DERIVING FULL PRODUCT COSTS FROM FARM ACCOUNTANCY DATA (AN APPLICATION FOR SWISS DAIRY FARMS IN THE MOUNTAIN REGION)

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Abstract

This paper derives the full cost or full product cost for all activities or production branches of a sample of 48 Swiss dairy farms in the mountain region. For this purpose, data from the Swiss Farm Accountancy Data Network (FADN) are used, applying a non-proportional approach for joint cost allocation among production branches. This results in a median full product cost of CHF 2.12 per kilogram of milk, which is in accordance with the literature. In order to cope with potential price cuts in future, labour input per kilogram of milk, which is responsible for 60% of the full product cost, must be substantially reduced.

Key words: full product costs, production branch, dairy, Switzerland, mountain region

1. Introduction

As a non-member of the European Union, Switzerland has a different agricultural policy in place from the common agricultural policy (CAP). The production of milk, Switzerland's most important agricultural commodity, is supported by tariffs on all dairy products except cheese, as well as by subsidies for cheese production. As a result, the farm-gate milk price in Switzerland is substantially higher than in neighbouring regions such as southern Germany or Austria. In 2010, the average price for a kilogram of raw milk was CHF 0.62[1] (Federal Office for Agriculture, 2011), while prices in Bavaria and Austria were CHF 0.43 (EUR 0.31; Agrarmarkt Austria, 2011). A potential free-trade agreement for agricultural commodities between Switzerland and the European Union as currently under discussion would lead to a substantial drop in the producer milk price in Switzerland. Trade liberalisation represents a considerable challenge, especially for dairy farms in less-favoured areas such as the Swiss mountain region. Accordingly, a detailed knowledge of the present cost situation of dairy farms in the mountain region is of major interest. The full cost or full product cost of a kilogram of milk for a large group of dairy farms in the mountain region is a valuable source of information for dairy-farm managers and farm consultants, providing both the absolute size and cost structure of cost items.

Comprising several hundred dairy farms in the mountain region, the Swiss Farm Accountancy Data Network (FADN) provides direct costs for all production branches or activities. Joint-cost items such as labour, machinery or buildings are reported on a farm-wide basis. As usual, the allocation of joint costs to production branches is necessary in full product cost analysis in order to derive full product costs. Although a proportional joint cost allocation has been widely used, Lips (2012) suggested an approach allowing a non-proportional allocation, and applied this for Swiss crop farms. This paper is based on the same method, while extending it to farms with crops and animal husbandry and addressing the situation of Swiss dairy farms in the mountain region.

[1] CHF = Swiss Franc, exchange rates (Feb. 28, 2013): CHF 1 = EUR 0.82; CHF 1 = USD 1.08.

Furthermore, since milk production consists of highly diverse sub-activities such as roughage production, breeding, and of course dairy-cow husbandry, this paper calculates full product costs at the sub-activity level. Subsequently, the full product costs per kilogram of milk are derived.

2. Method

2.1. Direct costs, land costs and joint costs

There are three categories of cost items to distinguish for the analysis: direct costs, land costs and joint-costs. Direct costs such as feed concentrates or veterinary services and products are recorded at the production-branch level by the Swiss FADN, ready to use for full product cost analysis. For land, the average costs per hectare must be calculated assuming homogenous land quality among all plant-production branches except for forest. The FADN provides the total rent for leased land, while the opportunity costs of own land are derived by applying the interest rate of Swiss federal term bonds.

The third class of joint costs such as labour and machinery is available in the FADN for the whole farm. Joint costs must be assigned in order to derive full product costs for production branches. For this, factors or items which are available for all production branches (e.g. area or working hours) are typically used (AAEA 2000). In our case, budgeted or forecasted costs for all joint-cost items and production branches are available at the production-unit level (e.g. hectare or livestock unit). From the FADN, we know the number of hectares or livestock units for all production branches. Consequently, we can calculate the farm-wide costs for joint-cost items such as machinery. In doing so, and assuming that the farm is perfectly in line with the budgeted costs from the farm-management literature, we arrive at the machinery costs of a particular farm, which can be compared to the farm's actual machinery costs as reported by the FADN system. Based on these two figures, an adjustment factor can be calculated to allow adjustment of the budgeted machinery costs per production branch to the absolute size of the farm-wide machinery costs. In other words, the adjustment factor represents the ratio of the observed farm-level costs to the budgeted farm-level costs. Thus, when taken together, the budgeted costs of all production branches form the allocation key which is applied proportionally.

Although the proportional cost allocation outlined above is widely applied for joint-cost items, it has several major drawbacks. Firstly, all production branches are adjusted in the exact same manner. Consequently, the proportions between production branches remain constant. Secondly, all farms under consideration are treated equally.

As an alternative, Lips (2012) suggested a non-proportional joint cost allocation based on maximum entropy. As a precondition, the approach requires budgeted costs from the literature for all production branches and all joint-cost items. Furthermore, the approach is based on the assumption that the resultant joint costs at production-branch level lie in an interval between zero and twice the budgeted costs from the literature. Both interval boundaries are assigned with probabilities adding up to one – for instance, if both boundaries have a probability of 0.5, this yields the value from the literature. If farm-wide costs are greater than suggested in the farm-management literature, the costs resulting after joint cost allocation lie above the budgeted costs for all production branches of the farm. In other words, the probabilities of the upper boundary are higher than 0.5, whilst the lower boundaries have probabilities below 0.5. The 'maximum entropy' approach provides the best probability distribution for all boundaries subject to a total allocation of actual joint costs at the farm level. There is a single solution, the typical outcome of a 'maximum entropy' application which is suitable for overcoming data gaps[2]. This approach leads to a non-proportional adjustment, meaning that production branches with high budgeted costs undergo a more marked adjustment than branches with lower budgeted costs. Generally speaking, maximum entropy provides a probability distribution in which the adjustment of high budgeted costs is more likely than the adjustment of low costs. This corresponds perfectly to agricultural reality, in which the higher the absolute costs, the higher the possibility of cost adjustment. In addition, since the non-proportional joint cost approach is applied separately for each farm, a farm-specific joint cost allocation is provided.

2.2. Definition of production branches

Whereas Lips (2012) focused exclusively on farms with crop production, dairy farms in the mountain region include both animal and plant-production branches. Thus, to allow us to compare several types of animal production, another reference base besides hectares for plant-production branches must be introduced. Given that the necessary inputs for a single animal differ greatly (e.g. laying hen versus dairy cow), the number of animals would be misleading. The livestock unit (LU) is a potentially useful reference base, since necessary inputs have a similar magnitude, an important requirement for joint cost allocation. Accordingly, two reference units – hectares and LU units – are applied for the joint cost allocation.

The definition of production branches is of great importance. For instance, defining just two production branches – dairy production and the rest – does not take full account of deliveries within dairy production (e.g. hay to dairy cows). The fodder produced on-farm for the winter period, such as silage or roughage, can be used to feed dairy cows as well as sheep. Accordingly, we define roughage and silage maize as 'own production' branches[3]. For dairy livestock, we distinguish two production branches: on the one hand, dairy-cow husbandry, including labour-intensive milking; on the other, the breeding of future dairy cows. This distinction is motivated by the substantial variation that exists between farms in terms of organisation. Some farms may outsource breeding, whilst others breed their own future dairy cows on-farm. In total, four production branches are directly connected with dairy production: Silage maize, roughage, dairy-cow husbandry, and breeding.

2.3. Results per kilogram of milk

In order to derive the full product cost per kilogram of milk – an important piece of information for dairy farmers and farm consultants – several steps must be taken to transform the full product cost of the dairy-related production branches. For this, we take advantage of additional data provided by the Swiss FADN, such as quantity of milk produced in kilograms.

As a first step, and based on the full product costs per hectare of silage maize and roughage, we calculate total costs for in-house fodder production by multiplying these values by the corresponding number of hectares. Next, we take the sum of both branches. Assuming that all ruminants require the same amount of fodder per livestock unit, we multiply these costs by the percentage of total ruminants represented by breeding and dairy-cow husbandry (all measured in livestock units).

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2 The 'true' joint cost allocation can be interpreted as a data gap.

3 The storage costs for fodder produced on-farm are accounted for in the 'silage maize' and 'roughage' production branches.

Secondly, in order to obtain the total costs of the 'dairy-cow husbandry' and 'breeding' production branches, we multiply these full product costs per livestock unit by the corresponding number of livestock units. The resultant costs are then added to the costs from step one, yielding the total costs for milk production.

Thirdly, we must bear in mind the different outputs of the composite branch of milk production. In addition to the production of milk, old cows are slaughtered and breeding animals can be sold to other dairy farmers. Assuming a joint production of all outputs, the total costs for dairy production must be multiplied by the percentage of total milk-production turnover represented by milk sales.

Finally, the resultant total costs of milk production are divided by the total number of kilograms of milk produced, less the milk used for breeding, in order to obtain the full product cost per kilogram.

3. Data

Because of the focus on dairy production in the Swiss mountain region, we use the accounts of Swiss FADN specialist dairy farms in mountain zones 1 to 4. A total of 12 production branches are defined in order to depict the typical agricultural activities of these farms. Besides the four dairy-related production branches mentioned in section 2.2 (silage maize, roughage, dairy-cow husbandry, breeding), three further branches dealing with plant production are important: cereals (wheat and barley), forest, and other plant production including potatoes, fruits, vines and specific ecological areas. Another five production branches are devoted to animal production: fattening cattle (including calf fattening), sheep and goats, pork (pig fattening and pig breeding), poultry (poultry fattening and laying hens), and other animals (e.g. horses and donkeys).

The analysis is based on eight cost items in total, of which three are devoted to direct costs: purchased feed (feed concentrates and purchased roughage), veterinary services and products (including insemination), and other direct costs (e.g. seeds, fertilisers, and purchase of animals). Land is treated as a single cost item. Four cost items deal with joint costs: labour, machinery, buildings, and other joint costs (e.g. energy, telephone, insurance, and further training).

As regards labour, the Swiss FADN reports farm-wide labour input measured in working days. Labour is allocated to production branches in form normal working days rather than costs for labour. Working days are then rated with an opportunity cost of CHF 280 (10 hours per normal working day at CHF 28 per hour, Gazzarin, 2011). The machinery costs include depreciation and interest of invested capital as well as repair, maintenance and fuel costs. Machines associated with animal husbandry such as milking parlours are also considered part of machinery costs. Building costs take account of depreciation, interest charges and maintenance.

Since our focus here is on agricultural activities, we exclude farms involved in agriculture-related activities of over CHF 5,000 in value. Otherwise, the allocation of joint costs, especially of labour, would not be possible. Using data from the year 2010, a sample of 48 dairy farms is available. On average, these farms have 15 dairy cows and cultivate 19 hectares of land. Whilst the production branches of roughage, dairy-cow husbandry and breeding are represented on all farms, the other branches are represented by between one and thirty farms in each case (Table 1). The analysis covers 206 production branches in total.

The budgeted costs are provided for all production branches and joint-cost items (Gazzarin et al. 2013; 48 values = 12 production branches x 4 joint-cost items). The values are derived from farm- management literature and calculated at a hectare or livestock-unit level, as appropriate.

4. Results

Table 1 reports the full product costs per hectare or livestock unit for all production branches. In addition to the mean cost value, the minimum and maximum costs for the entire sample of 48 farms are reported.

Table 1. Full product costs for all production branches in CHF per hectare or livestock unit

Production Branch	Unit	Number of Observations	Full Product Costs in CHF per Unit		
			mean	minimum	maximum
Cereals	ha	5	4,245	2,778	5,463
Silage maize	ha	2	8,130	3,708	12,551
Roughage	ha	48	4,580	2,431	8,927
Forest	ha	30	1,003	684	1,315
Other plant production	ha	7	13,621	5,032	25,616
Dairy-cow husbandry	LU	48	8,220	3,515	14,477
Breeding	LU	48	4,734	2,377	10,076
Fattening cattle	LU	1	7,956	-	-
Sheep and goats	LU	6	4,196	2,239	6,369
Pork	LU	5	3,504	2,637	4,822
Poultry	LU	1	3,763	-	-
Other animals	LU	5	4,281	3,050	5,192

ha = hectare; LU = livestock unit

On average, the full product costs of dairy-cow husbandry amount to CHF 8,220 per livestock unit. Among the 48 farms, costs vary between CHF 3,515 and CHF 14,477 per livestock unit, i.e. by a factor of 4.1, thus indicating an enormous heterogeneity between farms. The differences for roughage (factor of 3.7) and breeding (factor of 4.2) are also substantial.

The full product costs derived per kilogram of milk are depicted in Table 2. In the mean of the sample, costs come to CHF 2.49, of which CHF 1.54 or 62% relates to labour, the main cost item. In second place, machinery costs account for CHF 0.36 per kilogram (14%). Cost positions three and four, purchased feed and buildings, respectively, are similar in size, accounting for around 7% each.

The resultant full product costs of three specific farms from the sample allow us to assess the heterogeneity in greater detail. Whereas the best farm has full product costs of CHF 1.23 per kilogram, the worst farm has a value six times larger, indicating an outlier. The median farm in terms of full product costs of milk has costs of CHF 2.12 per kilogram. Different production technologies might to some extent explain the differences in labour and building costs between the best and

Table 2. Full product costs in CHF per kilogram of milk

	Mean		Best Farm	Median Farm	Worst Farm
	CHF	in %			
Purchased feed	0.18	7.4	0.20	0.28	0.18
Veterinary	0.05	2.2	0.04	0.03	0.14
Other direct costs	0.06	2.4	0.02	0.05	0.12
Land	0.04	1.4	0.03	0.00	0.06
Labour	1.54	61.9	0.55	1.44	5.42
Machinery	0.36	14.4	0.19	0.19	0.83
Buildings	0.15	6.2	0.15	0.03	0.61
Other joint costs	0.10	4.1	0.05	0.11	0.20
Total	2.49	100.0	1.23	2.12	7.56

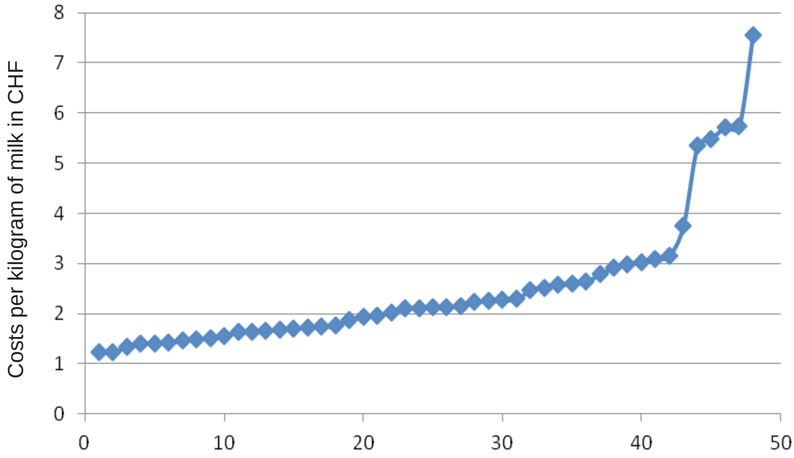

Figure 1. Distribution of full product costs for a kilogram of milk

the median farm. The best farm has probably invested in new buildings, enabling a substantial savings in working hours.

Figure 1 shows the full product costs per kilogram of milk for all farms in the sample. Between CHF 1.23 (best farm) and CHF 3.17 (42nd farm) there is a line with more or less the same slope, indicating that there are not even two farms with identical costs. Otherwise, groups of farms with similar costs would lead to several areas of the line with different slopes. At the far right of the graph, six farms with costs of over CHF 3.50 per kilogram are depicted, clearly indicating that a minority of dairy farms are either subject to specific circumstances (e.g. an extreme event), or have production systems that scarcely reflect economic realities.

5. Discussion and conclusions

Our results can be compared with two analyses of Swiss dairy farms in the mountain region. A typical Swiss dairy farm with 18 cows is included in the annual dairy report of the International Farm Comparison Network (IFCN, Hemme 2012) quoting costs of USD 2.42 or CHF 2.15 per kilogram, which are very close to those of our median farm. Haas and Höltschi (2012) analyse full product costs of 26 dairy farms in the mountain region with an average of 22 cows. They found that the average full product costs come to CHF 1.54 per kilogram of milk. Two reasons may account for the differences between the full product costs observed by Haas and Höltschi (2012) on the one hand and in our study on the other. Firstly, the dairy farms of the sample investigated by Haas and Höltschi are clearly larger than ours (22 cows on average as compared to 15 cows in our sample). Secondly, in the Haas and Höltschi sample, all participating farm managers regularly calculate their full product costs per kilogram of milk and compare their results in working groups, which represents a substantial effort in farm management. The said farm managers are therefore greatly interested in production costs, and can be assumed to have implemented cost-reducing measures. Consequently, their full product costs are markedly lower than those of the FADN sample.

Comparisons with the literature show that the applied approach leads to meaningful results. Furthermore, the comparison with Haas and Höltschi (2012) highlights just how important the attitude of the dairy-farm manager is.

Bearing in mind that the average milk-producer price in Switzerland is around CHF 0.60 per kilogram, we may draw the general conclusion that dairy production of the analysed sample (average CHF 2.49, median CHF 2.12) does not even come close to covering costs. Accordingly, a substantial part of the direct payments is used to cover production costs. In 2010, direct payments averaged CHF 73,000 per dairy farm in the mountain region (Mouron and Schmid, 2012). In addition, the assumed hourly wage of CHF 28 is far higher than is usually paid in practice.

The cost structure reveals that labour is the main cost driver, being responsible for around 60% of full product costs. In order to cope with the additional price pressure that would result from a potential free-trade agreement between Switzerland and the European Union, the labour input per kilogram of milk must be reduced substantially. In addition, costs for purchased feed and machinery, both accounting for between 30 and 60% of the producer milk price, must be reduced.

Consequently, there are two main conclusions for dairy farmers and farm consultants. Firstly, the efficiency of purchased feed must clearly be increased. Secondly, and more importantly, labour and machinery inputs must be reduced – an objective which would appear to be possible, to judge by the dairy farm with the lowest costs in the sample. For this purpose, taking advantage of economies-of-scale effects by e.g. starting a cooperation with other farmers should prove a promising strategy.

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