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Short and medium-term impact of dairy barn investment on profitability and herd size in Switzerland

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Abstract: Investing in larger barns and increasing herd size are crucial milestones in dairy production. Based on the Swiss Farm Accountancy Data Network and data on government-supported investments, we investigate the development of two key variables over the first eight years after investment: change in herd size and calculated profit, that is, farm income minus opportunity costs for family labour and capital. We apply a fixed-effects panel regression and test for autocorrelation present in the time series. Compared to the year before the investment, calculated profit decreases in the first three years, while in the remaining years no significant difference compared to the year before investment can be seen. Herd size increases slowly, predominantly in the second and third years after investment, to some extent explaining the less favourable development of profitability in these years. We conclude that investment in a dairy barn does not lead to improved profitability in the short and medium term, pointing to the question of whether this picture changes in the long term.

Keywords: farm growth; fixed-effects; investment support; opportunity cost quota abolishment

Investing in larger barns and increasing herd size are crucial milestones in dairy production. Furthermore, in Switzerland the government supports such investment by providing interest-free loans.

In dairy farming, economies of scale exist (Hüttel and Jongeneel 2011; Hoop et al. 2015), and technical progress has led to a considerable improvement of labour productivity (Schick and Hartmann 2005). As a result, investments in dairy barns usually lead to an increase in capacity compared to the pre-investment situation and therefore allow dairy herds to grow. In addition, technical progress and the obligation to increase animal welfare has triggered a comprehensive shift from stanchion to free stall barns, although these require more capital (Pietola and Heikkilä 2005).

Farmers consider the full utilisation of their barn capacity as necessary to meet loan repayment requirements (Faust et al. 2001), but while U.S. farmers make use of their additional capacity immediately (Stahl et al. 1999; Faust et al. 2001), studies in Denmark and Austria have shown a rather slow and constant increase (Sauer and Zilberman 2012; Kirchweger and Kantelhardt 2015). Hüttel and Jongeneel (2011) found that under a quota regime, small dairy farms show a higher probability to stay in the smaller size class than without quota, hampering structural change. Samson et al. (2016) found low capacity utilisation in Dutch dairy farms under their quota system. They assume two reasons underlie this observation. An increased milk yield per cow combined with the farm's quota could have triggered a need for a reduction in cow numbers. Furthermore, farmers might have invested in surplus capacity to prepare for quota abolishment. In Switzerland, the milk quota was abolished between 2006 and 2009, a period that coincided with a peak in milk prices (Haller 2014). There are also indications that farmers held idling capacity prior to quota abolishment (Jan et al. 2005; Gazzarin et al. 2008).

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While some authors have studied economic indicators after farm investment (Salvioni and Sciulli 2011; Spicka and Krause 2013), no study has taken opportunity costs fully into account. Salvioni and Sciulli (2011) find an increase in profit per family working unit, though they do not divide between different production factors. We evaluate the calculated profitability after dairy barn investment. With slowly changing herd size, as indicated by the literature (Sauer and Zilberman 2012; Kirchweger and Kantelhardt 2015), and capital being rather mobile, we hypothesise a low profitability after investment unless herd size is adjusted.

The novelty of this paper is the analysis of profitability of dairy barn investments on a single-farm basis, taking all opportunity costs into account instead of farm income only. In addition, we analyse dairy herd expansion after investment to provide insights into the cause of profitability changes. We are the first to combine data from the Swiss Farm Accountancy Network (FADN) with government data on investment-supported farms.

MATERIAL AND METHODS

Swiss FADN

Our analysis uses Swiss FADN data (2017), where we focus on two types of farms: dairy farms and combined dairy/arable crop farms. Both types of farms specialise in dairy. They keep more than 75% of livestock units (LU) in cattle, with at least 25% of them being dairy cows, but differ in the usage of acreage. To be classified as a dairy farm, a maximum of 25% of acreage may consist of open cropland, while for combined dairy/arable crop farms open cropland may make up more than 40% of acreage (Hoop and Schmid 2015). Focusing on the years 2003 through 2014, farm observation of the valley and hill region are used.

Identification of investing farms

A major challenge of our analysis is the identification of dairy farms investing in a new barn. First, we identify farms in the FADN data showing an increase in an interest-free loan between consecutive years. Since the granting of these interest-free loans is organized at the cantonal level, no overall data exists about rejected loan applications. Given the attractiveness of interest-free loans, very few farms exist which have invested in dairy barns without this kind of support. Therefore, an increase in interest-free loans indicates investment in a farm building in general, but not necessarily in a dairy barn. To improve the accuracy of the sample in this respect, we use information provided by MAPIS[1] (Meliorations- und Agrarkredit-Projekt-Informations-System) which contains all government-supported investments. We match farm-level FADN and farm-level MAPIS data (2017) on municipal code, loan amount and year of investment. In this manner, we obtain a data set of farms with investments specifically aimed at dairy barns. The sample comprises 103 farms with 544 observations, corresponding to 5.3 observations per farm on average. The time span of observations per farm is between two and ten years.

Dependent and independent variables

Reliable information on the capacity of new barns is not available, but FADN data contains records on the number of cows $N_{i,t}$ on a farm i in each year t. To circumvent autocorrelation, we analyse the annual change of dairy cows, denoted as $\Delta LU\ cows$ and defined as follows:

$$\Delta LU\ cows_{i,t} = N_{i,t} - N_{i,t-1} \tag{1}$$

Note that due to the use of $\Delta LU\ cows$, some observations are lost, as opposed to using *LU cows* in absolute terms. As a second variable to explain, we use *calculated profit* as a measure of economic success of a farm. We compute *calculated profit* of farm i in the year t as farm income less opportunity costs of equity and labour. The use of the opportunity costs of labour is regulated by law (Bundesrat 1998) stating that agricultural income has to be commensurate to the income achieved in other sectors of the regional economy[2].

$$\begin{aligned} \mathit{Calculated\ profit}_{i,t} &= \mathit{Agricultural\ income}_{i,t} - \\ &- \mathit{Opporunity\ costs}\Big(\mathit{labor},\ \mathit{capital}\Big)_{i,t} \end{aligned} \tag{2}$$

Interest rates to compensate equity capital are determined by the interest rate of government bonds, which is also applied to compensate own agricultural

[1]The Ministry of Agriculture maintains records of all loans granted, together with value and purpose.

[2]The wage of other sectors in the region is determined by the Federal Statistical Office. This is multiplied in FADN by the amount of labour input for each farm.

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land. As opportunity costs are typically larger than the remuneration factor, *calculated profit* is negative on average.

Concerning explanatory or independent variables, an important determinant of the profitability and the herd size of a farm is its acreage (Hoop et al. 2015). First, dairy farming relies strongly on the availability of roughage, which is closely linked to acreage. Moreover, the number of *LU* per area is *de facto* restricted by the amount of manure per area. Direct payments, an important source of income in Swiss agriculture, are also linked to acreage. Due to its relation to herd size and income, acreage (ha) is added as a first independent variable.

To control for the abolishment of the milk quota during the sample period, we introduce a dummy variable into our model, indicating whether an observation is within the affected period (2006–2009).

Econometric model

Fixed-effects (FE) and random-effects (RE) models are typical models for performing a regression on panel data (Giesselmann and Windzio 2012; Verbeek 2012; Baltagi 2013). It is criticised by Baltagi (2013) and Giesselmann and Windzio (2012), that often only the Hausman test is used to decide between FE or RE model. Giesselmann and Windzio (2012) argue that this choice needs to be assessed with respect to the research question, the sample, and variables considered. The FE model is designed for the analysis of intra-individual effects, which requires an intra-individual variation to obtain a coefficient (Verbeek 2012). Coefficients of the FE model are an average of all single coefficients of the individuals. Since in our data set we focus on intra-individual effects, we use the FE model.

Panel data consist of individuals repeatedly measured in time. As a result, autocorrelation is a frequent challenge in panel data analysis. It must, therefore, be assessed whether error terms between different periods correlate (Verbeek 2012). If autocorrelation is present but ignored, estimates are still consistent, but inefficient due to biased standard errors (Verbeek 2012; Baltagi 2013). This increases the risk of wrong inferences. Although this problem in panel data is well known, Petersen (2009) finds that 42% of 207 reviewed papers in finance journals do not adjust standard errors for possible autocorrelation. He, however, concedes that an appropriate correction of standard errors might be difficult, as the order of the autoregressive process needs to be known.

First-order serial correlation in an unbalanced panel can be assessed by a Wooldridge test (Drukker 2003). We, therefore, use this test for our models and only retain them if the error probability exceeds 10%. Below this value, the null hypothesis of no first order serial correlation is rejected. In this case, we resort to analysing changes of the dependent variable from one year to the next instead of its absolute value. In this way, autocorrelation can be ruled out, which is also confirmed by a Wooldridge test. However, results may be less sharp in terms of explanatory power and significance, and interpretation differs slightly. Compared to a wrong inference due to autocorrelation, this cost might be worthwhile.

Estimated models are as shown in Equation (3):

$$X_{(i,t)} = \alpha + \sum_{j=1}^{8} \delta_j (i,t) \beta_j + ha_{(i,t)} \beta_{ha} + \gamma_{(i,t)} \beta_\gamma + \varepsilon_{(i,t)} + \mu_i \quad (3)$$

where $X_{(i,t)}$ denotes the dependent variable of farm i in year t, either Δ*LU cows* or *calculated profit*. The constant is given by α and dummies for year j after investment by δ_j. We use the year before the investment (δ_0) as a basis. We denote the dummy for quota abolishment as γ, the one for acreage as *ha*. To account for the panel structure, the model contains an unobservable individual specific effect $\varepsilon_{(i,t)}$ and the remainder disturbance μ_i.

RESULTS

Descriptive statistics

Summary and descriptive statistics for the analysed variables are given in Table 1. The sample comprises 544 observations, 290 observations from the valley region and 254 observations from the hill region.

Our data set shows that the number of observations decreases as the number of years after investment increases. Regression coefficients in our models will, therefore, be based on fewer observations at later stages.

The farm size in terms of *LU cows* of our sample is above the average for FADN farms of the same type. Unsurprisingly, Δ*LU cows* [*cf.* Equation (1)] shows an average increase over all observations.

The sample includes 55 observations with an increase of more than five *LU cows* within one year, whereof 53% occurred from 2006 to 2007.

The overall mean acreage for dairy farms in the hill region and valley region is around 21 ha per farm. Combined dairy/arable crop farms are large with an av-

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Table 1. Descriptive statistics for analysed variables of the FADN-sample

Variable	Observations	Mean	Std. dev.	Minimum	Maximum
δ_0	90	–	–	–	–
δ_1	103	–	–	–	–
δ_2	84	–	–	–	–
δ_3	73	–	–	–	–
δ_4	58	–	–	–	–
δ_5	45	–	–	–	–
δ_6	39	–	–	–	–
δ_7	27	–	–	–	–
δ_8	22	–	–	–	–
LU cows	544	31.572	11.815	8.98	74.89
Δ*LU cows*	503	1.474	3.364	–11.12	18.92
Acreage (ha)	544	26.943	9.347	8.57	69.62
Quota abolishment period	544	–	–	–	–
Calculated profit (CHF*)	544	–21 203	44 972	–149 574	149 986

*average exchange rates 2017, 1 CHF = 0.90 EUR = 1.02 USD (https://data.snb.ch, accessed 29 January 2018); δ_{0-8} – year after investment; *LU* – livestock units

Source: own calculations based on the dataset used

erage of around 27 ha and 28 ha in the hill and valley region, respectively. Farms cannot compensate for their input on average and the overall mean over farm type and region is –32 278 CHF. This is still above average in the overall FADN sample.

Econometric estimations

Both model specifications [*cf.* Equation (3)] are tested on first-order serial correlation. For *calculated profit*, the probability level of the Wooldridge test is at 91%. In contrast, for *LU cows* as a dependent variable, the Wooldridge test is highly significant, indicating that the first order serial correlation is a problem in this specification. To amend this, we use Δ*LU cows* from one year to the subsequent year as a dependent variable. This, in turn, yields a probability level of 65% for the Wooldridge test, meaning autocorrelation can be excluded.

For easier comparison, regression results are shown in one table for the two different dependent variables and stated in Table 2.

For *calculated profit*, the coefficients of the first three dummies after investment are negative and highly significant, meaning that compared to the situation before investment, the *calculated profit* is clearly reduced. From the fourth year onwards, the dummies are no longer significant. Accordingly, the dairy farms have the same profit as prior to the investment.

The acreage of a farm shows a significantly positive contribution, increasing the *calculated profit* by 3 280 CHF/ha.

Regarding the change in the number of cows, there is no statistically significant difference in the first year after the investment. For the second and third year after investment, changes in *LU cows* are significant and positive. More prominent, though, are the negative values for dummies δ_5 to δ_7. This means that herd size changes were smaller in these years, compared to the basis, the left out dummy δ_0. An increase of one hectare in acreage yields an additional 0.15 *LU cows*. Finally, quota abolishment period influences change in herd size of *LU cows* positively with a rate of 0.66 *LU cows*.

DISCUSSION

General picture

The results of our analysis question the economic rational of an increasing income due to the investment at least in the short and medium term. Three arguments may help explain this.

First, with an investment in a dairy barn, the factor allocation of a farm changes. To reflect this change,

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Table 2. Regression results of regressions with either *calculated profit* or Δ*LU cows* as dependent variable

	Calculated profit (CHF)	Δ*LU cows*
Probability > *F*	0.0003	0.00
R^2 overall	0.1200	0.08
R^2 within	0.1400	0.11
R^2 between	0.1200	0.15
Constant	−103 664*** (22 818)	−2.77* (1.49)
δ_1	−11 930*** (3 338)	−0.02 (0.42)
δ_2	−16 892*** (4 757)	0.99* (0.53)
δ_3	−14 279*** (4 548)	1.19* (0.60)
δ_4	−4 447 (5 132)	0.43 (0.54)
δ_5	−3 123 (5 008)	−1.63** (0.64)
δ_6	1 053 (5 101)	−1.04* (0.59)
δ_7	9 385 (8 294)	−1.39* (0.72)
δ_8	−1 282 (8 248)	−1.09 (0.78)
Acreage (ha)	3 280*** (896)	0.15** (0.06)
Quota abolishment period	3 254 (3 112)	0.66** (0.33)

*, ** and *** represent p-value < 0.1, 0.05, 0.01, respectively; R^2 – coefficient of determination; δ_{1-8} – year after investment; *LU* – livestock units; values in parentheses represent standard errors

Source: own calculations based on the dataset used

calculated profit is a suitable variable, since it reflects all production factors by using opportunity costs. Some authors argue that opportunity costs are very specific to a farm and might be close to zero in some cases (Hüttel and Jongeneel 2011), or they might not be perceived to be as high as they actually are (Kahnemann et al. 1991). However, given that an investment in a dairy barn fixes the factor allocation for a significant period, it is important to consider opportunity costs.

Secondly, investments in larger barns are fixing the input-output ratio for years (Sauer and Zilberman 2012), not only in the short and medium terms, but in the long term. A dairy barn investment might be seen as a tipping point where a farmer can decide between opting out of dairying and using the production factors differently, or investing and being tied to the production, even if it does not ultimately pay off. Therefore, it remains very important to address the long-term economic consequences of investing in a new barn. Due to the time covered by our data set, we are restricted from doing so.

As a third explanation, investments might also be inspired by non-monetary motives like the attractiveness of the workplace (Olsen and Lund 2009; Eidgenössische Finanzkontrolle 2015) or non-monetary job preferences (Lips et al. 2016).

When assessing the development after the investment, the implications of the declining number of observations need to be considered. For *calculated profit*, the statistical insignificance of coefficients from the fourth year after investment onwards might stem from the fact that the variables show considerable variation and the number of observations is hardly sufficient. On the other hand, significant coefficients for dummies further away from the investment mean that the effect is quite clear. Another characteristic of our analysis is that larger time spans of observation stem from investments made earlier, that is, if observed eight years after investment, the investment would have been made in 2006 the latest.

Dependent variables

Even if the exact quantitative meaning of commensurability and other aspects leave room for interpretation, our manner of assessing opportunity cost is well established within Swiss agriculture. Although the farms analysed show better profitability on average than the remaining FADN farms, a clear drop in *calculated profit* occurs after investment. The fact that a significant increase in profitability does not occur at any point in time after investment contradicts the economic theory that investments aim at achieving higher income. However, there is no significant decrease either. As a result, an investment might be, at least for some farmers, just a way to keep up with structural change, as Olsen and Lund (2009) suggest. The large heterogeneity between single farms and the decreasing number of observations do not allow us to identify a clear trend by means of significant coefficients. The increasing standard errors with increasing distance

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in time from investment indicate a decreasing efficiency of the estimates.

Based on the increase in cows being kept in free stall houses (Meyre 2016), we assume that a majority of farms in our sample used the investment to switch from stanchion to free-stall housing. In theory, this change in housing type allows for a substantial increase in labour productivity (Schick and Hartmann 2005). Given the rather constant nature of labour input on farms (Hoop et al. 2014), labour input might be the production factor most difficult to adapt to the new system, suppressing profitability for several years.

While no clear long-run conclusion can be drawn from the development of profitability, a clear indication exists of why profitability is suppressed. Given the literature that indicates a hesitance to increase herd size (Sauer and Zilberman 2012; Kirchweger and Kantelhardt 2015) and the perceived need of farmers for capacity utilisation to fulfil financial requirements (Faust et al. 2001), there is a strong indication that idle capacity at least contributes to the suppression of profitability. Maybe farmers in the United States manage their farms in a more business-oriented manner since literature about substantial herd size increases after investments rely on data from U.S. farms (Stahl et al. 1999; Bewley et al. 2001).

The constantly negative values for dummy δ_5 through δ_7 on Δ*LU cows* can be interpreted as herd size reaching a stable plateau. So, farms probably increased their herds in the year before investment, which is the reference basis for the other dummies. This raises the question of whether the farms had not been utilising full capacity before investment, since it seems that they were able to increase herd size at that time. The major increase occurs in years two and three after investment, as indicated by the significant positive coefficients for δ_2 and δ_3.

Explanatory variables

Quota abolishment does not affect the two dependent variables in the same magnitude. It is only significant for change in *LU cows*. At first sight, this significant coefficient supports the finding from Jan et al. (2005) and Gazzarin et al. (2008) that dairy farms had idling barn capacity prior to quota abolishment. A significant influence, without further knowledge of the data, could be interpreted as evidence that farms were restricted by the amount of their milk quota. But the amount of time within our period of analysis when the quota system was effectively in place comprises only three years, a rather short period. The high number of large changes in *LU cows* during the period of quota abolishment indicates that during this period larger projects were realised. Farms with an opportunity to increase herd size by a large extent might have consciously delayed their investment until the quota system was abolished to avoid the obligation to buy quota. Thus, the positive and significant influence of quota abolishment on herd-size change may be due to the realization of larger projects during that time.

Acreage per farm as an influencing factor on profitability is comprehensively identified in the literature (Hoop et al. 2015). The availability of additional acreage in Switzerland is rather low. The significant effect of acreage on both *calculated profit* and change in *LU cows* might, however, be caused by different factors. Switzerland is subsidising agriculture on a relatively high level. A considerable proportion of this support is transmitted via direct payments linked to acreage, which might explain the link between acreage and calculated profitability. For change in *LU cows*, restrictions on cows per ha and roughage production might be the most important considerations. The finding of Samson et al. (2016), that investing farmers rely on increasing acreage through leasing, supports this hypothesis.

CONCLUSION

We analysed the development of profitability and herd size for Swiss dairy farms after their investment in a new barn.

The combination of FADN and governmental data allows us to investigate the short and medium-term effects by analysing the first eight years after investment at the farm-level. The analysis confirms our hypothesis of an undesired profitability development after investment, questioning the investment to some extent from an economic point of view. During the first three years after investment, the farm faces a substantial loss of calculated profit, followed by a period in which the income situation resembles that prior to the investment.

An important reason for profitability change after the investment is the herd size, which increases slowly. In our sample, it takes a dairy farm three years until the new proportion of allocated input factors no longer results in a decrease in profitability. The additional capacity is not used completely in the first years, and the aim of the investment, proposed by investment

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theory, an increased income, is not achieved. We conclude that the investment in a dairy barn does not lead to improved profitability in the short and medium term, as postulated by the policy goals. The question arises whether the governmental loans should be linked to more detailed planning of herd development or more detailed financial planning in general.

Further research is needed in at least three matters. Firstly, having analysed the short and medium term, the question arises of whether the picture changes in the long term. Secondly, it remains an open question of why farms do not increase their herd size more quickly after investment. The under-utilised barn capacity clearly leads to depressed profitability. Finally, our results might point to non-monetary motives for investing in a dairy barn. There may be a substantial willingness to pay for a better work environment, lessening physical strain.

REFERENCES

Baltagi B.H. (2013): Econometric Analysis of Panel Data. John Wiley & Sons, West Sussex.

Bewley J., Palmer R.W., Jackson-Smith D.B. (2001): An overview of experiences of Wisconsin dairy farmers who modernized their operations. Journal of Dairy Science, 84: 717–729.

Bundesrat (1998): Federal Act on Agriculture. Available at https://www.admin.ch/opc/en/classified-compilation/19983407/index.html (accessed Feb 20, 2018).

Drukker D. (2003): Testing for serial correlation in linear panel-data models. The Stata Journal, 3: 168–177.

Eidgenössische Finanzkontrolle (2015): Investitionshilfen in der Landwirtschaft – Evaluation der Konzeption, Kosten und Wirksamkeit. Eidgenössische Finanzkontrolle, Bern. (in German)

Faust M.A., Kinsel M.L., Kirkpatrick M.A. (2001): Characterizing biosecurity, health, and culling during dairy herd expansions. Journal of Dairy Science, 84: 955–965.

Gazzarin C., Bloch L., Schneitter O., Lips M. (2008): Wie reagieren Verkehrsmilchbetriebe auf die aktuellen Herausforderungen? Eine repräsentative Umfrage in der Ostschweiz vor Aufhebung der Milchkontingentierung. Agroscope, Tänikon. (in German)

Giesselmann M., Windzio M. (2012): Regressionsmodelle zur Analyse von Paneldaten. Springer VS, Wiesbaden. (in German)

Haller T. (2014): Abolition of the milk quota system in Switzerland – assessment of the quota abolition and its impact in consideration of accompanying measures. Study commissioned by the European Milk Board. Bern University of Applied Sciences, Bern. Available at http://www.europeanmilkboard.org/fileadmin/Dokumente/Press_Release/EMB-allgemein/2014/Study_Switzerland_milk_quota_EN.pdf (accessed May 9, 2018).

Hoop D., Mack G., Mann S., Schmid D. (2014): On the dynamics of agricultural labour input and their impact on productivity and income: an empirical study of Swiss family farms. International Journal of Agricultural Management, 3: 221–231.

Hoop D., Schmid D. (2015): Grundlagenbericht 2014 – zentrale Auswertung von Buchhaltungsdaten. Agroscope, Tänikon. Available at https://www.agroscope.admin.ch/agroscope/de/home/themen/wirtschaft-technik/betriebswirtschaft/za-bh/grundlagenbericht.html (accessed Sept 13, 2017).

Hoop D., Zorn A., Lips M., Gazzarin C. (2015): Determinants of Full Costs of Dairy Production in Switzerland – a Comparison of two Disproportionate Joint Costs Allocations. International Farm Management Association, Laval University, Québec City.

Hüttel S., Jongeneel R. (2011): How has the EU milk quota affected patterns of herd-size change? European Review of Agricultural Economics, 38: 497–527.

Jan P., Lips M., Gazzarin C. (2005): Betriebstypologie für Milchwirtschaftsbetriebe im Berggebiet. AGRARForschung, 12: 120–125. (in German)

Kahnemann D., Knetsch J.L., Thaler R.H. (1991): Anomalies: the endowment effect, loss aversion, and status quo bias. The Journal of Economic Perspectives, 5: 193–206.

Kirchweger S., Kantelhardt J. (2015): The dynamic effects of government-supported farm-investment activities on structural change in Austrian agriculture. Land Use Policy, 48: 73–93.

Lips M., Gazzarin C., Telser H. (2016): Job preferences of dairy farmers in Eastern Switzerland: a discrete choice experiment. German Journal of Agricultural Economics, 65: 254–261.

MAPIS data (2017): MAPIS data. Federal Office of Agriculture (FOAG), Bern, Switzerland.

Meyre S. (2016). Food and Agriculture – Pocket Statistics 2017. Federal Statistical Office, Neuchâtel.

Olsen J.V., Lund M. (2009): Incentives and Socioeconomic Factors Influencing Investment Behaviour in Agriculture. International Farm Management Association, Bloomington/Normal, Illinois.

Petersen M.A. (2009): Estimating standard errors in finance panel data sets: comparing approaches. The Review of Financial Studies, 22: 435–480.

Pietola K., Heikkilä A.-M. (2005): Switching toward capital-intensive technologies in Finnish dairy farms. Agricultural Economics, 33: 381–387.

https://doi.org/10.17221/170/2018-AGRICECON

Salvioni C., Sciulli D. (2011): Farm Level Impact of Rural Development Policy: a Conditional Difference in Difference Matching Approach. European Association of Agricultural Economics, Ancona.

Samson G., Gardebroek C., Jongeneel R. (2016): Explaining production expansion decisions of Dutch dairy farmers. NJAS – Wageningen Journal of Life Sciences, 76: 87–98.

Sauer J., Zilberman D. (2012): Sequential technology implementation, network externalities, and risk: the case of automatic milking. Agricultural Economics, 43: 233–251.

Schick M., Hartmann W. (2005): Arbeitszeitbedarfswerte in der Milchviehhaltung. Landtechnik, 60: 226–227. (in German)

Spicka J., Krause J. (2013): Selected socioeconomic impacts of public support for agricultural biogas plants: The case of the Czech Republic. Bulgarian Journal of Agricultural Science, 19: 929–939.

Stahl T.J., Conlin B.J., Seykora A.J., Steuernagel G.R. (1999): Characteristics of Minnesota dairy farms that significantly increased milk production from 1989–1993. Journal of Dairy Science, 82: 45–51.

Swiss FADN data (2017): Swiss FADN data. Agroscope, Tänikon.

Verbeek M. (2012): A Guide to Modern Econometrics. John Wiley & Sons, Chichester, England.

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