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A composite optimisation-simulation model for the analysis of the dynamic interactions in the Swiss Milk and Meat Market

Abstract

By 2011 Switzerland aims to liberalise the milk market which will result in market changes in the basic conditions for agriculture. The impacts of the liberalisation are investigated with a composite model obtained by combining an optimisation model for the agricultural sector and a dynamic simulation model for the milk and meat market. The calculations with the composite model indicate that milk price depends strongly on the phasing out of market support, while the abolition of milk quotas in 2009 is less decisive. An introduction of a dairy cow premium leads to a higher milk production, especially with abolished milk quotas. In this case the European milk price level represents the lower limit for the milk price in Switzerland. Compared to the milk market, with falling quantities meat prices are likely to exhibit a stable development.

1. Introduction

By 2011 Switzerland aims to carry out a far-reaching liberalisation of the milk market, the scope of which exceeds that foreseen in the EU and in other member countries of the OECD. This plan involves three measures: 1. The current milk quota regulations will be completely abolished in Switzerland by 2008, whereby organisations which have their own quantity management can withdraw prematurely as per May 2006. 2. Mid-2007 will see the implementation of the bilateral agreements with the European Union resulting in the complete liberalisation of the cheese trade between Switzerland and the EU. 3. Parallel to the cuts in milk market support between 2004 and 2008 in the EU (European Commission 2003), finance policy reasons will also lead to a reduction of support for milk in Switzerland by 2007 and further cuts are to be expected up until 2011 (BLW 2003, BLW 2004). This will result in marked changes in the basic conditions for Swiss agriculture in the coming years. In this environment the introduction of a dairy cow premium to compensate income losses is discussed.

From the point of view of political and administrative decision-makers, it is very interesting to know how farmers will react to the new basic conditions and how agricultural production structures will develop in the next few years. Since the multifunctional targets or functions of agriculture are defined in both the Swiss Federal Constitution (Art. 104) and the laws on agriculture this is particularly relevant with regard to the second point. For example, if it became apparent that the constitutional targets for agriculture, such as the conservation of natural resources or the upkeep of landscape could no longer guaranteed due to the liberalisation, it follows that the question would arise regarding a modification or reformulation of the measures.

The impacts of liberalisation for two liberalisation scenarios are investigated by creating price and supply forecasts with an optimisation model for the Swiss agricultural sector and a dynamic simulation model for the milk and meat market. The composite model obtained by combining the two methodological approaches is presented in this study. In addition to describing and discussing the two approaches, the results relating to future developments in the milk and meat market in Switzerland as well as developments in sectoral land use and developments in livestock numbers are presented. The paper closes with conclusions relating to both the content and the methodology.

2. Models

The output of an optimisation model is a statement of the best way to accomplish a goal. Given the exogenous basic conditions indicated and the behaviour assumed in the model, the results of a normative optimisation model provide a clear solution indicating the best from among a well-defined set of alternatives (Sterman 1988). In the context of this study, a sectoral optimisation model yields optimal land use and numbers of livestock. In addition to the limitations arising from their technical characteristics, the fundamental problem of sectoral optimisation models is that they need exogenous details regarding not only product prices, but also concerning costs and the political measures in favour of agriculture (Hazell and Norton 1986). Therefore, the models fail to capture the interaction between farm reactions and impacts on the factor and product markets (Zeddies 2003).

While it has been possible to use expert knowledge to obtain an exogenous assumption of price development for the major agricultural products in the market environment in which Swiss agriculture finds itself up to now, with its numerous domestic market support regulations and trade policy measures, this will no longer be reasonable, or indeed possible in future. In particular, this applies to markets for products for which the trade policy protection measures are reduced or completely rescinded in future and, at the same time, the current quantity regulations governing production are abolished. In this new market environment, the future development of prices depends directly on the interrelationship between supply and demand. As a consequence the evaluation of future supply developments in agriculture can no longer be based on exogenous price assumptions.

Simulation models are primarily suitable for analysing a system. The purpose of a simulation model is to mimic the real system so that its behavior can be studied. While optimisation models are prescriptive, simulation models are descriptive. A simulation model clarifies what would happen given a certain situation. The purpose of simulations can be foresight (predicting how systems might behave in the future under assumed conditions) or policy design (designing new decision-making strategies or organisational structures and evaluating their effect on the behavior of the system) (Sterman 1988). The results of the simulation in the context of this study reveal development scope, or development prospects for the simulated system, the milk and meat market for two liberalisation scenarios. Bouamra-Mechemache et al. (2002) describe the INRA-Wageningen simulation system for the EU dairy sector. This simulation system consists of two stand-alone models, one for milk and beef production on farms, the other for the processing of milk into dairy products and their allocation between domestic and foreign markets. The models simulate milk production, processing and market clearing in 14 EU member states. The production model is a simulation model with econometrically estimated behavioural equations. The processing and demand model breaks total milk supplies down into fat and protein components. Market demands for milk products drive the derived demands for the milk components, which are reconstituted at market level. Domestic and world markets for 14 dairy products complete the model. The two models can be run separately (to simulate quota scenarios) or interactively (no-quota scenarios).

In order to predict future price and quantity developments simultaneously while giving due consideration to these dependencies, the forecast of agricultural supply in Switzerland combines an optimisation and a simulation model. The sectoral optimisation model described in section 2.1 uses exogenous prices to evaluate optimal land use and animal husbandry. The simulation model described in section 2.2 endogenously calculates prices and the interactions between the milk and meat market.

2.1 The Swiss Optimisation Model SILAS-dyn

Agroscope FAT Taenikon, the Swiss Federal Research Station for Agricultural Economics and Engineering, has developed the Swiss agricultural sectoral information and forecasting system (SILAS) on behalf of the Swiss Federal Office of Agriculture since 1996. The model is used as a decision support system in connection with budget funds planning for Switzerland’s agricultural sector. The system is also used to analyse the effects of policy measures on regional and sectoral production, factor input in agriculture and income (Malitius et al., 2001).

The concept of SILAS is based on regionally differentiated process analysis models, as developed by Henrichsmeyer et al. (1996). These approaches are characterised by the modelling of so-called "regional farms", the depiction of all the interconnecting relationships between production, outlay and production factor generation and utilisation as well as the delimitation of the sector according to the concept of agricultural accounting (Jacobs, 1998). The development to a recursive-dynamic model approach, SILAS-dyn, with a 10 year forecast horizon, ensures that long-term factor utilisation decisions can be optimised in the model (Mann et al., 2003).

The Swiss SILAS-dyn model bases the regional farms on eight agricultural areas defined by increasingly difficult production and living conditions. These form the basis for a large number of agricultural policy measures. This enables very accurate modelling of the Swiss direct payments system, which is characterised by regionally graduated direct payment approaches and contribution restrictions. Furthermore, the homogeneous production potential of individual areas can be adequate represented in the model, as most of the statistical data are available at this regional level.

The sector model depicts all the prevalent crop and animal production activities in Switzerland. These are all differentiated according to organic and non-organic farming methods, whereby extensive production variants are also taken into consideration in the case of cereals, rapeseed and grassland. All the requirements a farm must meet with regard to a balanced nutrient balance sheet are depicted by means of a fertiliser module. A feed ration module ensures a correct, minimum cost feeding of all animals and a sectoral projection of commercial feed consumption and costs. A labour module optimises the use of hired labour as a function of specific regional working time requirements and available family labour. A building module optimises investments in stable construction depending on the availability of existing buildings from previous years and building requirements. Balance sheet equations at regional and sectoral levels ensure domestic utilisation of all agricultural intermediate products. As Switzerland's agricultural sector is cut off from the EU market for agricultural intermediate products, no trade relations with other countries are modelled.

The objective function maximises simultaneously the gross value added minus costs for outside labour and the fixed costs of investments in replacements and expansion for all eight areas, thus ensuring an optimal regional allocation of production. The positive mathematical programming method (PMP) (Howitt, 1995) is used to calibrate the base year to reality. To achieve this, complementary information from observation data is incorporated into the objective function in the form of a quadratic term (Röhm, 2003). Therefore due to its methodological approach, the sector model lies midway between pure normative optimisation models and positive econometric models (Cypris, 2000).

The mathematical model is:

$$Max\ Z_t = \sum_{iz} p_{izt} y_{zit} + \sum_{jz} d_{jzt} x_{jzt} - \sum_{kz} v_{kzt} u_{kzt} - \sum_{kz} v_{kzt-1} u_{kzt-1} - \sum_{jz} \alpha_{jzt} x_{jzt} - 0.5 \sum_{jz} \beta_{jzt} x_{jzt}^2$$

subject to

$$\sum_{jz} \mathrm{a}_{\mathrm{jlzt}} \mathrm{x}_{\mathrm{jzt}} \le b_{lzt}$$

$$\sum_{jz} e_{jkzt} x_{jzt} \le u_{kzt} + (1-\theta) u_{kzt-1}$$

$$y_{izt}, x_{jzt}, u_{kzt} \ge [0]$$

Z = Objective function value
z = 1...8 (Number of regions)
p = Product price vector
d = Vector of direct payments
v = Vector of investment cost
x = Vector of production activities (crop and livestock)
u = Vector of investment activities
y = Vector of buying and selling activities
c = Variable cost vector of production activities
α = Vector of parameters associated with the linear term (PMP)
a = Matrix technical coefficients of production activities for using production resources
b = Vector of available resources
e = Matrix technical coefficients of production activities for using investment resources
β = Matrix of parameters associated with the quadratic term (PMP)
θ = Reciprocal value of useful life expectancy of investment activities
j = 1...n (Number of production activities)
i = 1...m (Number of buying and selling activities)
k = 1...r (Number of investment activities)
l = 1...s (Number of investment resources)
t = 1...11 (Number of years)
t-1 = Previous year

The SILAS-dyn sector model represents a pure supply model for Swiss agriculture. It optimises agricultural factor utilisation and production with exogenous, specified product and factor prices, the development of which has up till now been periodically estimated in advance by experts from the agricultural administration on the basis of specialised knowledge. Variables relating to developments due to technical progress are predicted using trend extrapolation. As already discussed in the Introduction, the far-reaching reform and liberalisation of agricultural markets will make expert forecasts far more difficult. Therefore the sector model for the milk and beef sectors is combined with a partial market model which simulates future price development on the basis of market development. Other product and factor prices up to 2011 are obtained using estimates provided by exogenous experts from the agricultural administration sector. These anticipate that the Swiss price index for agricultural products will fall steadily by 15 to 20% between the initial year 2001 and 2011 due to further reforms of the markets. In contrast, the price index for factor prices is only expected to fall by about 3% since it is unlikely that there will be any great changes in the consumer environment if Switzerland goes it alone.

2.2 Dynamic Simulation Model for the Milk and Meat Market

A dynamic simulation model is used for the simulation of future price and quantity developments in the milk and meat market under differing basic agricultural policy conditions. Comparable applications for system dynamics in the market development sector are to be found primarily in the relevant American literature. One example of this is the work of Pagel et al. (2002) which investigates the influence of agricultural policy measures on the development of the American milk production and milk market using a dynamic simulation model. By way of comparison, the work of Nicholson and Fiddaman (2003) focuses on the volatility of the milk price in the American milk market and the identification of those factors which exert the greatest influence factors. The structure of the partial simulation model for the milk and meat market corresponds to that of the FAPRI model (Fapri 2004). The model, as in the case of FAPRI, is a non-spatial policy model. Price formation for the partial markets is realised via market clearing, whereby due consideration is likewise given to foreign trade and the associated restrictions as well as meat imports within the tariff quota. In contrast to the FAPRI or GTAP models which, applied to the milk market, distinguish between butter, cheese and milk (Fapri 2004a) or between milk production and milk processing (GTAP; Lips 2002), the simulation model permits a detailed depiction of demand and the associated relevant support and any changes it undergoes.

The simulation model consists of the following eight subsystems:

1. Herd model including feeding and feed balance

2. – 4. Meat supply, Meat demand and Meat market (veal and beef)

5. – 7. Milk supply, Demand dairy products and Milk market

8. Decisions

Figure 1 presents the aggregate structure of the simulation model. The figure does not include the subsystem ‘decisions’. It also does not show the feedback loops between prices on the two markets and the remaining six subsystems. These relationships are shown in figure 2.

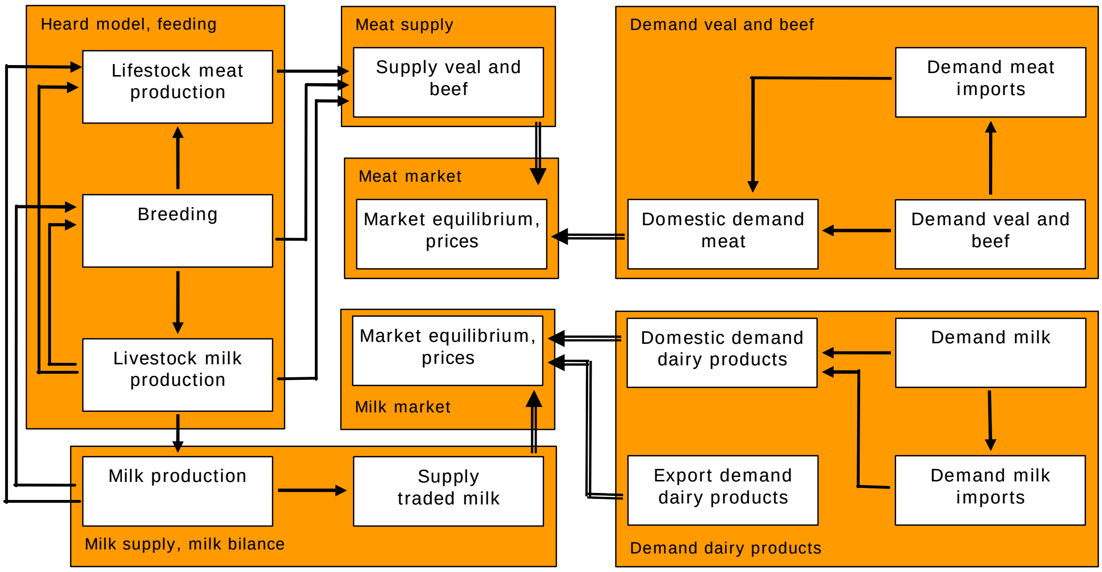

Figure 1: Subsystem diagram of the simulation model for the milk and meat market

In addition to the development of the milk and meat market, the mutual dependencies of these two partial markets are of special interest. To this end, figure 2 provides a detailed illustration of the two partial markets for milk as well as for beef and veal. The figure illustrates the relationship between prices, proceeds and cost developments and numbers of livestock on the one hand, while on the other hand it shows the market dependencies between supply and demand. Imports and exports of milk products are endogenously incorporated for the milk market.

Figure 2 shows that the interactions within and between the milk and meat market are driven by a series of balancing feedback loops. These loops control the reinforcing feedback loop in the herd model that allocates livestock units to meat or milk production. In the absence of the price control mechanisms animal husbandry would concentrate entirely on either of the two categories given an incremental disturbance of an initial equilibrium. The balancing feedback loops operate on several levels such as domestic and export markets. This constitutes a major source of instability because the adaptation times on these markets and within the herd model are very different. The concern about oscillatory behaviour on the two markets arises especially in a liberalised market environment where the feedback loops controlling the ratio between domestic production and import will become much more dominant.

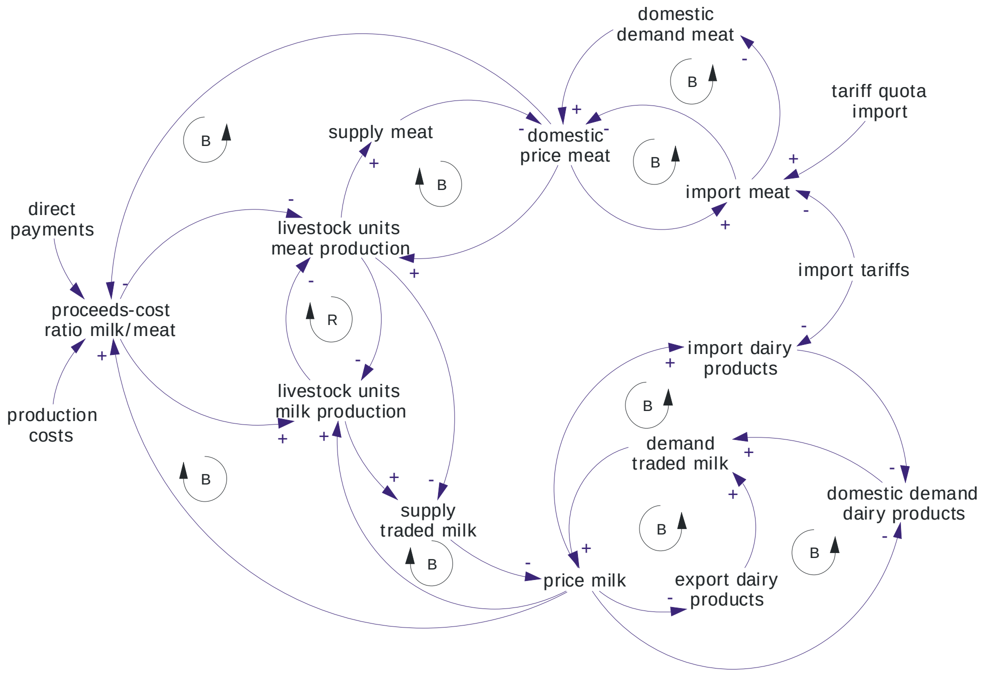

Figure 2: Demand, supply and price formation on the milk and meat market

The development of supplies of milk and meat is depicted by means of an aggregated herd model for the entire sector (not shown in figure 2). On the consumption side, the aggregated demand for beef and veal at wholesale trade level is relevant. The calculation of demand is based on four factors: 1. the prices estimated in the model, 2. the initial market balance 2001, 3. price developments for the competitor products pork and poultry, and 4. demand elasticity. In addition, it is assumed in the model that additional imports will compete against domestic produce for demand. In the case of the milk market, the model considers seven distinct product branches from the consumption point of view: drinking milk, fresh milk products and milk specialities, cream, butter, cream and soft cheeses, hard and semi-hard cheeses as well as long-life milk products. In these partial markets, demand for domestic products is depicted as well as imports and exports, whereby the simulations for the milk market are realised at wholesale trade level. Thus, the processors' demand for milk for a product branch is calculated in the model, whereby demand depends on price development, initial balance 2001 and demand elasticities. As in the case of domestic demand, demands for cheese exports into the EU and non-EU countries as well as for cheese imports are subject to iso-elastic demand functions. With the exception of the impact generated by competition from imports, changes in demand in the simulation only occur as the result of price adjustments at wholesale trade level. Price developments also depend on support of the milk market and border protection measures.

The simulation of the price for beef, veal and milk as illustrated in figure 2 represents a central element of the model. It is assumed that the quantities of milk and meat produced must correspond to medium and long term demand. A short term supply surplus leads to a price slump. On the other hand, additional demand generates a rise in prices and possibly an increase in production, whereby the numbers of livestock must be adjusted accordingly. While the price for beef and veal is based on overall supply and aggregated demand, the price formation for milk is obtained separately for the four partial markets, drinking milk and milk in fresh milk products, milk for cheese-making, milk in butter as well as milk in long-life milk products. In the model, price differences are offset by transferring milk to partial markets with a higher price. From a medium and long term point of view, the resulting adjustment of milk utilisation leads to a price balance within the partial markets.

2.3 Description and Discussion of the Composite Model

The composite model presented in this paper consists of the sectoral forecasting system SILAS-dyn and the simulation model for the milk and meat market. It permits a genuine improvement in forecasting developments in agricultural prices and supplies in Switzerland. The main reason for this is that the two model approaches, both of which are characterised by specific strengths and weaknesses, combine to complement one another. The optimisation model, with its depiction of the competition for scarce production factors, facilitates exact forecasts regarding supply developments in animal husbandry and arable farming. However, the forecasts are based on exogenous price assumptions, which remain constant regardless of the respective supply reaction. On the other hand, the price forecasts which are obtained from the simulations with the market model for the milk and meat market only cover the supply and demand changes in the two partial markets. Therefore, modifications resulting from changing competitive forces between animal husbandry and arable farming or activities within the scope of ecological compensation are not covered. However, the latter is the strong point of the sectoral optimisation model, which optimises future supply developments under the fixed production factors available and the respective basic conditions.

Forecasting of future price and supply developments in Swiss agriculture is therefore carried out using an iterative combination of the two models (see Figure 3): To start with, the market model simulates price forecasts only (1st run). These represent initial values which are used for forecasts with the sectoral optimisation model and form the basis for the formulation of new milk and beef supply forecasts. The supply forecasts for milk and beef are then re-entered in the market model in order to formulate new price forecasts (2nd run), whereby iterative price and supply forecasts are formulated with both models until prices and quantities no longer change. Due to the interchange of results between the simulation model and SILAS-dyn, medium and long term market balances can be delimited with a relatively high degree of precision. This applies in particular to medium and long term developments in production quantities, as these can be calculated much more exactly with SILAS-dyn than with the simulation model. On the other hand, the simulation model is highly effective for the calculation of future price developments in the milk and meat market.

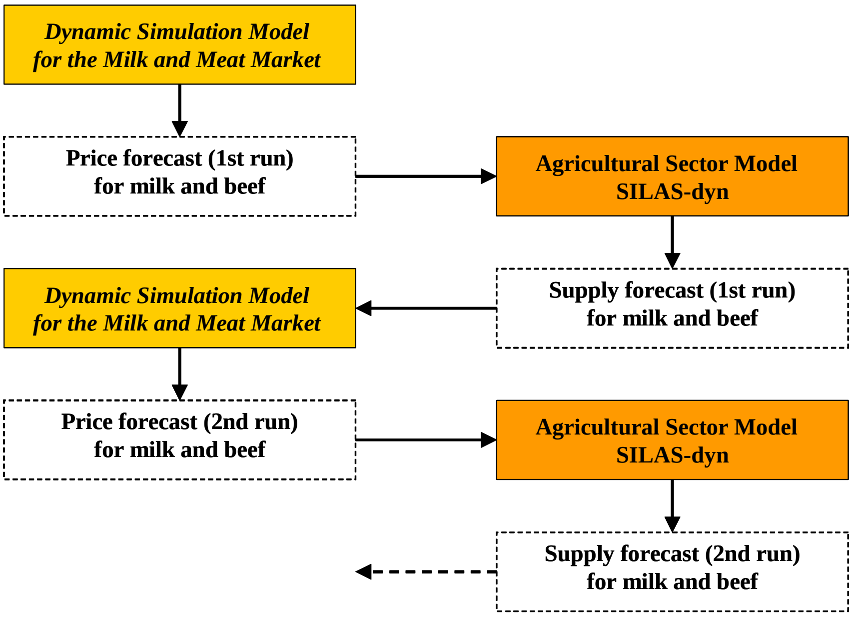

Figure 3: Structure of the iterative combination of the composite model

3. Development of the Milk and Meat Market in Switzerland up until 2011

The investigation of the impact of the liberalisation on sectoral supplies of milk and beef as well as domestic prices for milk and beef was carried out using calculations with the composite model. The calculations are based on two liberalisation scenarios which were elaborated in collaboration with decision-makers within the agricultural administration and observing a time horizon up until 2011. The first scenario (Scenario I) studies a 25% reduction in milk market support in Switzerland by 2007. The implementation of the bilateral agreements means that support payments for the export of cheese into the EU must be phased out completely. There are no further cuts between 2007 and 2011. After a slight increase between 2001 and 2007 milk quotas are abolished with no transitional phase as per 2008. On the other hand, the second scenario (Scenario II) considers the complete discontinuation of milk market support by 2007, the abolition of milk quotas as per 2008 as well as the introduction of a dairy cow premium amounting to CHF 700 per LSU from 2008. The funds which are no longer needed to support the milk market are to be used to finance the dairy cow premium. With this adaptation, the premium is paid for all cattle. Up to now, dairy were excluded.

3.1 Milk and Meat Market in Switzerland up until 2011 in Scenario I

Table 1 and Figure 4 show the price forecasts for Scenario I with a 25% withdrawal of market support and the abolition of milk quotas as per 2008. In the first run, which was performed with no link-up to the sectoral optimisation model (see Figure 3), milk price forecasts obtained using the simulation model show a 19% fall in prices by 2007. In spite of the abolition of milk quotas, there are no further noteworthy price changes between 2007 and 2011. Price development can be explained by two factors: 1. In spite of the fall in milk prices, the export price for cheese (hard and semi-hard cheeses) increases due to the elimination of contributions for cheese exports and the reduction of market support. 2. The liberalisation of the cheese market and the decreasing market support in the EU lead to a rise in cheese imports into Switzerland resulting in increasing price pressure on the domestic cheese market. In the case of beef, the market model shows a steady 13% decline in prices from 2004 up until 2011. This fall in prices is due to increased supplies, whereby imports nevertheless remain constant.

Table 1: Domestic and Export Prices (in CHF per tonne; 1 Euro = 1.55 CHF) for Milk Products in 2001 and 2011 for Scenario I (1st Run)

Products	Domestic price 2001	Export price 2001 EU	Domestic price 2011	Export price 2011 EU
Drinking milk	800		657	
Fresh milk products	800		657	
Cream	748		619	
Butter	608		516	
Hard and semi hard cheeses	568	407	486	486
Cream and soft cheeses	517	410	486	486
Long-life milk products	645		544	
Milk price CH	**800**		**657**	

The supply forecasts based on the prices obtained from the 1st run with the sector model SILAS-dyn show that the number of dairy cows producing traded milk will fall by 11% in the first half of the forecast up until 2007 due to declining milk prices (-19%). After this, numbers will rise again by 5% with no changes in the price of milk up until 2011. Finally, by 2011 numbers will settle at a level of 94% of those registered in 2001. The increasing number of dairy cows in the second forecast period indicates that, with prices in general on the decline and stable milk prices, the competitivity of keeping dairy cows rises slightly. This development in the number of animals will result in a decline in milk quantities to 3.2 million tonnes by 2007. Due to the growing number of dairy cows and increasing milk yields, milk quantities can be expected to rise to roughly 3.55 million tonnes between 2008 and 2011. Furthermore, the calculations with the agricultural sector model SILAS-dyn show that there is a close competitive relationship between dairy and suckler cow farming. On the one hand, milk price developments lead to an increase in cows used to produce traded milk, while on the other hand suckler cows are ousted. From an overall point of view, the number of cows remains relatively constant up until 2011. This also means that no great changes are to be expected in beef quantities up to this date.

New price forecasts (2nd run) are formulated using the simulation model taking the milk and beef production determined with the sectoral optimisation model as their basis. Figure 3 shows that the increase in milk production calculated for the second forecast period leads to a lower milk price in the price simulations, while the price for beef is slightly higher than in the first run. In the second run, the milk price will amount to roughly 0.60 CHF per kg in 2011 while prices for beef will rise slightly.

The supply forecasts for milk and beef based on the new price forecasts (2nd run) show that they are clearly lower than the first quantity estimates. New price forecasts based on these supply quantities from the 2nd run reveal that prices for milk and beef then lie at an intermediate level. Thus it may be expected by 2011 that the price for milk will lie between 0.60-0.65 CHF per kg. According to the SILAS-dyn forecasts, milk production will amount to 3.3 – 3.5 million tonnes by 2011. In addition, it is clear that in spite of the abolition of milk quotas, a partial liberalisation of the milk market will lead to a decline in the number of dairy cows and that this will not be offset by an increase in the number of suckler cows. Therefore, a steady fall by about 9% in beef supplies is to be expected in Scenario I.

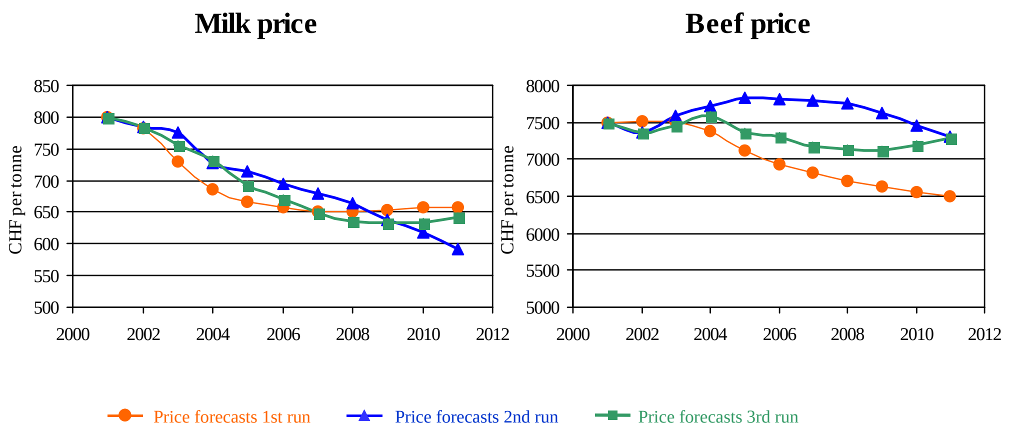

Figure 4: Price forecasts for milk and beef using the simulation model for Scenario I

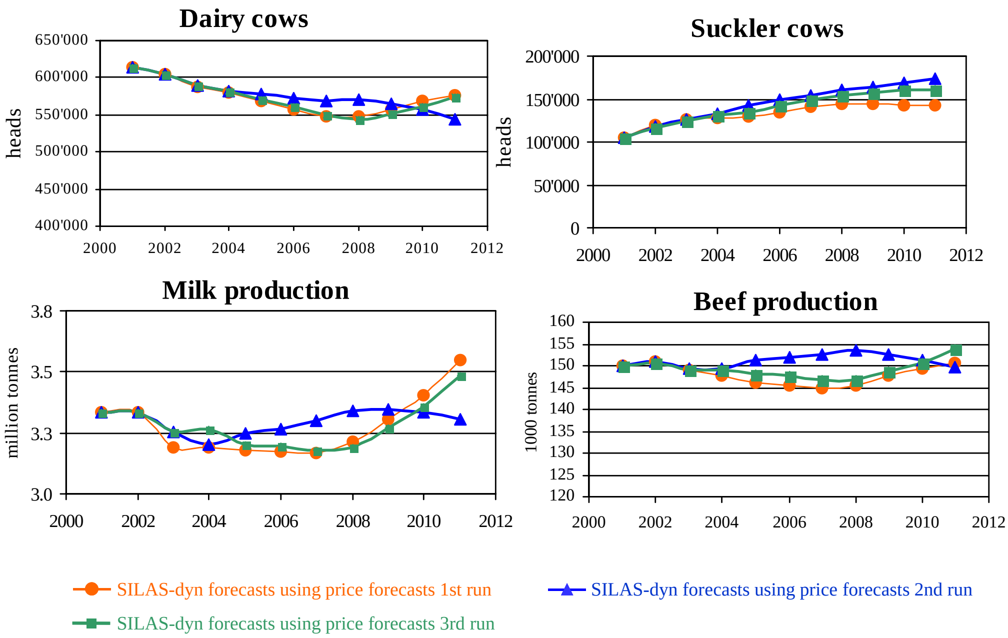

Figure 5: Number of cows plus milk and beef supplies using the sector model for Scenario I

3.2 Milk and Meat Market in Switzerland up until 2011 in Scenario II

The main difference between Scenario II and Scenario I is that market support for milk is phased out gradually by 2008 and a new dairy cow payment is granted.

Figure 6 shows that price forecasts obtained using the market simulation without link-up to the sectoral optimisation model (1st run) in Scenario II amount to 0.51 CHF per kg for milk in 2011. Although the foreseen abolition of market support leads to a fall in the price of milk, this is relatively low due to the reduced milk quantities in the simulation. In contrast, the optimisation model indicates that, at this price, a considerably higher number of dairy cows is to be expected due to the abolition of milk quotas and the payment of a dairy cow contribution (CHF 700 per cow) from 2008 onwards. Given an average milk yield of 6000 kg per cow and year, the payment corresponds to a compensation of 0.12 CHF per kg. Therefore, compared to Scenario I, there is a noticeably higher number of dairy cows with dairy cow payments than with product price support, even though milk prices are similar. Evidently, when milk prices exceed 0.50 CHF per kg, animal-specific payments represent an incentive to expand milk production; especially after the abolition of quotas and slightly lower payments for keeping other bovines (suckler cows or cattle for fattening). On the other hand, due to a shortage of funds no increase is to be expected in the number of suckler cows and their numbers will even out at the 2001 level. Therefore, for the sector as a whole, the beef production in the 1st run remains constant up until 2011. Even when milk quotas are abolished, it would be possible to achieve a marked increase in the quantity of traded milk, namely 3.9 million tonnes, with the same number of cows as in 2001 merely by exploiting higher milk yields and by limiting the amount of milk used for feeding purposes.

If milk quantities rise to over 3.9 million tonnes, the calculations obtained with the simulation model indicate that milk prices can be expected to fall to the EU level in 2011 (see Table 2). In the case of beef, the simulation model indicates constant market prices up until 2011 with unchanged production. Given these milk and beef prices, and in spite of the payment of a dairy cow contribution, the SILAS-dyn calculations show a steady 14% decline in the number of dairy cows to about 530000 animals by 2010, after which only a slight increase is to be expected. At the same time, the decline in numbers of dairy cows on the one hand and stable beef prices on the other lead to a 25% increase in the number of suckler cows. Therefore, given a milk price of 0.40 CHF per kg, the milk production calculated with the sectoral optimisation model SILAS-dyn falls to roughly 3.3 million tonnes in the 2nd run and is thus somewhat lower than the quantity produced in 2001. The decline in the number of cows in the sector would lead to a 7% fall in beef production.

In the 3rd run of the market simulation, the decline in milk quantities forecast in the 2nd run with SILAS-dyn results in a new milk price of 0.49 CHF per kg in 2011 which, combined with a dairy cow payment of CHF 700 per LSU and the abolition of milk quotas, leads to a long term build up in the numbers of animals. In this case, the abolition of milk quotas also results in an increase in the quantity of milk produced and this would clearly put pressure on the milk market.

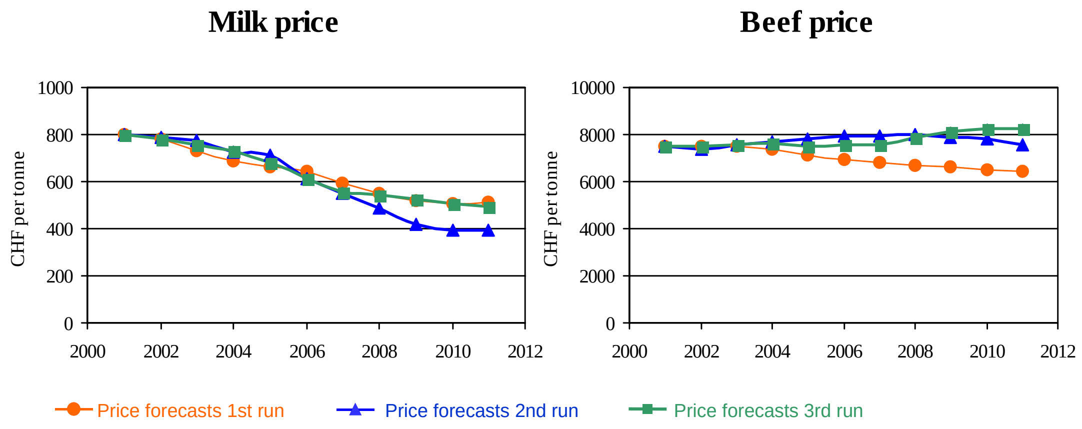

Figure 6: Price forecasts for milk and beef using the simulation model for Scenario II

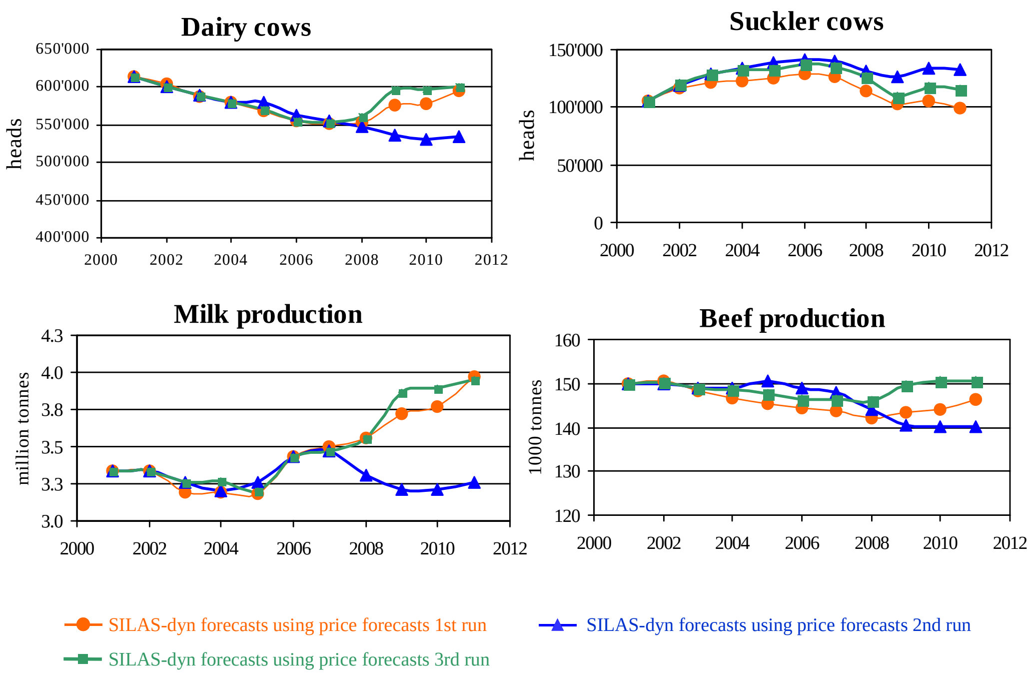

Figure 7: Number of cows plus milk and beef supplies using the sector model for Scenario II

3.3 Discussion of the Development of the Milk Market in Switzerland

Cheese exports into the EU and cheese imports play a major role in the development of milk prices in Switzerland. The first depend strongly on the relationship between the milk price for Swiss export cheese and the European price for milk for cheese-making. Table 2 shows the development of the milk price in Switzerland and the export price for cheese in both Scenarios. In addition, the anticipated price for milk for cheese-making in the EU is also indicated. Thus, a comparative price can be calculated via the Swiss allowances and the preferences of Swiss consumers for domestic products.

The direct comparison of prices shows that the export price for cheese in Scenario I exceeds the European price for milk for cheese-making (price EU-5). On the other hand, the domestic milk price obtained from the market simulation is only slightly higher than the comparative price (price EU-5 plus allowances and preference). A further decline in cheese exports is to be expected due to export price differences and this will increase pressure on milk prices in Switzerland. Pressure on prices is influenced by domestic milk production and by the preferences of Swiss consumers for home produce. If milk production in Switzerland continues at today's level and preferences for Swiss products are low, the milk price will fall below the comparative price plus allowances of 0.56 CHF per kg by the year 2011.

In Scenario II, the calculations using both the SILAS-dyn optimisation model and the market model indicate that the milk price and domestic milk production will be highly volatile. The abolition of milk support by 2008 means that price developments depend directly on domestic milk production: If lower quantities of milk are produced than in the initial year there is less pressure on prices and it can then be expected that prices in Switzerland are slightly higher than in the EU, whereby the magnitude of the difference depends primarily on the preference of Swiss consumers for milk products "made in Switzerland". On the other hand, if it is assumed that milk production remains practically the same as in 2001, the price of milk in Switzerland would probably come quite close to the European price. Due to the dairy cow premium foreseen in Scenario II, the quantity of milk produced in 2011 will be the same as in the initial year, even if the price for milk settles at 0.45 CHF per kg.

Table 2: Development of the milk price and the price of cheese for export into the EU as well as the European comparative price

	Milk Price (CHF per tonne)										
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Scenario I											
Milk price CH Export price for cheese	800 407	782 417	729 439	686 465	666 475	657 476	650 476	652 477	653 481	657 485	657 486
Milk price EU-5[1]	507	469	475	478	457	434	412	395	394	394	394
Milk price EU-5 plus allowances CH	739	689	683	675	642	607	582	565	564	564	564
Milk price EU-5 plus allowances CH and domestic preference [2]	815	765	759	751	718	683	658	641	640	640	640
Scenario II											
Milk price CH Export price for cheese	800 407	782 417	729 439	686 465	666 475	645 473	591 467	553 473	520 490	505 504	515 513
Milk price EU-5[1] Milk price EU-5 plus allowances CH	507 739	469 689	475 683	478 675	457 642	434 573	412 504	395 441	394 394	394 394	394 394
Milk price EU-5 plus allowances CH and domestic preference [2]	815	765	759	751	718	649	580	517	470	470	470

Remark: [1] Milk price EU-5: anticipated milk price for Germany, France, Italy, Austria and Belgium or the Netherlands.

[2] The domestic preference amounts to CHF 76 per tonne raw milk.

4. Summary and Conclusions

There will be major changes in the basic conditions for Swiss agriculture in the coming years. These changes are not only due to the liberalisation of agricultural market foreseen within the scope of current WTO negotiations, but are also attributable to the implementation of the bilateral agreements with the EU on the one hand and Swiss financial policy on the other. Shifts in agricultural production structures will be one direct result of these changes in basic conditions, whereby the liberalisation of the milk market will probably be particularly significant. As medium and long term flexibility rises, both the basic conditions for agriculture and technical progress are relevant for the decision-making process from the farmers' point of view. The development of agricultural production structures confronts decision-makers at political and administrative levels with the question of ensuring the multifunctional targets of agriculture and the possible modification of agricultural policy measures. Decisions are based on ex-ante forecasts of future developments in agriculture under the expected basic conditions. In this paper, a composite model consisting of a sectoral optimisation model and a simulation model for the milk and meat market serves as the methodological instrument used to provide this scientifically-based policy advisory service. The main task of this composite model is to assess future developments in the milk and meat market, sectoral land utilisation and numbers of livestock up until the year 2011 in the event of an abolition of milk quotas and a possible reallocation of the current milk market support in Switzerland.

From a content point of view, the calculations with the composite model indicate that the development of milk and meat prices depends strongly on the degree of liberalisation to which the milk market is subjected and, consequently, on the phasing out of market support in Switzerland. The abolition of milk quotas is less decisive. A partial liberalisation (25% withdrawal of market support) would lead to milk prices in a range of 0.60-0.65 CHF per kg and thus considerably higher than the prices for 2011 calculated on the basis of the price forecasts obtained from the FAPRI model (FAPRI, 2004b), the Model AGLINK (OECD, 2004) and forecasts of the European Commission (2004). These forecasts indicate a price of about 0.41 CHF per kg. In addition to the factors already mentioned, the development of milk prices in Switzerland is highly dependent on the preferences of consumers both at home and abroad for Swiss dairy produce. If we assume a low degree of preference, the milk price in Switzerland will come close to the European price. In the case of a partial liberalisation, the allowances which continue to be disbursed will make a difference, whereby their support effect depends directly on domestic milk production. Compared to the milk market, meat prices are likely to exhibit a stable development. Basically, with falling meat quantities and the specified imports (WTO tariff quota), the calculations in the composite model indicate that meat prices can be expected to remain steady or even to rise. However, under the current organisation of the import system, it is probable that additional imports would be permitted if meat prices were to go up. As in the case of milk, the amount of these additional imports depends on the Swiss consumers' preference for Swiss meat. However, since the origin of meat is a decisive factor in the decision to buy (BAG 2003), imports of meat may not be increased arbitrarily.

The model calculations indicate that milk prices and milk production would exhibit a relatively high degree of volatility in the event of a complete liberalisation of the milk market and the transformation of current support into a dairy cow premium. In this case the cow premium represents an incentive to expand milk production, especially in combination with the abolition of milk quotas. Given free access to the cheese market, the European price level represents the lower limit for the milk price. This leads to a milk price of at least 40 CHF per kg in the year 2011. On condition that the milk quantity does not change by 2011, the market simulations indicate a price of 47 CHF per kg; however at this price, the sectoral calculations with SILAS result in a slightly higher milk quantity as the competitivity of milk production is enhanced by the introduced dairy cow payments. Consequently, the milk price is likely to amount to roughly 40 to 45 CHF per kg, whereby the influence of consumer preferences is a decisive factor in this case as well.

From the methodological point of view, the conclusions pertain to the choice of a suitable methodological procedure and the combination of a sectoral optimisation model with a dynamic simulation model as presented in this paper. Basically, it must be stated that sectoral optimisation models, such as the SILAS-dyn model presented here, are ideal instruments for a scientifically based policy advice. In particular, this aspect gains in importance within the context of changing basic conditions and the associated modifications in production structures which must be implemented in future. The principal strength of sectoral optimisation models lies in the detailed assessment of development in agricultural supplies and production structures. Furthermore the optimisation also indicates the optimal allocation of production factors which are in short supply. Given the exogenous specified basic conditions, factor allocation is realised on the basis of the competitive strength of the activities and their changes. However, the latter depend heavily on the exogenous assumed product prices. Due to the limitations of the optimisation model on the supply side, there is no interaction between supply and price developments, which is detrimental to the validity of the forecasts.

The demand side must be included to mitigate this weak point; in this paper, this aspect of the milk and meat market is solved by using a dynamic simulation model. The fundamental strength of the market model lies in the model-endogenous simulation of future price developments giving due consideration to demand and supply developments. The latter can be taken over from the sectoral optimisation model. The results presented here show that an iterative link-up of the two models for price and quantity forecasts is possible and that future price and quantity developments can be delimited in this way. An extension of this procedure to other product markets should therefore be investigated.

The main advantage of linking the two model approaches together lies in the deliberate combination of their individual strengths; on the one hand, the detailed depiction of supply development obtained from the optimisation model and on the other hand, the price simulation based on an exact assessment of supply and demand developments. In this way, by using a combination of the two model approaches, it is possible to forecast, or rather delimit, future market and production structure developments in agriculture with a higher degree of precision. This is an important point since price and supply forecasts will be far more difficult in a liberalised market environment. However, political decision-makers require the most precise assessment possible regarding future developments.

From the methodological point of view, the market simulation requires further research, in particular concerning the demand function and elasticities used for assessing demand. The empirical bases which are available today are founded entirely on investigations carried out largely in a state-controlled market environment. Thus, the question arises concerning the extent to which the consumers' reactions in a liberalised product market can be explained on the basis of previous demand behaviour. The most vital aspect is the future development of imports and exports in a completely liberalised market, and thus the consumers' preferences for Swiss dairy products.

By way of contrast, surveys on the development of agricultural production structures reveal clearly that not only economic, but also numerous non-economic factors are highly relevant to farmers when they make decisions regarding production and investments. However, these factors are, to a large extent, not included in the sectoral optimisation model or are entered as constant over time with the positive mathematical programming approach. It thus becomes apparent that there is a need for research to provide an adequate, reality-orientated depiction of decision-making behaviour at the farm level in the optimisation model. A system dynamics modelling approach can contribute significantly to this task.

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