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The cheese processing aid in Switzerland: ex-post and ex-ante evaluations

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Abstract: The cheese processing aid is used in Switzerland since 1999 to support cheese production and raw milk producer. This paper presents ex-post and ex-ante evaluations of reductions of this processing aid. The ex-post analysis, using vector autoregressive models and monthly milk prices, estimates the effects of reductions of the aid on milk prices for Emmentaler, Gruyère and industrial cheese production. Declines in the aid were found to have significant negative but heterogeneous effects on milk prices and that these reductions are transmitted only imperfectly. The ex-ante analysis evaluates the effects of a complete removal of the aid using a partial equilibrium model. Despite the contraction of cheese production, this was found to have a positive net global welfare impact due to the reallocation of raw milk to other milk channels.

Keywords: Switzerland, dairy, producer support, vector autoregressive model, partial equilibrium model

JEL codes: C51, C63, D60, Q11, Q17

[1] *The views expressed in this article are the sole responsibility of the authors and do not reflect, in any way, the position of the FOAG.*

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1. Introduction

In this paper, we make use of both ex-post and ex ante analysis to provide a comprehensive assessment of a market support policy measure. We focus on the processing aid for cheese in Switzerland. The dairy sector is of key relevance for European agriculture and has been and still is subject to several policy interventions (e.g. Bouamra-Mechemache et al., 2009, Kempen et al., 2010). This is particularly the case in Switzerland, where milk production and processing (in particular cheese production) is of outmost importance and represents about 25% of the total agricultural production value. Furthermore, about 44% of all Swiss farms are engaged in milk production (SBV, 2013; SMP, 2013). While the milk and cheese markets have been under state control until the end of the 1990s, new policies have been implemented since around that time. Notably, milk quotas in Switzerland were officially abolished as of 1st May 2009 with a transition period of the three years.

One of the most important instruments to support cheese production that is still in place in Switzerland is the processing aid for cheese[2]. Following the elimination of export subsidies under the WTO agreement (in gradual decline steps, with a final abolishment in 2004) and the liberalization of cheese trade with the European Union (2002-2007; see e.g. BAKBASEL, 2012; El Benni and Finger, 2013a; Mann and Gairing, 2011, for details), the processing aid[3] was introduced in 1999 as a temporary measure to support the revenue of Swiss producers reducing the processing costs of raw milk and allowing the production of cheese at competitive prices. The processing aid is a subsidy paid for each kilogram of raw milk used for cheese production. Note that this subsidy applies for all types of cheeses, requiring cheeses to have a minimum fat content of 15%[4] (Bundesrat, 2014). Starting from 2004 there have been three reduction steps of the processing aid (for a total of about 5 cents[5]/kg of milk) with the current level being at 15 cents/kg of milk since 2007. Thus, the processing aid represents a significant share of the milk price. For instance, it represented 22% of the price for (non-organic) milk that was used for cheese making in 2011 (see

[2] Art. 38 of the Swiss Federal Law on Agriculture (LwG, RS 910.1) and Ordinance regarding supplements and data recording in the field of milk (OSL, RS 916.350.2).

[3] Next to the processing aid, a support scheme for the use of silage free milk for cheese production also exists. Silage free milk is of particular relevance for the production of the various high quality raw milk cheeses in Switzerland, which represent the majority of cheeses produced in Switzerland (LID, 2004). In this paper, however, we focus on the processing aid for cheese only for three reasons: first, it is substantially higher than the support for the use of silage free milk (e.g. currently 15 vs 3 cents/kg of milk); second, the aid for cheese production with silage free milk has decreased only once (by 1 cents in January 2007) since its introduction, hampering ex-post analysis on effects of changes in this measure; third, the payment for silage free milk is not considered in the price data available for our analysis (see section 2.2.2).

[4] Furthermore, some traditional cheeses such as 'Ziger' and selected acid-curd cheeses are also supported (see Bundesrat, 2014, for details).

[5] 1 cent (1 Centime) = 0.01 Swiss Francs.

section 2.2.2). The level of the processing aid for cheese is fixed in the current agricultural policy regulations until 2017 (Bundesrat, 2014). However, it has been the object of significant political debate with discussions on further reductions or abolishment (see for example Krähenbühl, 2014).

Despite the political relevance, no comprehensive empirical investigations on the effects of this production support measure have been conducted. But, evidence on effect mechanisms and a quantitative assessment of changes in the processing aid for cheese are required to assist policy makers. We aim to fill this gap by providing comprehensive analysis which makes use of both an ex-post assessment of changes in the processing aid in the past and of an ex-ante assessment, which allows, by means of a counterfactual scenario in which the aid is removed, to analyze the functioning of the measure. First, the effects of the above described reductions of the processing aid for cheese are estimated in an econometric ex-post analysis. The availability of different milk prices allows a disaggregated estimation of marginal effects of past changes in the processing aid for cheese. Second, an ex-ante impact analysis (accounting for potential future policy changes), by using a partial equilibrium model and a counterfactual scenario in which the aid is removed, assesses the impact of the processing aid on Swiss dairy products. Thus, we here employ a two-part structure and methodologies for the ex-post and ex-ante evaluation of a market support measure, which enriches the perspective analysis on this measure and thus is results helpful for policy analysis.

The ex-post analysis considers the effects of reductions of the processing aid in the three most important channels of milk use for cheese production in Switzerland: Emmentaler, Gruyère and industrial cheese (the latter comprises all non-artisan cheeses, Mozzarella being currently the most relevant). The importance of these three segments is underlined by their share within cheese production in Switzerland in 2012: 29% for Gruyère, 26% for Emmentaler and 21% for Mozzarella; (TSM, 2012). The first two cheeses represent artisan raw milk cheeses (under protected designations of origin, see e.g. Barjolle et al., 2005) that are characterized by restricted regions of production of milk and the processing into cheese resulting thereof as well as the methods of cheese production. That is both milk and cheese production take place in a specific region, with this restriction being much more restrictive for the case of Gruyère than in the case of Emmentaler[6]. Furthermore, the artisan cheese production for Emmentaler and Gruyère requires milk to be produced without use of silage fodder[7]. In contrast to the artisan cheeses, industrial cheese production is neither restricted geographically nor by the use of silage fodder. Note, however, that

[6] An overview of the specifications is given, for instance, by the Swiss Federal Office for Agriculture at http://www.blw.admin.ch/themen/00013/00085/00094/index.html?lang=fr .
[7] Thus, cows are fed with natural forage (grass in summer and hay in winter) only and without any additives or ensilage.

the processing aid is paid for the production of all cheese types. In summary, there is only a limited substitutability between the three milk use channels, especially in the very short run. In the long run, however, prices are expected to react clearly on each other because farmers can adjust production techniques and adapt to market conditions, and milk prices are interlinked via third markets (e.g. fresh milk[8], substitutability of cheeses from consumers' perspective, drop out from milk production, e.g. Pieralli et al., 2014). This background motivates an econometric analysis that accounts for the potential spillovers across different milk use channels when investigating the effects of decreases of the processing aid. To this end, a vector autoregressive framework is used in our empirical analysis that is based on a unique dataset comprising monthly milk prices for the specific cheese production channels covering the period 2000-2012.

This econometric analysis allows the identification and quantification of effects of past policy changes. A particular advantage of this approach is the ability to depict all interdependencies between milk used for different cheese production. There are however limitations concerning the analysis of potential future policy developments, as these go beyond the changes observed in the past. In our example, only small reduction steps of the processing aid have been observed in the past. Thus, it is not possible to derive ex-post indications on the effect of the complete abolishment of this measure. Furthermore, policy analysis requires the consideration of a wider array of welfare effects beyond effects on milk prices received by milk producers. The required welfare estimates combining consumer and producer surplus cannot be easily provided by an econometric model. To overcome this drawback, we will turn to the ex-ante analysis.

More specifically, our ex-ante analysis makes use of the market module of the Common Agricultural Policy Regionalized Impact (CAPRI) model (e.g. Britz and Witzke 2014) that since 2011 also includes Switzerland as a separate trade block. The CAPRI market module is a spatial comparative static multi-commodity model. The version of the model used for this analysis covers about 50 primary and secondary agricultural products and allows to represent nine processed dairy products: butter, skimmed milk powder, cheese, fresh milk products, cream, concentrated milk, whole milk powder, whey powder and casein. The representation of the dairy market ensures - through balancing equations - that processed dairy products make use of the exact amount of fat and protein available in the raw milk used for processing. In order to depict likely future developments in agricultural markets under current agricultural policies, the CAPRI model integrates several

[8] Note that the fresh milk segment and the industrial cheese production channel are highly interlinked. In contrast to the artisan cheeses, the industrial cheese production is located at major dairies that process raw milk into various products, and do not discriminate milk producers with respect to the product made from their supply. Instead, some mixed re-distributions of processing aids are made and milk prices paid for industrial cheese and fresh milk production are thus difficult to distinguish. We have thus not considered fresh milk channels in our analysis.

agricultural market projections provided by various international institutions (e.g. OECD, FAPRI, FAO and DG-AGRI). The model is able to provide results on imports, exports, production and producer and consumer prices as well as on welfare (Kempen *et al.* 2011; Witzke *et al.* 2009), since the strong microeconomic foundations of the model used as well as the template structure of the model equations allow also recovering consistent figures for the welfare analysis. A particular advantage of this approach is the possibility to analyze the impact of the processing aid for cheese on both milk producers and dairy processors. A limitation is the impossibility of explicitly distinguishing the three cheeses analyzed in the ex-post analysis since only one aggregate product category for cheese exists in the model for all trade blocks. Indeed, while the use of a partial equilibrium model is well suited for large scale cross-commodity, cross-country analysis, it is clear that this comes at the cost of a higher degree of product aggregation.

Making use of both an in-depth ex-post policy analysis on the level of individual milk prices as well as of an ex-ante analysis of a counterfactual scenario in which the policy measure is removed allows both to describe how historical stepwise reductions in the processing aid for cheese were transmitted to the producer price of the different milk channels and to describe the impacts of the processing aid on milk producers, dairy processors and consumers. The application of ex ante and ex post analyses allows to further shed light on the functioning of this policy measure.

The remainder of the paper is structured as follows. Section 2 briefly introduces the stylized microeconomic framework and presents the methodology used for both the ex-post and the ex-ante analyses, highlighting the main hypotheses and assumptions. Results are presented and discussed in Section 3 while Section 4 presents some concluding remarks.

2. Methodology

In this section, we first introduce the stylized microeconomic framework that serves as basis for our analysis (Section 2.1). Then, the methodology as well as the empirical base underlying the ex-post analysis are presented (Section 2.2), together with the partial equilibrium model used for the ex-ante analysis (Section 2.3).

2.1. Stylized microeconomic framework

A stylized microeconomic framework constitutes the base for both the ex-post and the ex-ante analysis. Our aim is to motivate potential impacts of (changes in) the processing aid for cheese on the price transmission of dairy producers, taking into account the equilibrium conditions for the production of raw milk and cheese. The microeconomic impact of the processing aid for milk processed into cheese might be interpreted as a subsidy (reduction steps being similar to taxation) of milk used for cheese production (see e.g. Varian, 1992, for formal treatments)[9]. From the initial equilibrium conditions, the introduction of the processing aid shifts up to the right the demand of raw milk for cheese production and the supply of cheese down to the right. As a result, more milk is processed for cheese production, milk prices increase and more cheese is produced and sold at lower prices. The introduction of the aid, departing from the initial market competitive equilibrium conditions, leads to a market inefficiency (deadweight loss) similar to the one introduced by a standard market price support on production (Varian, 1992). This prevents the processing aid from being fully transferred to the milk producers (see also OECD 2002)[10].

The transmission of the processing aid on the milk producer prices across the three milking channels will be the central element for the ex-post analysis whereas the ex-ante analysis will focus on the impact of the processing aid on dairy products markets as well as on the welfare analysis of this policy measure. For the first, we use the framework presented above to derive hypotheses regarding the transmission of the processing aid that will then be investigated in the empirical analysis (e.g. Varian, 1992). For the latter, the theoretical framework is actually reproduced in the demand and supply functions of the partial equilibrium model that we use.

2.2 Ex-post analysis

This subsection describes the methodological approach used in the ex-post analysis that focusses on three channels for milk use, namely Gruyère, Emmentaler and industrial cheese. We expect milk prices to depend on market and policy conditions as well as on their own realizations in the past, i.e. to be auto-correlated. Furthermore, as outlined above, the prices of milk are also expected to be interrelated to some (but not full) extent across channels. Due to the similar relevance of all three market segments with respect to milk quantities used (e.g. TSM, 2012), we cannot assign a-priori causality on how milk prices influence each other. This requires the milk prices to be analyzed within a dynamic framework that accounts for potential interrelation over several periods using a vector autoregressive (VAR) modeling approach (e.g. Hendry and Juselius, 2001). This

[9] Note that we are aware that increases and decreases of the processing aid may have asymmetric effects on markets (e.g. Meyer and von Cramon-Taubadel, 2004). As we analyze effects of reductions of the processing aid only, inference will be strictly limited to this case.

[10] Further contributions worth mentioning on price transmission mechanisms along the food chain are Gardner (1975) and McCorriston et al. (1998, 2001). Accounting for the entire chain, Gardner (1975) shows how farm and retail prices move together in different ways depending on the source of the exogenous change that has caused the movement. Notably, events that increase the supply of farm products will increase the ratio between the retail and the farm price. Along these lines, McCorriston et al. (1998) account for market power in the downstream food sector. They find that elasticity of substitution and market power have offsetting effects; notably, while a higher value of the elasticity of substitution increases the price transmission elasticity, a higher degree of market power lowers the price transmission elasticity. This model is extended by McCorriston e al. (2001) by allowing for non-constant return to scale: if the industry is characterized by increasing returns to scale, the level of price transmission will increase.

econometric framework will be used to estimate the effect of changes over time in the processing aid for cheese on milk prices in the different segments, accounting also for changes in other potential explanatory variables. The changes in the processing aid considered in our analysis comprise three reduction steps, namely in May 2004 (by 1 cents/kg of milk), May 2005 (by 1 cents/kg of milk) and January 2007 (by 3 cents/kg of milk). Since 2007, the processing aid has been fixed at a level of 15 cents/kg of milk. In the remainder of this section, the model specification tests (2.2.1), the data (2.2.2) and the econometric specifications (2.2.3) are presented.

2.2.1 Model specification tests

The specifications to be used in this modeling approach depend on the properties of the time series under analysis (e.g. Hendry and Juselius, 2001). More specifically, three cases may be distinguished: i) if time series are stationary, the VAR models can be estimated in levels, allowing to especially investigate long-term dynamics, ii) if time series are non-stationary and cointegrated, a vector error correction model has to be employed, allowing to focus on both long- and short-term, dynamics; iii) if time series are non-stationary and not cointegrated, a VAR model in first differences is used, restricting inference on short-term dynamics.

To test for stationarity, both the augmented Dickey Fuller (ADF) and the KPSS (Kwiatkowski, Phillips, Schmidt, and Shin) tests are used. The null hypotheses in the latter test is that the time series under investigation is I(0), while under the ADF test the null hypothesis is that the time series is I(1). Applying both tests has the advantage that series that are near unit root processes (and would be accepted by the ADF test) are revealed by the KPSS test (e.g. Esposti and Listorti, 2013)[11]. Throughout our analysis, trends and seasonality (using monthly-dummies) are considered as these are important characteristics for milk production, milk prices and thus the time series analyzed.

In a next step, we test whether time series are also cointegrated. Due to the at least partial substitutability of the products they are expected to share a common equilibrium state their relationship returns to. To test for cointegration of the three milk prices, we follow Johansen (1991). As sensitivity analysis and supporting investigations, we also used pairwise tests on cointegration instead of an analysis of the system of all three prices as well as applied the test strategy suggested by Engle and Granger (1987)[12]. The conclusions presented below are not affected by the choice of the test strategy. Results for both the Maximum Eigenvalue Test and the Trace Test (see Johansen, 1991) are presented, even though we are aware that in case of small

[11] All analyses presented in this section are made using the ‚*gretl*' software (Cottrell und Lucchetti, 2013).

[12] We focus on the Johansen test as primary tool for our analysis because of the lower power of the Engle and Granger approach (see e.g. Ericsson und MacKinnon, 2002, for a discussion on different cointegration test procedures).

sample sizes the trace test may be preferred (e.g. Lütkepohl et al., 2001)[13]. The lag-length considered in the Johansen test is selected based on the Akaike criterion[14]. To account for the (potential) linear trends in the underlying time series, we focus on a model specification with an unrestricted constant (e.g. Hendry und Juselius, 2001). Further sensitivity analyses also include the case of a restricted trend (allowing the cointegration relation to exhibit a linear trend), which did not affect the conclusions drawn from this analysis. We follow, for instance, Asche et al. (2012), Clements et al. (2011) and Wu et al. (2011) and account for seasonality in the specification of the Johansen test, with months entering as seasonality component (see Cottrell and Lucchetti, 2013, for details).

2.2.2 Data

The data underlying our analysis are monthly price data for milk used in the three cheese production channels discussed above (Gruyère, Emmentaler and Industrial cheese production) provided by the Swiss Federal Office for Agriculture[15], covering the period January 2000 - August 2012[16]. The prices used represent producer prices received by the farmer. The Swiss Federal Office for Agriculture corrects milk prices for the subsidy for silage free production, other duties and benefits, in order to ensure comparability across milk prices. These prices are collected at the level of the cheese dairies. The Federal Office for Agriculture surveys every month the most important milk buyers, covering in total about 70% of the marketed milk in Switzerland (see BLW, 2013, for more detailed descriptions). For the artisan cheeses, milk prices are surveyed from a representative sample consisting of 110 cheese dairies. The milk price data[17] are summarized in Table 1 and presented in Figure 1. Next to presenting mean and range of milk prices, we also present the linear time trends that have been identified in simple linear regressions using price data on the annual level[18]. The presented trend estimate gives the identified annual change in the specific milk price. Milk price developments differed structurally across the different channels of use within the period observed. While producer prices decreased for all considered cheese production channels (e.g. to reductions in border control and export subsidies), the reduction has been less distinct for Gruyère.

[13] p-values are calculated in GRETL using the approximations described in Doornik (1998).

[14] Working with monthly data, we restrict the upper limit of periods considered to be 12. A further criterion to be considered is that the analyzed model does not suffer from autocorrelation (see Esposti and Listorti, 2013, for descriptions).

[15] More information on the data used is available at: http://www.blw.admin.ch/dokumentation/00844/index.html?lang=de .

[16] No earlier record of this price data was available, which would have allowed investigating also the effect of the introduction of the processing aid in May 1999.

[17] We opted to not apply a logarithmic transformation of prices because the absolute effects of 1 cents/ kg milk changes in the processing aid are of interest in our subsequent analysis.

[18] More specifically, we estimate the following model: $P_t = \varphi_0 + \varphi_1 t$, with P being the milk price and t being the year. We use OLS for estimation and report coefficient estimates for φ_1.

The different developments of milk prices for Emmentaler and Gruyère production also reflect the different developments of the market positions of the two cheese products. While Emmentaler faced a sharp decline of (particularly foreign) market position, Gruyère production faced an increasing demand, in particular on export markets (see e.g. BAKBASEL, 2012, TSM, 2012, for details). Furthermore, the Gruyère production chain at large[19] is able to exercise a high level of control of produced quantities of milk, avoiding to face excess supply of milk (see e.g. Blunier, 2013 and Flütsch 2012 for descriptions).

< Table 1. Summary of milk price data>

<Figure 1. Milk price data>

2.2.3 Econometric specification and tests

Table 2 reports the results for unit root tests (ADF and KPSS) on p_i and $\Delta_1 p_i$ (i.e. levels and first differences of milk prices). We find time series of milk prices to be I(1) but not I(2), because the time series of first differences are stationary while the time series in levels are not.

< Table 2. Unit root tests>

Next, results of the Johansen tests are presented in Table 3. It shows that the null hypothesis that the cointegration rank is zero cannot be rejected in either situation (see e.g. Doornik, 1998, for critical values). More specifically no cointegration is indicated by the here performed tests. This is surprising at first given the fact that we investigate three milk prices. However, the limited substitutability of the milk across channels as well as the fact that there seems no common (market or political) driving force bringing milk prices in a common equilibrium state (cp. Figure 1) partly explain this finding.

< Table 3. Results from the Johansen cointegration test: system and pairwise test results.>

In summary, we observed that the time series of milk prices are integrated of order one, but are not cointegrated. Thus, we focus in our subsequently presented econometric analysis on the VAR model in first differences[20]. The resulting VAR model in first differences can be written as follows:

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[19] The 'interprofession' of Le Gruyère AOC consists of milk producers, cheesemakers and cheese refiners (e.g. http://www.gruyere.com/en/organisation/?vt=int).

[20] However, to account for potential uncertainties underlying the above presented tests, we also ran the entire exercise using a VEC model. The conclusions with respect to the effect of changes in the cheese processing aid remain unaffected.

1a) $$\Delta E_t = \alpha_0 + \sum_{j=1}^{k} \alpha_j^E \, \Delta E_{t-j} + \sum_{j=1}^{k} \alpha_j^G \, \Delta G_{t-j} + \sum_{j=1}^{k} \alpha_j^I \, \Delta I_{t-j} + \delta_E \Delta CPA_t + \alpha_X X_t + \alpha_M M_t + \varepsilon_1$$

1b) $$\Delta G_t = \beta_0 + \sum_{j=1}^{k} \beta_j^G \, \Delta G_{t-j} + \sum_{j=1}^{k} \beta_j^E \, \Delta E_{t-j} + \sum_{j=1}^{k} \beta_j^I \, \Delta I_{t-j} + \delta_G \Delta CPA_t + \beta_X X_t + \beta_M M_t + \varepsilon_2$$

1c) $$\Delta I_t = \gamma_0 + \sum_{j=1}^{k} \gamma_j^I \, \Delta I_{t-j} + \sum_{j=1}^{k} \gamma_j^G \, \Delta G_{t-j} + \sum_{j=1}^{k} \gamma_j^E \, \Delta E_{t-j} + \delta_I \Delta CPA_t + \gamma_X X_t + \gamma_M M_t + \varepsilon_3$$

where ΔE_t, ΔG_t and ΔI_t denote first differences of milk prices for Emmentaler, Gruyère and industrial cheese production in period t, ΔCPA_t being the change in the processing aid for cheese in period t, X_t representing a vector of all other explanatory variables and M being a monthly dummy (capturing seasonality in milk price dynamics). ε_i are the error terms of the three equations (i=1, 2, 3). The error terms represent innovations, which can be correlated across each other but have to be uncorrelated with their own past realizations and the explanatory variables in the respective equation. Because explanatory variables are identical in all three equations, the estimation of the coefficients using ordinary least squares regression is efficient even if error terms across equations are correlated. Heteroskedasticity and autocorrelation consistent (HAC) standard errors will be presented throughout this analysis. Based on the AIC and (no) autocorrelation criteria (Esposti and Listorti 2013), a lag length of k=4 periods is considered.

Due to the small sample size, we restrict the inclusion of other explanatory variables X to a small set of dummy variables capturing the most important changes in the Swiss milk market in the period considered. First, we consider the last step of the abolishment of milk quotas (using a dummy indicating the period starting from May 2009) and expect this to have a negative effect on milk prices due to an expected expansion of milk production (see Mann und Gairing, 2011, for details). Note, however, that the effect of milk quota abolishment should not be overestimated in our analysis. First, the exit from the governmental quota system have been stepwise (i.e. quantity expansions have been allowed). Second and more importantly, private law regimes have been implemented to control the quantity (see Haller, 2014, p.26-27, for a list of detailed measures). As a result, expansions of quantities of milk produced have been lower than expected (see Haller, 2014, for a detailed analysis). Moreover, the developments at the cheese market (e.g. comparing Emmentaler and Gruyère) have not been driven by the change in the quota regime (Haller, 2014).

Second, we consider the last step in time of implementation of the free trade agreement for cheese between Switzerland and the European Union (using a dummy indicating the period starting from June 2007). Expected effects are ambiguous because the free trade agreement may result in threats for the domestic market but also offers new opportunities for export markets (see BAKBASEL, 2012, for detailed discussions). Third, we include the year 2008 as a dummy as this was characterized by high milk prices (see Figure 1) caused by developments on international markets that also resulted in upward milk price adjustments in the Swiss market (ZMP, 2013). The inclusion of these variables should contribute to an unbiased estimation of the effects of changes in the processing aid on milk prices.

Of particular interest for our analysis are the coefficients δ_E, δ_G, and δ_I (eq. 1a-1c), representing the effects of reductions in the cheese processing aid[21] on milk prices for Emmentaler, Gruyère and Industrial cheese production. These coefficients reveal the rate of transmission of changes in the processing aid on milk prices received by farmers. Based on the framework described in 2.1., the first hypotheses regarding these coefficients is that reductions in the processing aid are transmitted on milk prices, but not fully, i.e. we expect δ_i to be i) larger than zero (H_0: $\delta_i = 0$), ii) smaller than one (H_0: $\delta_i = 1$). Next, we expect the rate of transmission to be larger for industrial cheese production than for artisan cheese production (H_0: $\delta_I = \delta_G$ and $\delta_I = \delta_E$). This is due to the fact that industrially produced cheese faces a more elastic demand because much lower product differentiation is possible compared to artisan cheeses (comparing e.g. Mozzarella with Gruyère and Emmentaler), which leads to a higher price transmission. Moreover, this hypothesis accounts for the fact that there is a high degree of organization in artisan cheese value chains, i.e. for these cheeses (in particular Gruyère) quantities are controlled in the chain, allowing exercising downstream market power[22]. In such situation, reductions of the processing aid are transmitted to a lower extent to producers (comparable to the situation of taxes and market concentration, e.g. Varian, 1992). For completeness, we also test the null hypothesis that $\delta_G = \delta_E$. In order to test these hypotheses formulated under i) and ii), we use one-sided t-tests based on coefficient estimates and HAC standard errors. To test hypothesis iii), we use pairwise comparisons using the test procedure suggested by Clogg et al. (1995): $z = (\delta_1 - \delta_2)/\sqrt{(se\delta_1{}^2 + se\delta_2{}^2)}$, where δ_1 and δ_2 are the coefficients to be compared and $se\delta_1{}^2$ and $se\delta_2{}^2$ are their respective standard errors derived from

[21] Note that no increases have been observed, thus not allowing for conclusions on effects of increasing levels of the processing aid. This caution is particularly motivated by the observation that cost increases (a decreasing processing aid) do not necessarily have the same effect on up- and downstream markets as cost decreases (e.g. Bukeviciute et al., 2009, Meyer and von Cramon-Taubadel, 2004).

[22] For discussions on the empirical basis for this assumption in Swiss cheese markets see Mérel (2009) for an example of market concentration in French cheese markets.

the estimation of equations 1a-1c. Under the null hypothesis, the latter test statistic z is standard normally distributed.

In addition, Granger causality tests are conducted and presented. To this end, F-tests are performed to identify whether all considered lagged information from a specific milk price (e.g. for Emmentaler production) has a significant effect on the current price of another milk price (e.g. for Gruyère production). Note that we are aware that this represents only a necessary but not a sufficient condition for causality.

2.3 Ex-ante analysis

This subsection describes the dairy handling in the CAPRI market module and also defines the scenarios used for the ex-ante analysis. In the former particular emphasis is attributed in explaining the specification of the raw milk supply as well as the supply of the processed dairy products in relation to the previously introduced stylized microeconomic framework. This partial equilibrium framework will be used to analyze the impact of the processing aid for cheese on raw milk producers as well as dairy processors, thanks to a counterfactual scenario in which this measure is abolished. This will be done by looking at the impact on producer prices, production, consumption and imports/exports changes as well as on the welfare effects. Through the welfare analysis it will be also possible to analyze how the removal of processing aid is actually affecting raw milk producers, processors and consumers and to quantify market inefficiency.

2.3.1 Model specification

CAPRI includes a market module where Switzerland is included as a separate trade blocks (see e.g. Britz and Witzke, 2014 for more details on the structure of the model; and also www.capri-model.org). International trade policies are represented for all the trade blocks; for Switzerland, the aggregate applied ad-valorem tariff equivalents are calculated for the different products by the TRIMAG aggregation tool (Listorti et al., 2013). The market module is based on the 'Armington' assumption (Armington, 1969) that allows differentiating the price of products according to their country of origin. This allows depicting bilateral trade flows for about 50 agricultural products and 77 countries grouped in 40 trade blocks. In the CAPRI model, raw milk can be processed into nine dairy products: butter, cream, cheese, skimmed milk powder, whole milk powder, fresh dairy products, casein, whey and condensed milk. The nine dairy products can be traded among the different trade blocks, whereas raw milk itself is assumed to be non-tradable[23] and to be fully utilized for processing.

For each country, CAPRI accounts for the demand for human consumption, for feed consumption, as well as for country specific processing and a supply. The model allows simulating the endogenous changes for prices and quantities at the equilibrium for given exogenous changes on domestic and international policies. For the analyzed policy change, consequent changes for the welfare of producers, consumers and processors as well as the government outlays are simulated by the model. The processing aid for cheese is modeled in CAPRI as an aid per kilogram of produced cheese (rather than milk) since the model only represents the equilibrium condition between the aggregate supply and demand for raw milk without specifically representing the demand of raw milk used for the production of cheese. From a theoretical perspective, the modelling of the processing aid as an aid per kilogram of produced cheese is equivalent to an aid per kilogram of raw milk processed into cheese (see also Section 2.1).

The fat and protein balance between the nine dairy processed products considered in the model and raw milk is guaranteed using the following equation:

2) $\sum_s \gamma_{sc} \cdot PRS_s = \gamma_c \cdot PMR$

where PRS_s represent the production of the nine dairy processed products s, γ_{sc} is the content of the dairy processed products s in terms of $c \in \{fat, protein\}$, PMR the production of raw milk for processing, and γ_c is the content of raw milk in terms of $c \in \{fat, protein\}$. The physical constraint in equation 2 ensures that the content of fat and protein out of the nine dairy processed products entirely match the amount of fat and protein contained in raw milk for processing. The CAPRI supply function (see also Witzke and Tonini, 2009) of the dairy products (PRS_s) and the demand of raw milk (PMR_r) are derived from a quadratic normalized profit function (Lau, 1978) that simplifies to:

3) $PRX_i = \theta_{i0} + \sum_j \theta_{ij} \frac{PM_i}{PP_{rest}}$, with $i, j = 1, \ldots, r + s$,

where PRX_i represents the supply of the nine dairy processed products for $i = s$ or the demand of raw milk for $i = r$; PM_i is the processing margin; PP_{rest} is a general price index comprising all

[23] This is actually the case in most of the available partial equilibrium models representing the dairy sector, and it is due to several reasons: firstly, available statistics may not be sufficient for building a consistent and complete global data base; secondly, trade costs are usually high, then impeding trade between regions.

goods not directly modelled (either inputs or outputs). The dairy processing margin is specified as follows:

4) $PM_i = PP_i + CPA_i - \sum_c \gamma_{ic} PS_c$,

where PP_i is the producer price, CPA_i represents the producer price support measures (for *i=cheese*, the support measure corresponds to the processing aid for cheese), and PS_c is the endogenous shadow price for $c \in \{fat, protein\}$, which identifies inside the dairy supply of the processed products the costs of raw milk in terms of its fat and proteins. Therefore the processing margin of dairy products is driven by the difference between the endogenous dairy product's producer price and the endogenous value of its fat and protein content taking into account eventual support measures. The additive introduction of $CPA_{i=cheese}$ into the processing margin for cheese $PM_{i=cheese}$ has the direct effect of increasing the processing margin for cheese rendering the production of cheese more attractive relatively to the other dairy products with the ultimate effect of increasing the production of cheese. This has indirect effects on the fat and protein prices affecting also the production of the other dairy processed products. The final impact on producer price for raw milk and its production results from the combination of both direct and indirect effects.

The complementarity and substitution relationships between the different dairy products (e.g. the complementarity between butter and skimmed milk powder) are embedded in the exogenous supply response parameter θ_{ij}, which are initialized during the calibration of the reference scenario fulfilling the required microeconomic conditions (e.g. zero homogeneity condition for the equilibrium prices and symmetry) and relying also on information coming from the SWISSland model[24] (see Möhring et al. 2010). Integrating the supply response of SWISSland, based on farm level data, into CAPRI allows improving the empirical foundations of the underlying supply elasticities for Switzerland used during simulations.

2.3.2 Scenario description

For the ex-ante analysis two scenarios are developed and benchmarked against each other. The reference scenario (S_0) is defined as the most probable development of the future considering the continuation of the agricultural policies currently in place. As indicated above, the reference scenario is based on the projections prepared by several international organizations such as OECD, FAO (OECD-FAO 2010) and the EU (European Commission 2010). To account for recent

[24] SWISSland is a multi-agent model that allows taking into account farm decision-making behavior and interactions representing as closely as possible the heterogeneity of Swiss farms. For further information, see Möhring et al., 2010, Zimmermann et al., 2011, as well as http://www.agroscope.admin.ch (Research, Economics, Socioeconomics, Analysis of Social Macrostructures, SWISSland).

developments of Swiss Agricultural Policy (AP14-17, see e.g. Zimmermann *et al.* 2011), we also relied on projections derived from the SWISSland model. The reference scenario (S_0) includes for dairy the abolition of the milk quotas in the EU, the cheese free trade between the EU and Switzerland (see also Section 1) and the processing aid for cheese in Switzerland. For this analysis, we have used the year 2020 as reference point for the simulation. The market balance data for Switzerland are based on information coming from the Federal Office for Agriculture whereas the information on custom duties is from the Swiss Federal Customs Administration. In order to validate whether the baseline of the model was correctly representing the processing aid in terms of budgetary outlays it was checked that the Government spending figures for the baseline were consistent with the given amount of cheese produced in the baseline. The counterfactual scenario (S_1) considers a complete abolishment of the processing aid for cheese in 2020[25]. Results will be presented benchmarking scenario S_1 against S_0.

3. Results

3.1. Ex-post analysis

Due to the focus of our analyses, we limit the presentation of the results of the VAR model on the estimated effects of changes in the processing aid for cheese (Table 4)[26]. We find coefficients to be between zero and one, to be lowest for the Emmentaler and highest for the industrial cheese milk channel. On average across all three cheese types, the transmission of a reduction of the processing aid by 1 cents/ kg of milk is equal to 0.57 cents/kg of milk.

< Table 4. Effects of changes in the cheese processing aid.>

The tests conducted based on these estimates are presented in Table 5 and may be summarized as follows: the rate of transmission is significantly larger than zero for all milk prices. In contrast, the null hypotheses that the rate of transmission is perfect (equal to one) is rejected only for Emmentaler and Gruyère. The null hypotheses of pairwise equal effects across milk use channels cannot be rejected on 5% levels of significance. Thus, even though the results qualitatively support the hypothesis of different effects across milk use channels, these differences are not statistically significant.

In summary, our analysis of milk price developments in the period 2000-2012 reveals that the reductions of the processing aid for cheese that have been experienced in this period led to

[25] Since the processing aid has to be converted into a subsidy per ton of cheese produced in our model, we assume that on average 10 Kg of raw milk are necessary to produce 1Kg of cheese (e.g. Merel, 2009, Spreer, 2011). This has to be interpreted as an average value over all kinds of cheeses. This assumption is also confronted and validated with observed aggregated dairy statistics for Switzerland (SMP, 2014).

[26] Full result tables are available upon request from the authors.

significant reductions of milk prices. This reduction was, however, not entirely transmitted into the milk prices for artisan cheeses. On the contrary, in the milk channel for industrial cheese production, the null hypothesis of perfect transmission cannot be rejected.

< Table 5. Hypothesis tests.>

Moreover, we conduct tests on Granger causality, with results displayed in Table 6. We find Emmentaler milk prices to be influenced by past milk prices for industrial cheese, and the former to influence Gruyère milk prices. In contrast, the milk prices for industrial cheese production are not found to be influenced by past milk prices for the two artisan cheeses.

< **Table 6. Granger causality tests >**

3.2. Ex-ante analysis

This subsection describes the results of the ex-ante analysis focusing on the most important market indicators such as production, consumption, producer price, imports and exports. A counterfactual scenario consisting of the complete abolition of the processing aid for cheese (scenario S_1) is here compared to the reference scenario (S_0). All results refer to variation with respect to the year 2020 for scenario S_1 compared to scenario S_0 in which the aid is maintained. Price and market variations are expressed in relative terms with respect to the reference scenario whereas welfare changes are expressed in terms of absolute deviations.

The ex-ante analysis shows that by abolishing the processing aid for cheese, cheese production declines by about 5% whereas the price of cheese increases by about 4% (Table 6 and Figure 2). The cheese exports decline by 13%. The reduction of the total demand for raw milk for processing brings a contraction of the producer price for raw milk of 8% and a reduction in raw milk production of 1%[27].

For the remaining dairy products, we can see that after the reduction in the cheese production, their production slightly increases especially for those with high protein content such as skimmed milk powder (+10%, 3.000 tons), whole milk powder (+3%, 1.000 tons) and fresh milk products (+1%, 7.000 tons). For this reason, the producer prices decline for all the dairy products but cheese. In general we can also see that the market developments for the other dairy products are also affected due to a reallocation of the milk fats and proteins not anymore used for producing cheese (Table 7).

< Table 7. Price and market variations in S_1 with respect to S_0 (%)>

[27] It should be noted that as previously discussed in CAPRI it is not possible to distinguish between the milk used to produce the various dairy products; so this percentage price reduction refers to the aggregate price of all raw milk used for processing, whether it is used or not for cheese production.

< Figure 2: Cheese market>

In Table 8, the total welfare is decomposed in consumer surplus, agricultural producer surplus, surplus of the dairy industry and other surpluses (feed and processing industry, utilization of non-agricultural land), tariff revenue and quota rents and budget outlays for domestic support.

In scenario S_1 consumer surplus slightly increases (+7 million of Swiss Francs) with respect to scenario S_0, whereas the agricultural producer surplus and the surplus of the dairy industry decrease (-168 and -81 million of Swiss Franc less respectively). The spending of the Government is reduced due to the elimination of the processing aid for cheese (+278 million of Swiss Franc). The overall impact on Swiss welfare is still positive (+28 million of Swiss Francs). If we look at the detailed numbers for dairy (see Table 8), it is clear that the variation of agricultural producer surplus relates almost exclusively to raw milk, whereas the surplus of the dairy industry declines especially for cheese. Conversely, it increases for raw milk and milk powders due to the reduction of the price for raw milk. For the consumers, the reduction of surplus due to the price increase for cheese is compensated by the gains obtained through the price reduction in the other dairy products (fresh milk products). In addition, it is interesting to note that the losses for the agricultural producers are smaller than the budget outlays actually allocated for the processing aid. Thanks to this counterfactual scenario, it is possible to see that over the total budget outlays (278 million of Swiss Franc) only 60% are actually transferred to the agricultural producers (168 million of Swiss Franc) while 30% are transferred to the processors (81 million of Swiss Franc). This partial transfer to agricultural producers is essentially due to the effect that the aid has on the prices and quantities of the market equilibrium as already described in the previous sections. The remaining 10% represents a net economic loss (deadweight loss) representing the cost due to market inefficiencies consequent to the introduction of the aid supporting producer prices, influencing the overall value chain up to consumers. In other words, the simulations show that within the modeling framework used, the overall impact on global welfare of the abolition of this price support measure is still positive.

4. Conclusions

In this paper, we employ a two-structured methodological approach relying on both ex-post and ex-ante analysis to evaluate the impact of a market support policy measure. We focus on the processing aid for cheese in Switzerland. The ex-post analysis is used to evaluate the impact of stepwise reductions in the processing aid for cheese on the producer prices of the three most important Swiss milk channels. The ex-ante partial equilibrium analysis, by using a counterfactual scenario in which the processing aid for cheese is removed, allows to assess the impact of this policy measure on the Swiss dairy sector.

The ex-post analysis shows that the reductions of the processing aid for cheese during the period 2000-2012 led to a significant reduction of milk prices. However the reductions were not fully transmitted to milk producers. Moreover, this analysis revealed that artisan cheeses face a lower transmission on reduction of the processing aid on producer prices for milk than it is the case for industrial cheeses. A potential explanation for this phenomenon is a lower demand elasticity for artisan cheeses as compared to industrially produced cheese that are characterized by a lower product differentiation. In addition, artisan cheeses are typically subject to downstream market power. Our results show that reductions of the processing aid may have a different impact across milk producers. Due to the geographical restrictions associated with the production of artisan cheeses, this may – even though not explicitly addressed here – also increase income inequalities among Swiss farmers across regions and thus be of additional relevance for policy makers (see e.g. El Benni and Finger, 2013b).

The ex-ante analysis makes use of a partial equilibrium model characterized by a special handling for the dairy processed products, where a sophisticated balance for fat and protein allows a consistent representation milk and dairy markets. The strong microeconomic foundations of the model used as well as the template structure of the model equations allowed also recovering consistent figures for the welfare analysis. Results show that the processing aid for cheese in Switzerland plays an important role for the dairy market with a non-negligible impact for the producer price of raw milk and cheese. We find that only about 60% of the total budget actually spent on the processing aid is actually transferred to raw milk producers since, as prescribed by economic theory, the effect that the price aid has on the competitive market equilibrium reduce the transfer of the budget outlay allocated to this measure. Furthermore, we find that the impact of an abolishment of the cheese processing aid on aggregated Swiss welfare is slightly positive.

In conclusion, both the ex-post and the ex-ante analyses, which were conducted independently, contributed to shed light on the economic efficacy and efficiency of the processing aid for cheese. More specifically, the econometric analysis shows that reductions of the processing aid for cheese translate into reductions of the milk prices received by milk producers, but the coefficient of transmission in lower than 1. In parallel, the simulation model show that, as prescribed by economic theory, the transfer to agricultural producers of the budget outlay allocated to a market support measure is not full.

The combination of an ex-post and an ex-ante methodology then not only allows obtaining information on a bigger variety of aspects than what would be allowed by the use of either the one or the other method, but ultimately also adds robustness to our findings.

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Table 1. Summary of milk price data.

Channel of milk use	Producer prices in cents/kg		
	Mean	Range	Linear annual trend
Emmentaler	71	57-81	-1.16***
Gruyère	80	75-86	-0.12**
Industrial cheese	71	57-84	-1.57***

,* indicate that the null hypothesis of no time trend was rejected at the 5% and 1% level of significance, respectively.

Table 2. Unit root tests.

Channel of milk use	Prices in levels		First differences of prices	
	ADF ($H_O\colon I(1)$)	KPSS ($H_O\colon I(0)$)	ADF $H_O\colon I(1)$)	KPSS ($H_O\colon I(0)$)
Emmentaler	-1.41 (n.s.)	0.27***	-4.60***	0.10 (n.s.)
Gruyère	-1.94(n.s.)	0.40***	-8.01***	0.03 (n.s.)
Industrial cheese	-2.53 (n.s.)	0.12*	-5.67***	0.03 (n.s.)

*, ** and *** denote that the null hypothesis was rejected on a 10%, 5% and 1% level of significance, respectively. n.s. indicates that the null hypothesis could not be rejected. In the ADF test, a maximum number of lags of 12 periods was considered (and the AIC criterion used for lag length selection); in the KPSS test, the specification used was 4 lags. The qualitative interpretation of the results is, however, not affected by changes in these criteria that have been performed in sensitivity analyses.

Table 3. Results from the Johansen cointegration test: system and pairwise test results.

Considered Variables	**Trace Test**		**Maximum Test**	**Eigenvalue**
	H_0: Rank = 0	H_0: Rank≤1	H_0: Rank =0	H_0: Rank=1
a) Emmentaler/Gruyère/Industry	19.800	8.0271	11.773	7.2351
b) Emmentaler/Gruyère	12.289	0.99960	11.289	0.99960
c) Emmentaler/Industry	8.5452	1.1919	7.3533	1.1919
d) Gruyère/Industry	7.5300	0.11208	7.4180	0.11208

Note: the null hypotheses have not been rejected in any of the depicted cases.

Table 4. Effects of changes in the cheese processing aid.

Variable	Coefficient estimate (standard error)
δ_E	0.33 (0.15)
δ_G	0.63 (0.14)
δ_I	0.76 (0.99)

Note: hypotheses tests based on these estimates are presented in Table 5.

Table 5. Hypothesis tests.

Null-hypothesis	t-Statistic / z-Statistic
$\delta_E = 0$	2.23**
$\delta_G = 0$	5.16***
$\delta_I = 0$	3.45***
$\delta_E = 1$	4.76***
$\delta_G = 1$	3.04***
$\delta_I = 1$	1.11
$\delta_E = \delta_G$	1.59*
$\delta_E = \delta_I$	1.63*
$\delta_I = \delta_G$	0.50

*,**,*** indicate that the null hypothesis was rejected at the 10%, 5% and 1% level of significance, respectively.

Table 6. Granger causality tests

	Emmentaler-equation	Gruyère- equation	Industrial cheese - equation
Emmentaler	0.61	2.55**	1.21
Gruyère	0.34	6.13***	0.52
Industrial cheese	2.02*	1.69	1.18

Values represent test statisticts of F-tests. *, ** and *** that the Null hypothesis of no effect has been rejected at the 10%, 5% and 1% level.

Table 7. Price and market variations in S_1 with respect to S_0 (%)

	Producer price	Production	Consumption	Imports	Exports
Raw milk	-8.0%	-1.3%			
Butter	0.5%	-0.7%	-0.3%	0.0%	-4.4%
Cream	-0.2%	0.2%	0.1%	0.0%	1.5%
Cheese	3.9%	-4.8%	-0.3%	5.9%	-12.7%
Skimmed milk powder	-8.2%	10.4%	2.3%	-43.9%	10.0%
Whole milk powder	-5.2%	3.1%	2.5%	0.0%	10.2%
Fresh milk products	-3.8%	1.0%	0.9%	-0.1%	7.5%

Source: CAPRI simulations.

Table 8: Welfare analysis, absolute variations in S_1 with respect to S_0 for the overall agricultural sector (millions of Swiss Francs; details for dairy products)

Consumer welfare	**7**
Butter	*-2*
Cream	*1*
Cheese	*-54*
Skimmed milk powder	*2*
Whole milk powder	*6*
Fresh dairy products	*47*
Agricultural profits	**-168**
Raw milk	*-168*
Profits of the dairy industry	**-81**
Raw milk for processing	*11*
Butter	*-7*
Cream	*-4*
Cheese	*-91*
Skimmed milk powder	*10*
Whole milk powder	*2*
Fresh dairy products	*-3*
Others profits (feed, processing, others)	**-4**
Tariff revenues and quota rents	**-4**
Domestic budget outlays	**278**
Total welfare	**28**

Source: CAPRI simulations.

Figure 1. Milk price data

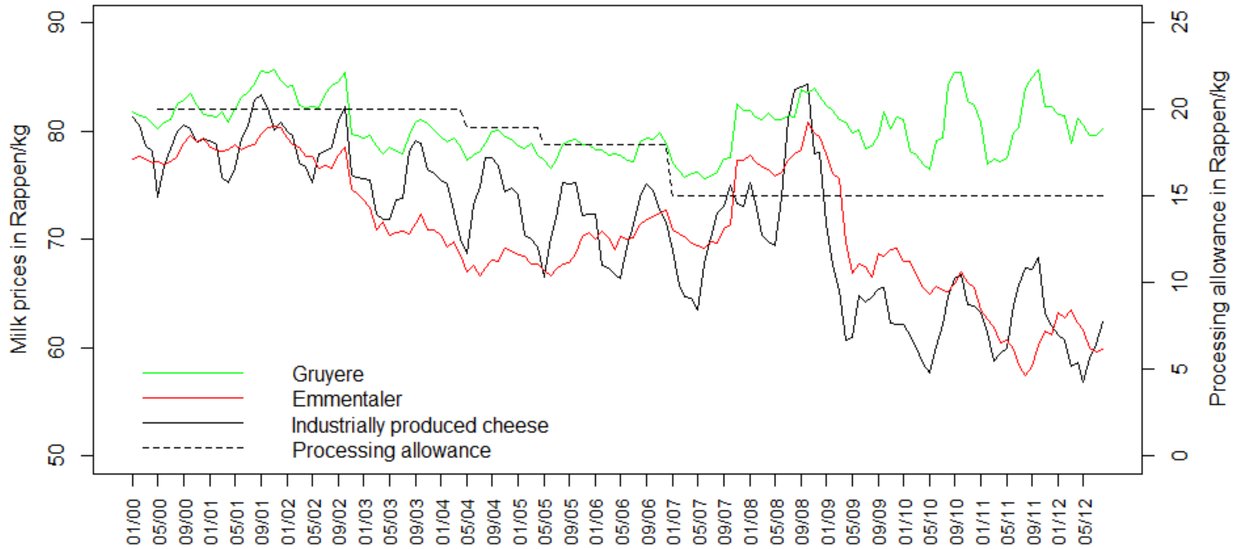
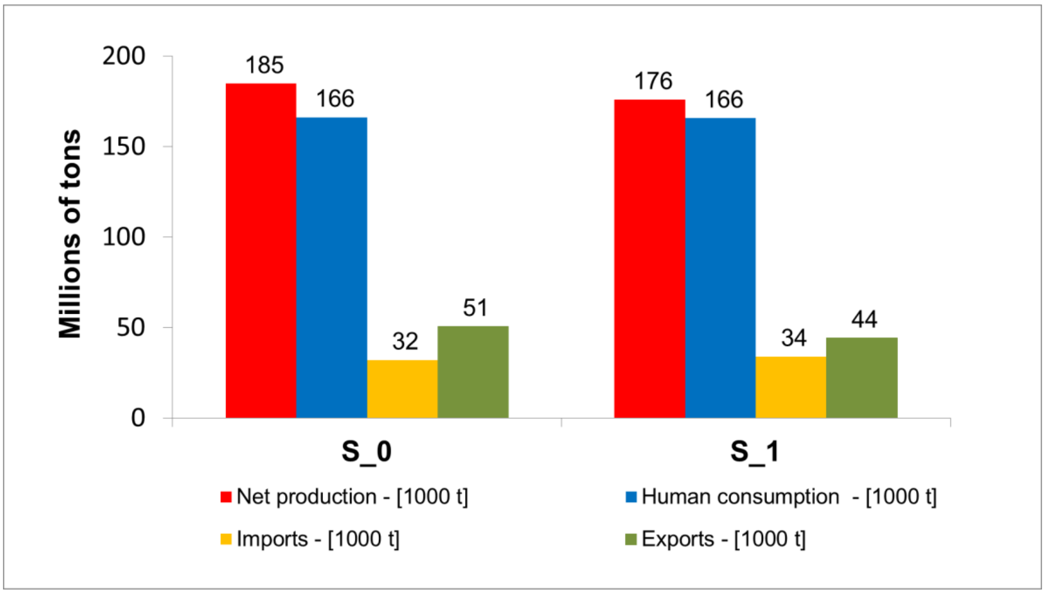


Figure 2: Cheese market



Source: CAPRI simulations.