2,513
Part-time character	152,150** (8.00)	506 (0.27)	529** (4.12)
Part-time character squares	6,634** (6.11)		
Farm size (Labour units)		54,386** (25.86)	
Land per worker			107** (20.7)
Animals per worker			-9 (-1.81)
Animals per hectare	27,261** (4.32)		
Region	-70,356** (-9.14)		-495** (11.5)
Environmental system	33,022* (2.11)	-3,647 (-1.32)	149 (1.66)
Farmer's education	18,528* (2.44)	1,562 (1.16)	
Farmer's age	-1,303* (-2.05)	-635** (-5.81)	-6 (-1.45)
Constant	495,930** (8.78)	72,842** (7.57)	1300 (4.45)
R^2	0.06	0.27	0.22

t-value in parentheses; * = p<0.05; **= p<0.01

5. Conclusions

In a context of growing interest for multifunctional and hobby agriculture, the literature on economic differences between PT farming and FT farming is becoming richer. Several papers have for example considered the differential in farm performance between both farming types (e.g. Goodwing and Mishra, 2004; Pfeiffer et al., 2009; Lien et al., 2010), while others have focused on differences in investment behaviour (e.g. Hertz, 2009; Kilic et al., 2009; Bakucs et al., 2010). However, whether PT and FT farms exhibit different labour returns and ecological subsidies is still an open question, to which our paper aimed to contribute with farm-level data in Switzerland in 2004.

Our analysis reveals that two differences between FT and PT farms could be detected. PT farms are more capital intensive than FT farms, a tendency that increases with a growing share of off-farm income. Due to this difference in structure, PT farms are more adapted to extensive land management, thereby providing more public goods and receiving more public payments. Again, this effect is non-linear and increases with a rising share of off-farm income.

This result has policy implications about the interdependencies between the labour market and agri-environmental policy. The more difficult it becomes for farmers to find a second occupation in addition to agricultural production, the more costly it will be to encourage extensive farming practices. And the more farmers will be absorbed by the labour market, the more will sustainable land management become a sure-fire success.

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