Protecting the Swiss milk market from foreign price shocks: Public border protection vs. quality differentiation

J. Hillen;

University of Göttingen, Agricultural Economics and Rural Development, Germany

Corresponding author email: judith.hillen@agroscope.admin.ch

Abstract:

In Switzerland, a number of different border protection policies are in place for dairy products as a result from stepwise market opening. While dairy products such as butter and milk powder are still subject to tariffs and tariff rate quotas, cheese trade with the EU is fully liberalized. It is not well-understood how such different types and levels of protection affect spatial price transmission for the respective products and the underlying raw milk. Therefore, we analyze price transmission between Germany and Switzerland for several dairy products at the wholesale level, and for raw milk producer prices. We find that not the degree of public border protection and the resulting trade volumes determine the degree and speed of spatial price transmission, but rather the qualitative differentiation of the Swiss products. While prices of tariff-protected dairy products are influenced by German price developments, cheese prices are not. Also at the producer level, raw milk prices for cheese processing are less strongly linked to foreign prices than milk prices for industrial dairy production. Our results suggest that for small high-income countries such as Switzerland, promoting high-quality products and hence reducing international substitutability alleviates international price pressure more than public protectionism via tariffs.

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ABSTRACT

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1. INTRODUCTION

Since the 1990s, the Swiss milk market has gradually opened up, resulting in many parallel border protection policies for different dairy products (Haller 2014, FOAG 2017). In particular, there is a distinction between the liberalized “yellow line” (cheese products) and the still protected “white line” (other milk products, such as butter and milk powder). While cheese trade with the EU is fully liberalized, industrial dairy products such as milk powder and butter are subject to tariffs and tariff rate quotas (TRQs).

Yet, is it not well-understood how such different types and levels of protection for products jointly produced from a single commodity influence spatial price transmission. This is valid for the respective products and for raw milk producer prices. Given that globally milk has become one of the most volatile commodities (IFCN 2011), it is relevant to understand how foreign price developments influence domestic wholesale and producer prices in such a setting.

There is a large body of literature on spatial price transmission, including some studies on milk markets. These studies mostly focus on dry milk product prices in the aggregate regions EU, USA, and Oceania and find spatial long-run linkages among these three regions (Newton 2016, Fousekis and Trachanas 2016, Zhang et al. 2017). Studies looking at fluid milk prices find some spatial price transmission from global markets to smaller countries, such as Panama (Acosta et al. 2014) and the Netherlands (Carvalho et al. 2015). Testing for raw milk market integration among 20 EU member states, Bakucs et al. (2015) find only 35% of the price pairs to be cointegrated. Yet, these studies provide limited insights into the situation in Switzerland for which, to date, there is only one case study on spatial price transmission: For Swiss wheat, Esposti and Listorti (2017) find no or weak links to international markets, depending on the type (bread vs. feed wheat) and the respective policy setting. Since Switzerland applies a particular reference and entry price system for wheat, this study's results cannot be transferred to the milk market.

The aim of our study is to understand to what extent foreign price developments influence Swiss milk and dairy prices. We analyze spatial price transmission between Switzerland and its major trade partner Germany for dairy products that are subject to different trade policies. We assess wholesale prices for tariff-protected industrial dairy products (butter and milk powder) and liberalized cheese products (hard- and semi-hard cheese). In addition, we analyze spatial producer price transmission for raw milk intended for either dairy- or cheese-processing.

We find weak or no spatial price transmission on the wholesale level, but strong linkages on the producer level. Hence, while tariffs and tariff rate quotas manage to "protect" domestic prices for the respective products at the wholesale level, they do not hinder price transmission for the input raw milk. In fact, the price of raw milk intended for processing into white-line products is more dependent on German price developments than raw milk that is used to produce cheese, and qualitatively differentiated raw milk for artisan cheese production or from organic production is least dependent of all.

Our results suggest that qualitative differentiation is an alternative to border measures such as tariffs and TRQs for protecting Swiss producer prices from foreign price shocks. In addition, qualitative differentiation does not generate the net welfare losses associated with border protection. Thus, for small high-income countries such as Switzerland, positioning domestic products in high-quality, differentiated product segments may be a more efficient way to stay competitive and to alleviate price pressure.

2. Characteristics of the Swiss Milk Market

About 41% of Swiss raw milk is processed into yellow-line cheese products, and the remaining 59% are used for other white-line products such as butter and milk powder. Both the overall production and the product shares are subject to some seasonal variation, but have remained stable over the past years, with a slight increase in cheese production since the early 2000s (FOAG 2017, TSM et al. 2017).

2.1 Processing channels

The processing channels for cheese and other dairy products are quite strictly separated in Switzerland. Raw milk intended for the white line is generally bought by large industrial dairy processors or producer organizations as a homogeneous bulk product (Mann and Gairing 2011, Flury et al. 2014). For such standardized dairy products, price and volume are decisive competition factors (Straete 2008).

Farmers supplying to the yellow-line cheese dairies often face specific quality requirements, especially silage-free feeding for raw milk cheese production. Cheese is produced by regional and artisan dairies of different sizes, but also the farm cheese model still plays a role, with several hundred processors engaged (Haller 2014). Some industrial cheese types are also produced by the large dairy processors.

2.2 Policy framework

These differences between the yellow and the white line are also reflected in border policies. White-line dairy products are protected by means of tariffs and TRQs, while the cheese market is liberalized. This situation developed as a result of gradual liberalization steps since the 1990s. Before then, Swiss milk producers, processors and policy makers were completely insulated from price volatility and world market developments, as the market was based on public price and volume guarantee schemes. After becoming a WTO member in 1995, and following the Uruguay round, markets for different milk products have been subject to different degrees of liberalization, leading to today's situation (Koch 2002).

White-line products are still protected by single tariffs or TRQs, fixed per weight (CHF/100kg), not per value of the imported good. To make tariffs comparable, we calculate ad valorem equivalents (AVE) in percentage terms. However, these AVEs can vary due to changes in foreign price developments and exchange rates, even if the nominal tariff stays the same.

Table 1 summarizes the border policies in effect for the products that will be included in our empirical analysis. For skimmed milk powder (SMP), there is a regular single tariff. For butter and whole milk powder (WMP), TRQs are in place, with a rather low tariff for a fixed yearly quota (100t for butter, 300t for WMP). These quotas are generally fully exploited, leading to import volumes smaller than 5% of the domestic production. Out-of-quota tariffs for butter and WMP are 341% and 171%, respectively, which is prohibitively high and makes both quotas binding. For more details on the Swiss TRQ system, see Loi et al. (2016).

Raw milk in unprocessed, fluid form is not traded across Swiss borders because of prohibitively high tariff protection, with a small exceptions: Imports from Liechtenstein and a defined border zone close to Geneva are exempted from tariffs and treated like Swiss production (Agricultural import regulation, Art. 35.1). Also, dairy products and cheese need to contain 100% Swiss milk to be labeled as "Swiss" (Trade Mark Protection Act, Art. 48b). Hence, there is no direct trade and arbitrage opportunity for raw milk.

Table 1:
Swiss border protection policy type and level for selected dairy products

Product	Policy type	In-Quota AVE	Out-of-quota / Single tariff AVE
Butter	TRQ	5% (100t p.a.)	341%
WMP	TRQ	13% (300t p.a.)	171%
SMP	Single tariff	n/a	72%
Cheese	Free trade (EU)	n/a	0%

Source: Own calculations, based on FOAG / customs data
AVE = ad valorem equivalent; WMP = Whole milk powder; SMP = Skimmed milk powder; TRQ = Tariff Rate Quota; n/a = not applicable

For cheese, which is Switzerland's most important dairy export product, a free trade agreement with the EU is in place (Haller 2014). This liberalization took place gradually, starting in 2002 and resulting in full free trade after July 2007. Since this market opening, both imports and exports of cheese have increased (FOAG 2017). To offset the expected liberalization effects on milk producer revenues, a payment for milk processed into cheese was introduced in 1999. Starting with 0.20 CHF per kilogram of raw milk, the payment was gradually reduced to 0.15 CHF between 2004 and 2007 (see Finger et al. 2017 for more details).

Further policy events were the abolishment of the milk production quota in Switzerland (in May 2009) and in the EU (in April 2015). The Swiss public quota system ended gradually with long transition periods, and was followed by a private-law quota system that continues to control production quantities (Haller 2014, FOAG 2017). This explains why abolishment of the quota did not lead to increased production and falling prices, as was the case in the EU (Mann and Gairing 2011).

Because of these gradual, recent and partly overlapping policy changes, it is not possible to conduct rigorous evaluations of individual changes. Instead, we include these changes as explanatory or dummy variables in robustness checks of the later analysis to get insights into the direction and significance of their effects on prices.

2.3 Trade situation

Switzerland is a net exporter of aggregate milk products with a self-sufficiency of 117%. Cheese is the most important export product (TSM et al. 2017). Table 2 shows that more than half of the Swiss hard cheese production is exported, including well-known specialties such as Emmentaler and Gruyère. Simultaneously, there are notable imports especially of more industrial types of cheese such as fresh cheese and mozzarella (34% and 21% of the domestic production volume respectively).

Table 2:
Relative import and export shares, as percentage of domestic production volume (average for years 2000 – 2016)

Product	Policy type	Import (%)	Export (%)
Fluid milk	TRQ	5.0*	0.8
Butter	TRQ	4.0	5.4
WMP	TRQ	3.6	11.7
SMP	Single tariff	2.4	45.0
Cheese (all)	free trade	24.16	32.4
Fresh cheese/curd	free trade	33.9	6.9
Mozzarella	free trade	20.8	10.8
Hard cheese	free trade	3.1	51.6

* imports only from free trade zone (Geneva) and Liechtenstein
Source: Own calculations, based on FOAG data

Because of trade-restricting border policies, imports account for less than 5% of domestic production volume for all non-cheese dairy products. The only notable white-line export good is SMP, for which 45% of domestic production is exported, mainly as an ingredient of processed products, such as chocolate.

The EU is by far Switzerland's largest trade partner, receiving about 80% of its cheese export (TCM et al. 2017). Hence, the following analysis is exclusively concerned with trade policies between Switzerland and EU member states, not vis-à-vis the rest of the world.

2.4 Product characteristics and differentiation

White-line dairy products such as butter and milk powder are generally considered homogeneous bulk commodities, produced from pasteurized milk. Yellow-line Swiss cheese products are more heterogeneous, with a large variety of types, brands and qualities, especially for the typical Swiss hard- and semi-hard raw milk cheese. At the producer level however, agricultural products like milk are often classified as undifferentiated, i.e. milk is milk at the farm gate. Even though this perception is changing (Grunert 2005), previous price transmission studies only analyzed aggregate milk prices, neglecting aspect of quality differentiation.

For our study, we have separate price data for raw milk by processing channel: Non-organic milk for processing into white-line products, cheese, and artisan cheese, as well as organic milk. Hence, we can derive information about quality characteristics both at the producer and the wholesale level.

In addition to quality differences between product types, in Switzerland there is assumed to be a general preference for domestic products. More than 80% of consumers pay attention to "Swissness" when purchasing cheese and dairy products (FOAG 2015). Some consumer groups display an additional willingness to pay premium prices for domestic products in Switzerland, as they associate Swiss products with higher product quality, food safety, and ecological standards (Bolliger and Réviron 2008, Bolliger 2011).

There is no consensus on how to define quality in a food context, but clearly both producers and consumers are involved in this process (Morris and Young 2000; Callon et al. 2002). If products are perceived as qualitatively differentiated, whether for cognitive or affective reasons, this differentiation can alleviate price competition (Shaked and Sutton 1982; Chen et al. 2017).

Competing via quality differentiation and not via the price may be especially feasible in a high-income and high-cost country such as Switzerland: First, Switzerland is a small market with a large demand for high-quality products and the necessary purchasing power to pay for them (Bolliger 2011, FOAG 2017). Second, it has the highest average costs of milk production worldwide, which are only partly compensated through subsidies and direct payments (Hemme et al. 2014). Consequently, there may be a necessity to position Swiss products into a high-quality segment, by producing differentiated, rather than bulk products.

2.5 Hypotheses

Following the idea of the "Law of One Price", a standard assumption is that arbitrage and physical trade are the drivers of market integration. Whenever prices differ between two separate markets, spatial arbitrage will remove this difference, at least in the long-run, allowing for adjustment times and accounting for trade cost (Fackler and Goodwin 2001). As Switzerland is a small country and in principle an open economy, we expect it to be influenced by external, especially neighboring European price developments if no trade restrictions are in place. This is the case for cheese, where trade with the EU is liberalized and markets are connected through large bi-directional trade flows.

H1: In liberalized, tariff-free markets, EU and Swiss prices are highly integrated.

Conversely, public border protection measures applied to white-line dairy products can be expected to hinder international trade and hence impede arbitrage when prices differ. The main border measures for dairy products are TRQs with low, binding quotas. Consequently, trade volumes and physical market integration are low, which will limit the exposure of Swiss products to price competition from imported products. Thus, trade-inhibiting policies are assumed to constrain the pass-through of prices internationally (Conforti 2004; Bonnet et al. 2015).

H2: Products subject to trade-restricting policies have lower price transmission elasticities.

Besides public policy measures, spatial arbitrage can also be inhibited by qualitative differentiation of products, leading to lower international substitutability (Shaked and Sutton 1982). If domestic products are perceived as different or superior to (imported) potential alternatives, this may reduce their international substitution elasticities and consequently the dependence on foreign price developments. If this differentiation is very strong, two products may no longer be part of the same relevant market and not considered as substitutes at all. This may for example apply to Swiss specialty cheese or organic products.

H3: The higher the qualitative differentiation, the lower the price transmission elasticity.

To sum up, there are two product groups in the Swiss milk market: First, there are protected, but homogeneous bulk products such as butter and milk powder. Second, there are highly differentiated cheese products, for which trade with the EU is fully liberalized. Following the trade barriers and physical market integration hypotheses (H1) and (H2), cheese products and raw milk intended for cheese processing should be more integrated with foreign prices than prices in the dairy line. Following the differentiation hypothesis (H3), the opposite would be the case. In the following we test whether public policy or product characteristics play the dominant role for spatial price transmission.

3. DATA AND METHODS

Methods to study spatial price transmission and market integration have evolved over the past thirty years (for reviews, see e.g. Fackler and Goodwin 2001; Hassouneh et al. 2012; von Cramon-Taubadel 2017). We follow a widely used approach; testing for unit roots and cointegration and subsequently estimating pairwise vector error correction models (VECM) or vector autoregressive (VAR) models in first differences. We choose this procedure over non-parametric approaches, which may have a better model fit, for the following reason: We are specifically interested in the presence and strength of a long-run relationship (cointegrating vector) between the prices and short-term deviations from and adjustments to it. Estimating and comparing these model parameters is crucial for our purpose of understanding price transmission in the long- and short-run for joint products under different policy regimes.

Table 3
Descriptive summary statistics of monthly milk and dairy price data

	General information				**Summary statistics**		
	Timeframe	nobs	Source	Unit	mean	sd	cv
Raw milk prices							
CH - Dairy milk	01/2000 - 05/2017	209	FOAG	CHF/100kg	67.4	8.5	0.13
CH - Cheese milk (all)	01/2000 - 05/2017	209	FOAG	CHF/100kg	72.1	5.0	0.07
CH - Cheese milk (artisan)	01/2000 - 05/2017	209	FOAG	CHF/100kg	74.5	3.5	0.05
CH - Organic milk	01/2000 - 05/2017	209	FOAG	CHF/100kg	82.6	7.2	0.09
DE - Conventional milk	01/2000 - 05/2017	209	Eurostat	EUR/100kg	31.3	4.3	0.14
DE - Organic milk	01/2007 - 05/2017	125	AMI	EUR/100kg	44.3	4.2	0.09
Wholesale prices							
CH - SMP	01/2004 - 05/2017	161	FOAG	CHF/100kg	446.9	42.1	0.09
CH - WMP	01/2004 - 05/2017	161	FOAG	CHF/100kg	635.7	33.1	0.05
CH - Butter	01/2004 - 05/2017	161	FOAG	CHF/100kg	1008.0	71.8	0.07
CH - Hard cheese	01/2000 - 05/2017	209	FCA	CHF/100kg	996.2	100.5	0.10
CH - Semi-hard cheese	01/2000 - 05/2017	209	FCA	CHF/100kg	1279.0	110.9	0.09
DE - SMP	01/2000 - 05/2017	209	Eurostat	EUR/100kg	228.4	47.1	0.21
DE -WMP	01/2000 - 05/2017	209	Eurostat	EUR/100kg	272.5	47.0	0.17
DE - Butter	01/2000 - 05/2017	209	Eurostat	EUR/100kg	320.1	56.2	0.18
DE -Emmental type	01/2000 - 05/2017	209	Eurostat	EUR/100kg	422.8	41.3	0.10
DE -Gouda type	01/2000 - 05/2017	209	Eurostat	EUR/100kg	297.0	37.5	0.13

CH = Switzerland; DE = Germany; AMI = Agrarmarkt Informations-Gesellschaft, FCA = Swiss Federal Customs Administration, FOAG = Swiss Federal Office For Agriculture

3.1 Data

We use monthly Swiss average producer and wholesale prices from January 2000 until May 2017 (see table 3). As external price reference, we choose Germany, which is a direct neighbor and major trading partner for dairy products (FOAG 2017). Moreover, Germany has the most central position in the EU trade network for milk, and is hence an adequate representative of overall EU price developments (Benedek et al. 2017).

Prices are kept in original currencies (CHF and EUR) and the exchange rate is included as explanatory variable in the later analysis. Our study does not include transaction or transport costs and hence assumes them to be constant, which is frequently criticized (e.g., Abdulai 2000, Goodwin and Piggot 2001, Balcombe et al. 2007). Yet, in this setting we have reason to assume low and stable trade costs: First, there is small distance and good infrastructure between Germany and Switzerland. Second, the most-traded products cheese and milk powder have a high value (relative to volume) and low perishability. All this is associated with low trade costs (Hummels 1999, Limao and Venables 2001).

As the milk price in Switzerland is made up of several components including subsidies, premiums and deductions, we chose the prices in such a way as to make them as comparable as possible (see appendix for details). Prices include VAT and the cheese processing payment. Any other price premiums (e.g. for silage-free production) and deductions are not included. The following types of raw milk are analyzed:

- **"Dairy milk"** for production of any non-cheese products
- **"Cheese milk (all)"** for cheese production by industrial or artisan cheese dairies
- **"Cheese milk (artisanal)"** for cheese production by cheese dairies classified as "artisan"
- "**Organic milk"** for any processing channel, standards defined by Bio Suisse (2015).

On wholesale level, for industrial dairy products, complete and consistent price data are only available from January 2004. The following monthly prices are analyzed:

- **Butter** (industrial butter for cooking or further processing)
- **Whole milk powder (WMP)**, with 26% fat in dry mass, for industrial processing
- **Skimmed milk powder (SMP)**, with < 1.5% fat in dry mass, for industrial processing

For cheese, average Swiss domestic prices are only available at the retail level. As retail prices show almost no variation and in order to stay at the level stage of the value chain, we use export unit values of wholesale trade. However, export unit values do not necessarily represent average domestic prices, but are strongly influenced by the quality of the exported products (Hallak 2006). Therefore, we narrow down the product range to two categories:

- **Hard cheese,** >45% fat in dry mass, made from silage-free raw milk
- **Semi-hard cheese,** varying fat content, from raw or pasteurized milk

In both categories, few selected Swiss specialty brands with either protected origin or a registered trademark are included to ensure comparability of the prices over time. The German reference prices are Emmental type hard cheese and Gouda type semi-hard cheese. Hard and semi-hard cheese are chosen due to their large production and trading volumes.

3.2 Descriptive statistics

For all analyzed milk products, the Swiss price level is always higher than the German price, expect for milk powder during a short period in 2008 (figure 1). Besides this level difference, the volatility differs as well: For butter and milk powder, Swiss prices display less variation than the German prices. Swiss cheese prices have a larger short-term variation, which may be due to the different data source (export unit values instead of average wholesale prices).

For raw milk prices, there are yearly seasonal pattern in both Swiss and German prices (figure 2). The prices of Swiss raw milk for cheese and dairy processing follow very similar paths until 2008; then the gap widens and raw milk for cheese production sells for higher prices than industrial dairy milk.

Figure 1: Monthly Swiss and German wholesale prices for different dairy products (CHF/kg)
Source: Own representation based on FOAG, DG Agri, FCA

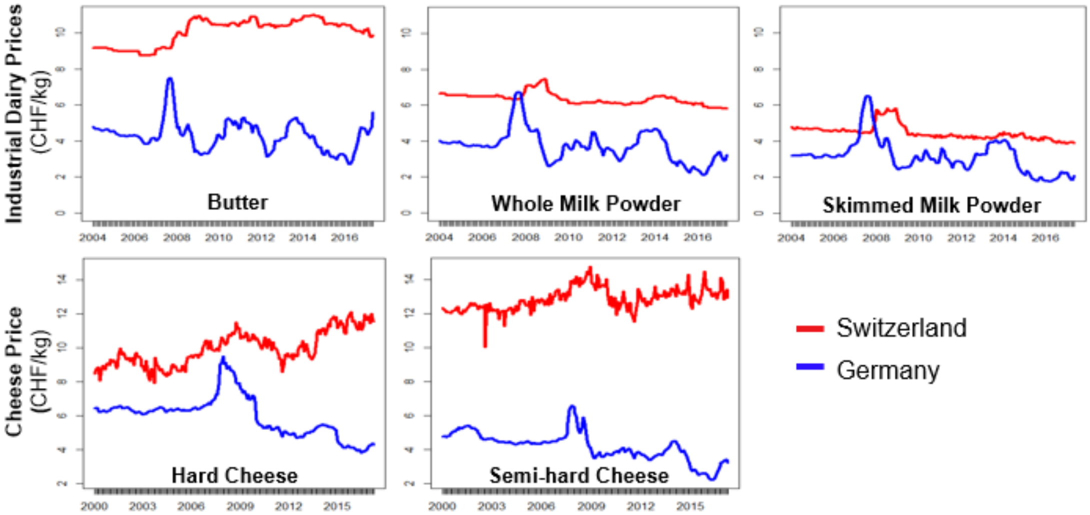
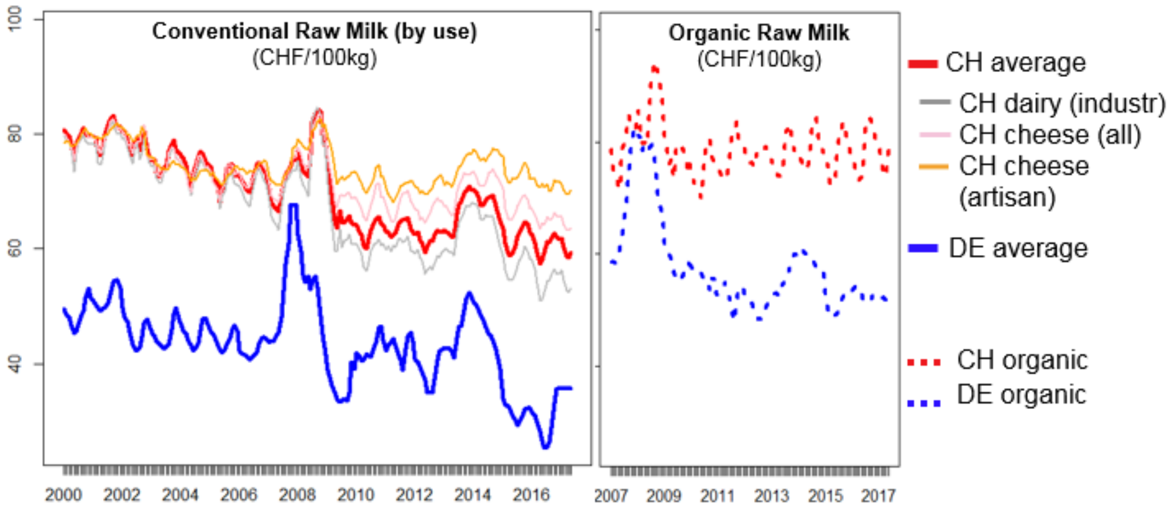


Figure 2: Monthly Swiss and German raw milk producer prices (CHF/100kg)
Source: Own representation based on FOAG, DG Agri, AMI



3.3 Individual testing for unit roots and structural breaks

First we test all price series individually on their statistical properties. Both the null hypothesis of a unit root and the null hypothesis of stationarity are tested to better detect "near unit root processes" (Esposti and Listorti 2013). To account for the time-varying variance, we conduct the Phillips-Perron (1988) unit root test, which is robust to heteroskedasticity in the error term, as it uses the Newey–West (1987) heteroskedasticity- and autocorrelation-consistent covariance matrix estimator and corrects the error term using a Bartlett window. To detect structural breaks, we execute the Zivot and Andrews (1992) test, which tests the null hypothesis of a unit root process with drift against the alternative of a trend stationary process that allows for a one time break in both the level and the trend. The break date is selected where the t-statistic from the ADF test of unit root is at a minimum (most negative), i.e. where the evidence is least favorable for the unit root null hypothesis.

3.4 Cointegration tests

If prices are found to be non-stationary, they are tested pairwise for cointegration, i.e. whether the two integrated processes share a common stochastic trend, using the Johansen (1988) cointegration test. Seasonality is considered using monthly dummies and lag-length is selected according to the Schwarz information criterion. As an exogenous variable, we include the exchange rate in first differences to account for exchange rate changes without distorting the results through the introduction of a third non-stationary variable. We do not directly convert all series into one currency because exchange rate fluctuations may or may not be fully transmitted in the given setting. Liefert and Persaud (2009) point out that tariffs prevent exchange rate transmission if they are trade-prohibiting, and TRQs do so if the quota is operative. Both is the case for the Swiss white-line products.

3.5 Model specification

The choice of the appropriate econometric specification to model the price dependencies between the two countries depends on the previously tested characteristics of the time series; resulting in three cases (table 4).

Table 4
Econometric model choice based on results from unit root and stationarity tests

Time Series	Model	Dynamic analyzed
I(0)	VAR-Model in Levels	Long-term
I(1), r>0	Vector Error Correction Model	Long-term + short-term
I(1), r=0	VAR-Model in First Differences	Short-term

I(0)/I(1) = integrated of order 0/1, r = rank (r > 0 implies cointegration);
Source: own representation, based on Hendry and Juselius 2001

If the German and Swiss prices of a given product are non-stationary and cointegrated, Vector Error Correction Models (VECM) are applied ($\mathrm{p}_\mathrm{t}^\mathrm{CH}$ and $\mathrm{p}_\mathrm{t}^\mathrm{DE}$, representing logarithmic prices):

$$(1)\quad \begin{bmatrix} \Delta p_t^{CH} \\ \Delta p_t^{DE} \end{bmatrix} = \begin{bmatrix} \alpha_{CH} \\ \alpha_{DE} \end{bmatrix} \left[p_{t-k}^{CH} - \beta_0 - \beta_1 p_{t-k}^{DE} \right] + \sum_{i=1}^{k} \begin{bmatrix} \delta_{CHj} & \rho_{CHj} \\ \delta_{DEj} & \rho_{DEj} \end{bmatrix} \begin{bmatrix} \Delta p_{t-i}^{CH} \\ \Delta p_{t-i}^{DE} \end{bmatrix} + \begin{bmatrix} \omega_{CH} \\ \omega_{DE} \end{bmatrix} [M_t] + \begin{bmatrix} \gamma_{CH} \\ \gamma_{DE} \end{bmatrix} [X_t] + \begin{bmatrix} \varepsilon_{CHt} \\ \varepsilon_{DEt} \end{bmatrix}$$

Equation 1 is in first differences, capturing short-term movements, but also includes the long-run equilibrium (cointegrating vector) between both prices, which can be re-arranged into:

$$(2)\quad p_t^{CH} = \beta_0 + \beta_1 p_t^{DE}$$

The coefficient β_1 represents the long-run price transmission elasticity, i.e. how much of the variation in p_t^{DE} is passed on to p_t^{CH}.This long-run equilibrium must not hold precisely at all times, but prices can meander around it. How strongly and quickly p_t^{CH}, p_t^{DE} or both return to the common equilibrium, is determined by the error correction terms (ECT) α_{CH} and α_{DE}, which ensure the stability of the equilibrium and describe the speed of adjustment.

The δ and ρ coefficients express the influence of both prices' past values on themselves and the respective other price. The coefficients ω capture seasonality for the twelve monthly seasonal dummies (M_t). X_t is a vector of exogenous variables, potentially affecting both to the Swiss and the German price. Besides the monthly exchange rate in first differences, we include the following dummy variables to account for policy changes:

- cheese free trade agreement with EU (07/2007)
- Quota-abolishment in CH (05/2009)

- Quota-abolishment in EU (04/2015)

We do not apply regime-switching VECM, as done in many recent price transmission studies for the following reasons: There is no need to allow for a “neutral band” in which no trade and possibly no transmission of price signals take place. Trade data show that as far as allowed by trade policies, there is always trade taking place. The gap between Swiss and German prices is large throughout the whole period, and very likely to exceed the non-observable trade costs. Finally, all the above events did not occur as sudden shocks, but took place gradually with long adjustment periods.

If German and Swiss prices are unit root processes, but not cointegrated in the long-run, a VAR-Model in first differences is used to assess short-term dependencies:

$$(3)\ \Delta p_t^{DE} = \alpha_0 + \sum_{j=1}^{k} \alpha_j^{CH} \Delta p_{t-j}^{CH} + \sum_{j=1}^{k} \alpha_j^{DE} \Delta p_{t-j}^{DE} + \alpha_X X_t + \varepsilon_1$$

$$(4)\ \Delta p_t^{CH} = \beta_0 + \sum_{j=1}^{k} \beta_j^{CH} \Delta p_{t-j}^{CH} + \sum_{j=1}^{k} \beta_j^{DE} \Delta p_{t-j}^{DE} + \beta_X X_t + \varepsilon_2$$

In this VAR in standard form, equations 3 and 4 are estimated simultaneously. X_t denotes a vector of other explanatory variables, which are the same as in the VECM above. Lag length k is selected based on the AIC. The error terms ε_1 and ε_2 are assumed to be independent and identically distributed, but can be contemporaneously correlated with one another.

4. RESULTS

Table 5
Results from unit root and stationarity tests

Tested variable	PP test	ZA test	KPSS test
	H_0: I(1)	H_0: I(1)°	H_0: I(0)
Raw milk prices			
CH - Dairy milk	-3.1 (n.s.)	-4.5 (n.s.)	1.3 ***
CH - Cheese milk (all)	-3.2 (n.s.)	-3.3 (n.s.)	3.4 ***
CH - Cheese milk (artisan)	-2.7 (n.s.)	-4.5 (n.s.)	2.3 ***
CH - Organic milk	-3.4 (n.s.)	-3.5 (n.s.)	2.32 ***
DE - Conventional milk	-2.9 (n.s.)	-4.51 (n.s.)	1.25 ***
DE - Organic milk	-2.7 (n.s.)	-4.89 *	0.52 **
Wholesale prices			
CH - SMP	-2.8 (n.s.)	-4.61 (n.s.)	1.6 ***
CH - WMP	-2.6 (n.s.)	-4.31 (n.s.)	1.44 ***
CH - Butter	-0.9 (n.s.)	-3.87 (n.s.)	2.06 ***
CH - Hard cheese	-4.0 ***	-4.61 (n.s.)	0.18 ***
CH - Semi-hard cheese	-6.5 ***	-3.39 (n.s.)	0.75 ***
DE - SMP	-2.3 (n.s.)	-3.23 (n.s.)	0.88 ***
DE -WMP	-2.7 (n.s.)	-4.61 (n.s.)	1.74 ***
DE -Butter	-2.7 (n.s.)	-3.23 (n.s.)	0.88 ***
DE -Emmental type	-2.5 (n.s.)	-3.01 (n.s.)	0.97 ***
DE -Gouda type	-3.0 (n.s.)	-4.26 (n.s.)	2.26 ***

°H0: I(1) with drift against HA: I(0) with max.1 breakpoint in intercept and/or trend
Lags selected according to AIC (including seasonality for producer prices, but not for wholesale prices)
*/**/*** denotes that the null hypothesis is rejected at the 10%/5%/1% significance level

4.1 Unit root and cointegration tests

Table 5 shows that all included price series on producer and wholesale level are non-stationary unit root processes. The Phillips-Perron tests fail to reject the null hypothesis of a unit root for all prices, except the Swiss cheese prices. This is because of large short-term variations in these export prices; if they are slightly smoothed however (see appendix), the null is no longer rejected. The Zivot and Andrews test confirms this result by ruling out the alternative of a stationary series with a breakpoint on a 5% significance level. Further, the KPSS test rejects the null of stationarity for all prices.

Cointegration between Swiss and German prices is found for all raw milk producer prices, but on wholesale level only for milk powder (whole and skimmed), and with weak evidence for semi-hard cheese. Both the Johansen trace and eigenvalue tests come to this result (table 6). Hence, we continue with VECM specifications for those products (table 7). For the remaining products with no long-run cointegrating relationship, we continue to analyze short-term dependencies between the two countries through VAR-models in first differences (table 8). For organic raw milk and semi-hard cheese however, only a weak cointegrating-relationship is found. To account for this uncertainty, we set up both a VECM, assuming cointegration, and a VAR specification, assuming no cointegration.

Table 6
Results from pairwise Johansen cointegration test

Tested variable pair		**Eigenvalue test**				**Trace test**			
		H_0: r=0		H_0: r≤0		H_0: r=0		H_0: r≤0	
Raw milk									
DE:	CH:								
conventional	dairy milk	22.8	***	3.3	(n.s.)	26.1	***	3.3	(n.s.)
conventional	cheese milk (all)	24.8	***	4.7	(n.s.)	29.5	***	4.7	(n.s.)
conventional	cheese milk (artisan)	21.8	***	6.0	(n.s.)	27.7	***	6.0	(n.s.)
organic	organic	16.9	*	4.9	(n.s.)	21.8	**	4.9	(n.s.)
Processed products									
DE:	CH:								
SMP	SMP	18.6	**	4.5	(n.s.)	23.1	**	4.5	(n.s.)
WMP	WMP	24.2	***	7.6	*	31.8	***	7.6	*
Butter	Butter	7.2	(n.s.)	2.4	(n.s.)	9.6	(n.s.)	2.4	(n.s.)
Emmental type	Hard cheese	6.7	(n.s.)	2.6	(n.s.)	9.3	(n.s.)	2.6	(n.s.)
Gouda type	Semi-hard cheese	14.4	*	6.7	(n.s.)	21.1	**	6.7	(n.s.)

r= rank, lag length acc. to Schwarz criterion, incl. constant in cointegration
Exog. variables: ΔEUR/CHF exchange-rate, ,*/ **/*** represent 10/5/1% significance level

4.2 Raw milk price results

There is strong evidence of cointegration for all conventional raw milk price pairs. Dairy milk shows a higher long-run price transmission elasticity (81%) than milk for cheese processing (69%). In all cases, only Swiss prices adapt to this joint equilibrium; dairy milk adjusts more quickly (11% of disequilibrium is corrected within one month) than milk for all cheese processing (9%) and artisan cheese (8%).

For organic raw milk, the Johansen test and VECM specification estimate a long-run price transmission elasticity of -1%. Even though the tests find some statistical significance to this parameter, its economic significance is practically zero. Therefore, we give preference to the VAR specification. This model finds evidence for some short-term dependencies in both directions (see table 8).

Table 7
Selected key parameters of VECM Specification for cointegrated Swiss and German price pairs

Tested variable pair		Long Run Factors		Short Run Adjustment		Model Fit	
		β_1 (PT elast)	β_0 (constant)	α_{CH} (ECT CH)	α_{DE} (ECT DE)	adj.R^2 CH-equ.	adj.R^2 DE-equ.
Raw milk							
DE:	CH:						
avg	dairy milk	0.81	0.55	0.11 ***	0.05 (n.s.)	0.53	0.53
avg	cheese milk (all)	0.69	1.27	0.09 ***	0.06 (n.s.)	0.63	0.54
avg	cheese milk (artisan)	0.69	1.35	0.07 ***	0.06 (n.s.)	0.35	0.56
organic	organic	-0.01	4.26	0.04 (n.s.)	-0.13 ***	0.66	0.72
Processed products							
DE:	CH:						
SMP	SMP	0.05	0.87	0.25 ***	0.21 *	0.23	0.38
WMP	WMP	0.07	1.70	0.09 ***	0.00 (n.s.)	0.16	0.43
Gouda	Semi-hard cheese	-0.33	2.91	0.09 *	-0.14 ***	0.21	0.29

Note: β-values stated with reverse sign, */ **/*** represent 10/5/1% significance level
Exog. variables: Δfx-rate, policy dummies, monthly dummies for raw milk, lag selection: Schwarz criterion.

4.3 Wholesale price results

Among the analyzed wholesale prices, there is evidence of cointegration for skimmed and whole milk powder. While this relationship is statistically significant, the long-run price transmission elasticity is weak (5% and 7%), i.e. hardly any variation of or shock in the German price is passed on to the Swiss price. The VECM specification suggests that Swiss prices follow German prices, as only the Swiss price changes in response to disequilibria (i.e. when the error correction term is non-zero).

Butter, as well as hard- and semi-hard cheese display no long-run price relationship between the two countries. The VAR-models reveal that there are no short-term interactions between Swiss and German prices either. In contrast to the German prices, which have strong positive autoregressive behavior, Swiss prices show no or even a negative influence of past price changes.

One case is not so clear: For semi-hard cheese, with rather weak evidence, a cointegrating vector is found, but with a negative long-term price transmission elasticity (-33%), i.e. prices moving into opposite directions. As this is no sign of economically meaningful co-movement in the long-run, we consider the alternative VAR representation, which finds no short-run cross-influence.

Table 8
Selected key parameters of VAR in first difference model for non-cointegrated Swiss and German price pairs

Tested variable pair		CH-equation				DE-equation				Model Fit	
		ΔDE.l1	ΔDE.l2	ΔCH.l1	ΔCH.l2	ΔDE.l1	ΔDE.l2	ΔCH.l1	ΔCH.l2	adj.R^2 CH-equ.	adj.R^2 DE-equ.
Raw milk											
DE:	CH:										
organic	organic	0.04	0.28 *	-0.30 ***	0.00	0.46 ***	0.42 ***	-0.05	-0.15 **	0.72	0.61
Processed products											
DE:	CH:										
Butter	Butter	0.00	-0.02	-0.03	0.13	0.55 ***	0.12	-0.23	-0.36	0.02	0.30
Gouda	Semi-hard cheese	0.04	0.02	-0.70 ***	-0.44 ***	0.50 ***	0.04	-0.10	-0.14	0.38	0.27
Emment.	Hard cheese	0.22	-0.05	-0.35 ***	-0.26 ***	0.35 ***	0.01	0.01	0.03	0.26	0.15

Note:*/ **/*** represent 10/5/1% significance level, lag selection acc. to AIC
Included exog. variables: Δ fx-rate, monthly dummies for raw milk

4.4 Robustness checks

Our results also hold if we control for subsidy changes. Adjusting for changes in the processing aid for cheese, we come up with similar results (see appendix). However, as there have been compensations and shifts between different subsidies, especially direct payments, we chose not to model single subsidy changes in the main model presented here. Further, these subsidies only explain a level difference in prices, but not the different degrees of price transmission.

For cheese and raw milk intended for cheese processing, we also estimated price transmission for the subsample before and after trade liberalization in July 2007. Results show that long-run price transmission elasticity and speed of adjustment have even increased after the trade liberalization. However, we cannot clearly attribute this to the policy change, because the global price spikes in 2008 and subsequently increased overall volatility occurred chronologically soon after the policy change. Also, the liberalization was a gradual process that already started in 2002, rather than a sudden change at one point in time.

5. Discussion

Our results show that German prices influence Swiss prices, for raw milk producer prices more than for processed products' wholesale prices. On both levels, this price pass-through from Germany to Switzerland is higher in the tariff-protected industrial dairy processing channel than for liberalized cheese products. We conclude that qualitative product differentiation contributes more than public border protection to segment the Swiss market from the surrounding EU market.

5.1 The role of border protection

We found that in the analyzed case, public border protection and trade policies are not the decisive factor. In spite of a free-trade agreement being in effect, prices on the liberalized hard- and semi-hard cheese market are found to be completely independent from German price developments. However, some long-run spatial price transmission is detected for skimmed and whole milk powder. Given that the protected dairy products are more homogeneous than cheese, this cannot be directly compared. Further, we have no counterfactual of the same products without the tariffs or TRQs, so no precise effect can be attributed to these policies. Public policies probably help to prevent more complete price transmission on wholesale level and to keep up the level gap between domestic and foreign prices.

On producer price level, however, these measures seem to lose their protective function. Prices for raw milk processed into protected dairy products are more strongly influenced by German price developments than raw milk for cheese production. A level difference between these two types of raw milk can be explained through targeted subsidies (Finger et al. 2017), but not the fact that farmers supplying milk to the dairy processing channels are more exposed to foreign price shocks than farmers supplying cheese dairies.

Also, we find that trade volumes only play a minor role in explaining price transmission. There are high long-run price transmission elasticities (69-81%) in non-traded raw milk, but only low, if any, price transmission (elasticity <10%) for traded products on wholesale level. This is rather surprising and may support the hypothesis that not only physical trade flows, but also information flows matter for market integration (Stephens et al. 2012). Since information on foreign markets is available to and analyzed both by public and private Swiss actors, we can assume that information flow is given and reacted upon at all times. Hence, processors and traders observe surrounding EU markets and pass on these signals to their Swiss suppliers, even though they do not compete directly, and do not adjust wholesale prices on the domestic market for protected dairy products. Alternatively, one may also interpret this passing on of price signals to producers as indirect arbitrage, as processors do compete with EU products when exporting goods like milk powder to world markets.

5.2 The role of qualitative product characteristics

Qualitative differentiation is found to be a core factor for limiting spatial price transmission. This differentiation can refer to raw milk (e.g. organic production, silage-free feeding) or the actual product processing (artisan production, specialty brands). It seems that both types of differentiation are closely linked, i.e. high-quality raw milk is processed into highly differentiated end-products, and it is not possible to disentangle which contributes more to reduce substitutability and to stabilize prices. On producer level, prices of differentiated raw milk are linked less strongly to European price developments than raw milk intended for industrial dairy products. This also holds when controlling for subsidies, e.g. for processing into cheese, silage-free feeding, or organic production.

Hence, price transmission elasticities and speed between German and Swiss milk markets are not primarily determined by the type or degree of public border protection or the physical trade volume, but rather by product characteristics that reduce the international substitutability, such as specialty cheese and organic products.

6. Conclusion

If the aim is to protect raw milk prices against foreign price shocks and to stabilize producer prices, we show that quality differentiation may be an alternative to public trade restrictions. This alternative positioning via high quality can support domestic production without a deadweight welfare loss associated with tariff protection measures and does not require government intervention. Hence, producers and processors themselves can take action and implement strategies to compete via quality characteristics, not via the price. Yet, as it takes bundled efforts along the value chain, governmental bodies could help to position Swiss products accordingly. Promoting *Swissness* as a brand could help the products to be gain visibility, to be perceived as high-quality, and to ultimately stay competitive in domestic and international markets. First steps have been taken with the implementation of a Swissness legislation, ensuring that products labeled as Swiss indeed contain significant share of Swiss raw ingredients, for milk products even 100 percent. Our study provides evidence that a policy focus on such a *quality strategy*, i.e. promoting less easily substitutable domestic products, may be more effective than protectionism via tariff barriers. An integrated value chain approach, coordinating differentiation efforts across milk production, processing and retail stage could ensure that farmers, producers and consumers benefit alike. This *quality* can take various appearances: organic, animal-friendly, ecological, regional, or traditional, depending on consumption trends. In the end, the consumer has to perceive it as a superior product, resulting in a higher willingness to pay and lower substitution elasticities with foreign products. Since quality is partly a credence attribute, communication and information must be trusted by the consumers.

We conclude that such a positioning is appropriate for Switzerland for the following reasons: First, as a small country with large close-by export markets, oversupply should not be a major issue. Second, as a high-income country, there is a large domestic demand for high-quality products. Finally, as high-cost country, there is a certain necessity to compete via quality, not via the price.

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