Price Developments on the World Markets for Milk Products: The Case of Butter

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Abstract

A time series model is estimated to identify the interrelation among prices on the international and the EU domestic market for butter. The fact that international prices in the EU and Oceania are cause each other is an indication of an integrated market. However, price transmission is not perfect suggesting that competition between the EU and Oceania exists, however, but not as intense as it could be expected for a homogeneous good like butter. Interestingly, changes of prices in Oceania have no impact on the domestic EU market. Fluctuations of the EU world market prices, on the other hand, are absorbed to a large extent. The reason for this reaction remains unclear. One explanation may an inappropriate fixing export refunds. Price variations within the EU are also transferred to the international markets.

JEL: F15, Q13, Q17

Keywords: dairy market, international trade, market integration.

1 INTRODUCTION

One important issue in the ongoing WTO negotiations concerns the further liberalisation of agricultural trade. One argument that favours free trade is that through distorted price structures resources are not used according to shadow prices. A reduction of barriers to trade would induce a reallocation of resources according to the comparative advantages. This would not only induce a redirection of trade flows, but more importantly would also improve overall welfare. However, the magnitude of these gains depends on several conditions. First, policies need to affect import demand and export supply of a country and not only the domestic market. Second, the markets have to be integrated so that signals provided in one market are transmitted to other countries. It can be assumed, that the benefits will be the larger the more the markets are integrated.

In this paper we choose the milk market as an example to discuss these aspects. This market is chosen because it belongs to the most protected agricultural markets, and, significant liberalisation can be expected from the Doha round of the WTO negotiations. Furthermore, milk export is highly concentrated; two third of total exports stem from the EU and Oceania. On the other hand, milk import by country is rather fragmented. This market structure allows not only a simple analysis of the relationships on the world market. A further advantage is that the data requirements are relatively low. We focus on development on the world butter market.

The main objective is to identify the interrelation of price movements on the world market, i.e. the correlation between world market prices in Oceania and the EU in order to access the degree of market integration. Since the milk market in the EU is highly protected by various policy means, we also investigate the degree of integration of EU external and internal markets. This concerns two questions. First, whether EU absorbs shocks on the external market, and second, whether it de-stabilises the external market by transmitting internal shock to the world market.

The procedure is as follows. Chapter 2-4 deal with developments on the world market (trade, prices) and agricultural policy. The description serves especially the justification of the theoretical model, which is discussed in chapter 5. Discussion of empirical results is subject of Chap. 6. Chapter 7 provides a summary and a discussion of the findings.

2 Developments on the World market of Dairy products

2.1 Trade of milk products

In relation to world production trade with milk products is relatively small and amounts to about 7% of total production. The world market of milk products is dominated by a small number of countries (Figure 1). The most important export region is the EU-25 with a share of about 30% on the world market. Exports amounted to about 15 mln t milk equivalents in 2004 which is about 11% of EU milk production. Other large exporters are New Zealand, Australia, and the USA with markets share of 21%, 13%, and 7%, respectively (Salomon 2003, Rabobank 2004).

The destinations of European exports are Russia, Northern Africa, the Near East and the USA. Oceania delivers mainly to Japan, South-East Asia and China. The fact that the individual import markets are located close to the export countries suggest that transport costs play a considerable role in milk trade. Moreover, since demand a relatively fragmented, the two main export regions may be able to exploit market power (Rabobank 2004).

Recently, a steady increase of exports from South America (Argentina) as well as from some Asian countries could be observed. However, their total market share is still low compared to that of the big players. Thus, the strong position of the two most important export regions did not change in the last decade years. However, due to the production quota and relatively stable domestic consumption exports of the EU are relatively stable[i]. Australia and New Zealand on the other hand have increased milk production and contributed increasingly to world exports. Although this weakened the position of the EU, however, it still plays a dominant role on the world market (Salomon 2003, OECD 2004).

Import demand for milk products is much more scattered than export supply. The largest importers are the economically developed countries. The most important import region is the EU with 3m t milk equivalents followed by the USA (1.8m t), Japan and Russia (1.6m t each). Besides these countries, especially highly populated countries imported a significant of milk products (Mexico 2.8m t, China 2m t). Total imports to Asia and Africa amounted to 16m t and 5m t, respectively. Due to economic growth, many of these countries experienced a substantial increase in domestic demand in terms of quality and quantity (Klohn, W., Windhorst H.-W. 2001; FAOSTAT 2005a).

2.2 Butter

In milk equivalents butter was still the most important milk product trade on the world market. According to FAOSTAT (2005a), the share of butter on total trade of milk products was about 50% in the last decade. Total butter trade was relatively stable in this period, decade, while the quantities of cheese and milk powder increased significantly.

This demonstrates the increasing importance of high value added products in trade of dairy products.

The supply side of butter is rather concentrated (Figure 2). In 2000-2003 New Zealand (350thd t), the EU-15 (200thd t) and Australia (100thd t) were the largest exporters and accounted for about two third of total exports. More than 90% of butter production in New Zealand and more than 50% of the production in Australia were sold on the world market (FAOSTAT 2005a and b). As in the case of milk products, import demand for butter is much for fragmented. Since many years Russia is the largest importer of butter (170thd t per year on average). The EU is not only exporting butter, at the same time, it is also on of the largest importers FAOSTAT (2005a). Most of the import (about 87thd t) come from New Zealand and resulted from a concession agreed upon when the UK joined the EU in the 1970s. Before 2004, Eastern European accession countries had preferential agreements which allowed them to export milk products into the EU. However, compared to New Zealand, the quantities were relatively low (Agrar Europe 2005).

3 EU POLICY AND THE MILK MARKET

Because of its high share on agricultural production, the milk sector also plays in important role for income generation in agriculture. Corresponding to that, the milk market traditionally enjoys intense policy interventions. Import tariffs and quotas, minimum prices, public storage in form of intervention, export subsidies as well as production quota are some of the means applied in the various countries.

Information about the intensity of policy intervention on the milk market in OECD countries is given in Figure 3. According to the OECD (2004, 2005), protection measured in % PSE has decreased from 59% to 36% in the 1990s. However, income support is still significant and can be clustered into three groups. The highest protection with more than 70% PSE can be observed in Norway, Switzerland and Japan. The second group consists of the EU, Canada, the USA and Hungary with 40-55 % PSE. Countries in the third group, especially Australia and New Zealand, forgo protection to a large extent.

The core element of the EU Market Organization for Milk and Milk Products is an intervention system prevented that market prices for milk and milk products could fall below a given level. The price guarantees were supplemented by a quota system that restricts production. In addition, the domestic market is protected by a system of import quota and tariffs. In order to sell surplus production on the word market the EU pay export refunds (Agrar Europe 2005). Transferred into milk equivalences, this amounted to about 11% of EU milk production in 2004 (ZMP2005).

The EU has defined about 400 products for which export refunds are paid. About 50% of these definitions concern butter, milk powder and cheese (Agrar Europe 2005). Until 2004 export subsidies were fixed weekly on the basis of the difference between domestic and world market prices. The estimation of world market prices relies on publication of the USDA (Court of Auditors 2003). This organisation publishes regularly a range of world market prices for Northern Europe for the different milk products. These are constructed from actual commercial contracts and price announcements. However, the contracts already take into account the amount of export refunds. In turn, the EU uses the publications of the USDA have a guideline for fixing the export refunds. Thus, there is a severe endogeneity problem involved in estimating world market prices and export refunds.

The Court of Auditors (2003) criticizes that there is no close connection between the price differences and the actual payments. The reason is that the EU Commission considers additional factors like the stability of the internal market, restrictions resulting from WTO commitments, as well as future trends on the markets. The individual contributions of these factors includes remains unclear, however, in sum these factor cause that export subsidies are in general higher than the price differences.

4 DEVELOPMENT OF WORLD MARKET PRICES

The high protection of the EU milk market leads to large differences between internal and external EU prices. Because of its subsidized exports and its high share on butter export, it can be assumed that the EU is able to affect world market prices. The data presented in figure 4 do not give a clear picture on that. It is to be observed that variations of the world market prices are reflected in changes of the EU prices and reverse. Moreover, volatility of world market prices did not change in the period under investigation. However, since 2000 EU internal prices show lower fluctuation than in the 1990s. This suggest that other important sources of world market instabilities exists. These include fluctuation of demand in import regions, but changes of production in other export countries as well. Moreover, the volatility of the international butter prices is also affected by the restrictions concerning market access and export subsidies.

5 MODELLING WORLD MARKET PRICE DEVELOPMENTS

The empirical information can be summarized as follows:

- Competition between the two main export regions exists. However, due to transport costs and a favourable development of demand the intensity is relatively low despite Oceania has increased its share on the world market.

- Export refunds have to be paid to sell the surplus of milk products in the EU on the world market. The size of the subsidies is related to the difference between world market prices and domestic prices in the EU.
- However, because export refunds are fixed as the difference between external and internal prices, world market prices faced by the EU also depend on the export subsidies.

These considerations lead to the following structural regression model:

$$(1) \qquad \begin{bmatrix} 1 & -\alpha_{12} & 0 \\ -\alpha_{21} & 1 & -\alpha_{23} \\ 0 & -\alpha_{32} & 1 \end{bmatrix} \begin{bmatrix} w_{oz} \\ w_{eu} \\ e_{eu} \end{bmatrix} = \begin{bmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \end{bmatrix} + \begin{bmatrix} 0 \\ \beta_2 \\ \beta_3 \end{bmatrix} p_{eu} + \begin{bmatrix} u_1 \\ u_2 \\ u_3 \end{bmatrix}, \text{ with}$$

$$\alpha_{12} > 0,\ \alpha_{21} > 0, \alpha_{23} < 0, \beta_2 > 0, \text{ and } \alpha_{32} < 0, \beta_3 > 0,$$

and p_{eu}, w_{eu}, w_{oz},and e_{eu} denote EU domestic and world market prices, prices in Oceania and EU export refunds, respectively.

A direct of estimation of (1) by 3 SLS would have been possible, however, because of the non-stationarity of the time series spurious results had to be expected. In order to consider the characteristics of the data, an error correction model was specified:

$$(2) \qquad \Delta\mathbf{p}_t = \boldsymbol{\alpha} + \Pi\mathbf{p}_{t-1} + \sum_{i=1}^{\rho-1}\boldsymbol{\Gamma}_i\Delta\mathbf{p}_{t-i} + \mathbf{u}_t, \text{ with } \mathbf{p}_t = \begin{bmatrix} w_{oz} & w_{eu} & e_{eu} & p_{eu} \end{bmatrix}',$$

with ρ as parameter for the degree of autocorrelation of the original series. $\boldsymbol{\Gamma}_i$ are (k×k) matrices picturing short run adjustments. The term $\Pi\mathbf{p}_{t-1}$ represent the long-run relationships. Given that the vector-autoregressive process governing (2) is non-stationary, the rank (r) of the matrix Π is smaller than k. In this case Π can be written as the product of two (k×r) matrices $\boldsymbol{\alpha}$ und $\boldsymbol{\beta}$, each with rank r: $\Pi = \boldsymbol{\alpha}\,\boldsymbol{\beta}'$. $\boldsymbol{\beta}$ is called the co-integration matrix. It transforms the non-stationary vector $\mathbf{p}_{t-1}$ into a stationary process. Thus, $\boldsymbol{\beta}' \mathbf{p}_{t-1}$ represents the long run relationship in the model. The loading matrix α reflect the velocity of with which, after a shock, the system converges to the long-term equilibrium. Unfortunately, matrices α and β cannot be used to identify economic relationships. First, the rank of Π, and thus of α and β, has to be determined with statistical methods and congruence between the structural model and the number of co-integration vector in β is not guaranteed. Second, α and β are not unique. Every transformation with a nonsingular matrix $\mathbf{C}$ ($\Pi = \alpha\, \mathbf{C}\, (\beta\, \mathbf{C}'^{-1})'$) provides a new loading ($\alpha\, \mathbf{C}$) and a new co-integration matrix ($\beta\, \mathbf{C}'^{-1}$) (Lütkepohl 2004).

Since the main focus will be on the identification of relationships between the variables, the estimates are used to reveal causal relationships and to construct the impulse response functions. These analysis rely on the transformation of (2) into an vector-autoregressiv (VAR) process (3) and a vector moving average (VMA) process (4), respectively (Breitung et al. 2004)

(3) $$\mathbf{p}_t = \boldsymbol{\alpha} + \sum_{i=1}^{\rho} \mathbf{A}_i \mathbf{p}_{t-i} + \mathbf{u}_t \text{, with } \boldsymbol{\Pi} = -\left(\mathbf{I} - \sum_{i=1}^{\rho} \mathbf{A}_i\right) \text{ and } \boldsymbol{\Gamma}_i = -\sum_{i=1+1}^{\rho} \mathbf{A}_i \text{ and}$$

(4) $$\mathbf{p}_t = \mathbf{p}_0 + \Xi \sum_{i=1}^{t} \mathbf{u}_t + \sum_{i=0}^{\infty} \Xi_i^* \mathbf{u}_{t-i} \text{, with } \Xi = \boldsymbol{\beta}_\perp \left[\boldsymbol{\alpha}_\perp' \left(\mathbf{I} - \sum_{i=1}^{\rho-1} \boldsymbol{\Gamma}_i \right) \boldsymbol{\beta}_\perp \right] \boldsymbol{\alpha}_\perp',$$

with initial conditions ($\mathbf{p}^*_0$). $\boldsymbol{\alpha}_\perp$ und $\boldsymbol{\beta}_\perp$ are orthogonal complements of $\boldsymbol{\alpha}$ und $\boldsymbol{\beta}$. Ξ_i^* are transitory effects, while Ξ represents long run impact of the shock in the residuals.

6 EMPIRICAL REESULTS

Table 1 provides some statistical test results regarding the structure of the model. According to the Hannan-Quinn- und Schwarz-criterion the optimal lag length of (3) is 2.

The correct identification of unit roots is pivotal for the formulation of the error correction model. However, since none of the various tests for unit roots is superior under all circumstances, different test statistics were analysed. The Augmented Dickey Fuller (Fuller 1996) and the Philips Perron (1988) test provide unambiguous results, insofar as the hypothesis of unit roots cannot be rejected. The conclusions are confirmed by the Breitung (2002) test, except for export subsidies. Despite this, it is assumed that variables may be co-integrated and that this relationship can be revealed by corresponding tests[ii]. The λ_{trace} and λ_{max} test were used to determine the number of characteristics roots of Π (Enders 2004). Both criteria provide that in the case of butter, the system is characterized by one co-integration vector.

In the following the causality structure revealed by the estimates are analyzed. Two concepts are used: Granger causality (Granger 1969) and instantaneous causality (Burda 2001). Granger causality is present when knowledge about previous realization of a series improves the predictability of other series. It was checked via restrictions in the ECM that lead to an exclusion of the variables of interest in the VAR. Instantaneous causality refers to a situation, in which the predictability of a series is improved when the realizations of other series in the period to be predicted are already known[iii]. Instantaneous causality analysed by checking correlations among the residuals. It comprises direct and indirect effects which causes that for $k > 2$ no direct relationships can be identified (Breitung et al. 2004).

Table 2 provides that all time series provide a significant contribution regarding the predictability of the development of the total system. This holds for Granger causality as well as for instantaneous causality. This conclusion has to modified when the impact on individual variables is investigated. Price change in Oceania do not improve the predictability of the EU prices. These, conversely, strongly affect prices in Oceania. When compared the test results presented in table 2 with the hypothesis of the structural model (1) a fast congruence has to be asserted. Exception are the non-significant impact of prices in Oceania on developments in the EU and the significant affect of EU domestic prices on prices in Oceania.

Parameter estimates of (2) are presented in Table 3. Noticeable is the structural difference in the significance of the parameter which concern the short and the long run adjustment. The long run effects are generally highly significant. On the contrary, high t-values for the long run affects are rather an exception. This can be seen as an indicator that second order autocorrelation explains price variation only to a limited extend.

According to the Jarque-Bera-test[v] normality of the residuals cannot be rejected for EU internal and world market prices at reasonable levels of significance. For the other series the differences in the kurtosis led to a rejection of the H0. Homoskedasticity of the residuals was checked with a autoregressive conditional heteroskedasticity maximum likelihood (ARCH-LM) test. The LM-values provide that homoskedasticity cannot be rejected. A further problem concerns autocorrelation among the residuals. The Portmanteau test suggests that no higher order autocorrelation exists. However, according to the Breusch Godfrey test, the hypothesis of autocorrelation among adjacent residuals cannot be rejected. Graphical inspection provides that this especially concerned export refunds and EU domestic prices[iv].

Even if not all test statistics are fully satisfactory, model (2) can be regarded as a reasonable approximation to the developments on the world market for butter. Thus, further analysis of the estimates in form of the impulse response function can be justified. According to the analysis of residual, it cannot be excluded that the errors are (instantaneously) correlated. In order to isolate the direct effects, orthogonalized impulse responses were calculated with a Cholesky transformation of the variance-covariance matrix of **u** in (4). The matrix Ξ were was adjusted correspondingly (Breitung et al. 2004).

Figure 5 provides that some shocks in the residuals have a permanent impact on the other variables. One reason is the existence of unit roots, which, by definition, have a permanent impact the change of the corresponding time series. In addition, permanent influences are also due to the co-integration among the variables. The long run effects of shocks are governed by Ξ in (4). Since the matrix has rank k-r, the number of zero columns cannot exceed r (Breitung et al. 2004). This implies that there are at most r shocks with transitory effects. These were only observed for the impact of export refunds and prices in Oceania on EU internal prices, otherwise permanent impacts, albeit sometimes on a relatively low level are present.

The individual reactions correspond largely to hypothesis discussed for the structural model (1). However, the results have to be interpreted with care, since as it was discussed in table 2, not all relationships are significant. Prices in Oceania increased in response to a shock in EU external prices ($\alpha_{12} > 0$). Interestingly, higher EU domestic prices also have a positive impact on w_{oz}. This reaction is only surprising on the first glance. Higher EU internal prices reflect an increase in scarcity of the product in the EU which is transmitted to the world market and results there in higher prices as well. EU world market prices are positively affected by prices in Oceania and EU domestic prices, while export refunds have a negative impact ($\alpha_{21} > 0$, $\beta_2 > 0$, $\alpha_{23} < 0$). Higher prices on the world market have a negative influence on export refunds ($\alpha_{32} < 0$). However, the expected influence of EU domestic prices on export refunds is not confirmed. In fact, refunds tend to decrease with higher prices in the EU. The reason may be the same as that discussed for the influence of p_{eu} on the prices in Oceania. In addition, this may be an indicator that refunds are not closely linked to the development of EU domestic prices as it was already argued in chapter 3. Furthermore, the largest impact of a shock is observed for the time series itself. The transmission of changes to other series is significantly lower. With regards to world market prices this corresponds to the hypothesis that competition on the world market is present, however, its intensity is reduced (chapter 5). This suggests that despite a homogeneous product is traded no pure Bertrand competition is present.

7 DISCUSSION

The empirical evidence can be summarized as follows. First, butter export by countries is rather concentrated. The main players on the world market are the EU and Oceania. However, due to transport costs and a favourable development of demand the intensity of competition may be relatively low. Second, EU domestic prices are significantly higher than prices on the world market. The reason is the high protection of milk production in the EU. However, the international prices for Northern Europe and for New Zealand are on the same level. Moreover, prices, domestic and international, seem to fluctuate together. Third, the EU pays export refunds to sell its surplus of milk production on the world market. Because export refunds are fixed as the difference between domestic and internal prices, which are a function of export refunds, a severe endogeneity problem exists.

With regard to the three objectives mentioned in the introduction the following conclusion can be drawn: International prices in the EU and Oceania are integrated. The reaction of these prices in response to shock corresponds to the theoretical reasoning. Higher prices on the world market in one regions lead to higher prices in the second. Moreover, the own price responses are larger than those transmitted to the competitor. This suggests that, also present, competition other the international market is not so intense it could be expected for a homogeneous good like butter.

The estimates provide furthermore indication that the EU absorbs fluctuations form the word market. Interestingly, changes of prices in Oceania have no impact on the domestic EU market. Fluctuations of the EU world market prices, on the other hand, are absorbed to a large extent. The reason for this reaction remains unclear. One explanation may an inappropriate fixing export refunds. Variations on the EU domestic market are also transferred to the international markets.

Although the findings were not derived from a causal model, the inspection of the data provide economically reasonable and important insights in structural relationship between international and domestic prices for butter. It can be expected that similar relationships exists for other milk products as well. Moreover, the findings have some important implication for assessing the effects of trade liberalisation. Since price adjustments are not fully transferred, the positive impacts of trade liberalisation may be overestimated, when this affect is not taken into account.

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i An increase of EU exports is mainly due to the accession of countries with a high degree of self sufficiency.

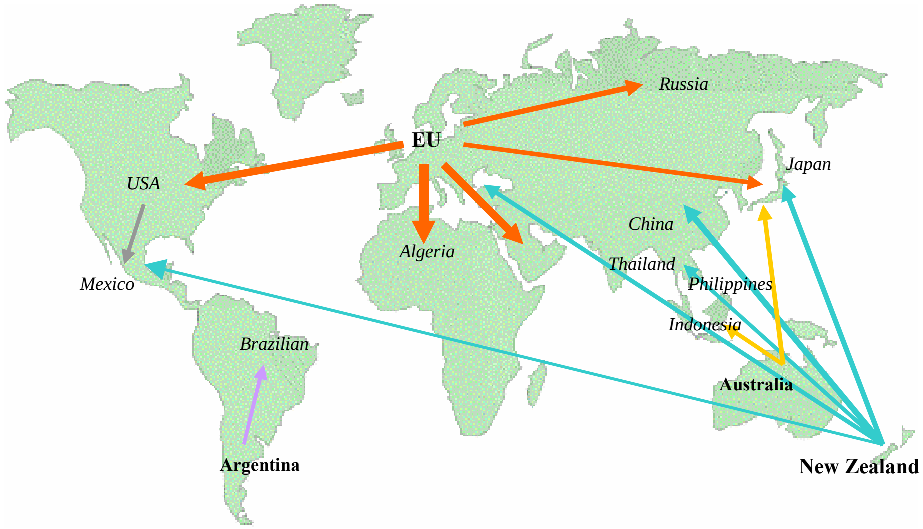
ii Lüthepohl (2004) point out that as a extension of the original definition of co-integration it is possible to consider integrated and non-integrated variables in an ECM in order to identify long-run relationships among the variables.

iii In order to present only direct effects, the analysis of instantaneous causality is restricted to the impact of one time series on all others.

iv An attempt was made to improve the quality of the estimation by a sequential elimination of those regressors that lead to an improvement of a given selection criterion. Again, the Hannan-Quinn und the Schwarz-criterion were chosen; both led to the same model structure. However, the test statistics regarding the desirable properties of the residuals improved only slightly. Especially the problems regarding autocorrelation and non-normality could not be removed.

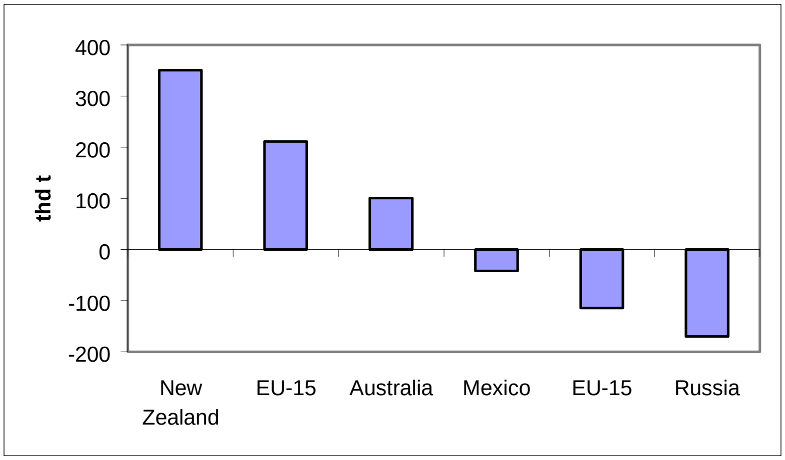
v A description of the test statistics can be found in Lütkepohl (2004)

Figure 1: Important international trade flows of milk products



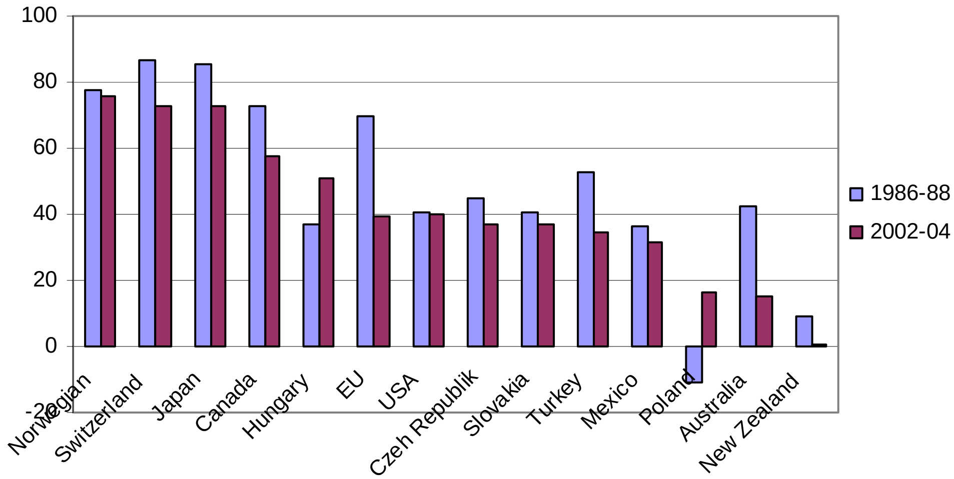
Source: Rabobank (2004).

Figure 2: Important export and import regions of butter, average 2000-2003



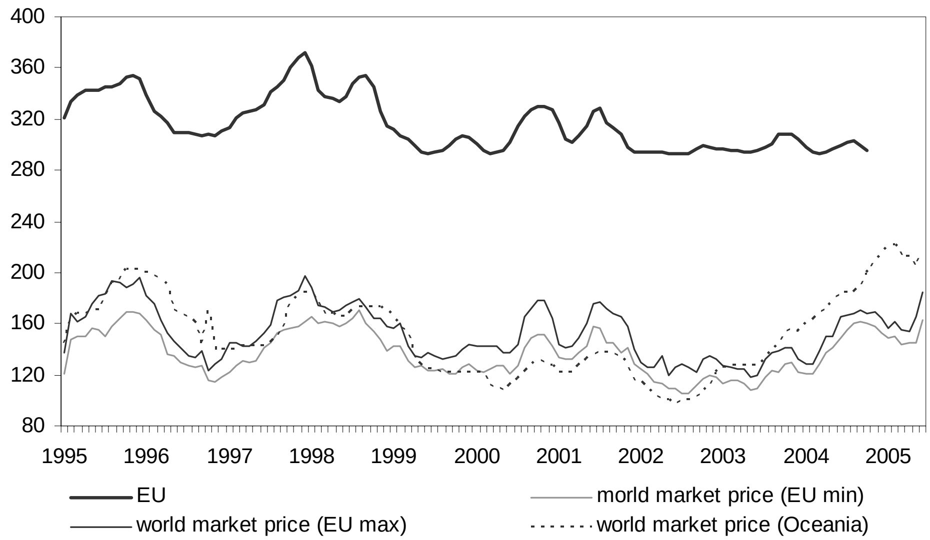
Source: FAOSTAT (2005a).

Figure 3: Producer Support Estimate (%PSE) for milk 1986/88 und 2002/04



Source: OECD (2005).

Figure 4: World market and EU prices of butter (€/100 kg)



Quelle: USDA (2005), UK Dairy (2005), MDC (2005).

Table 1: Properties of the butter price time series

		p_{eu}	w_{eu}	w_{oz}	e_{eu}
existence of unit root (10% level of significance)	ADF	H_0 not rejected	H_0 not rejected	H_0 not rejected	H_0 not rejected
	Phillips-Perron	H_0 not rejected	H_0 not rejected	H_0 not rejected	H_0 not rejected
	Breitung	Accept H_0	Accept H_0	Accept H_0	Reject H_0
lag length	Hannan-Quinn	2			
	Schwarz	2			
# of co-integrating vectors	λ_{trace}	1			
	λ_{max}				

Source: own estimates.

Table 2: Causality tests

			e_{eu}	p_{eu}	w_{eu}	w_{oz}
Instantaneous causality	χ^2		9.8 **	12.3 ***	22.6 ***	6.9 *
Granger causality	F-Test		3.6***	8.4***	3.4***	2.6**
	e_{eu}	χ^2	-	10.4 ***	6.9**	0.6
	p_{eu}		6.4 **	-	9.9***	3.7
	w_{eu}		8.4 **	13.8***	-	1.2
	w_{oz}		5.6	10,2***	8.3**	-

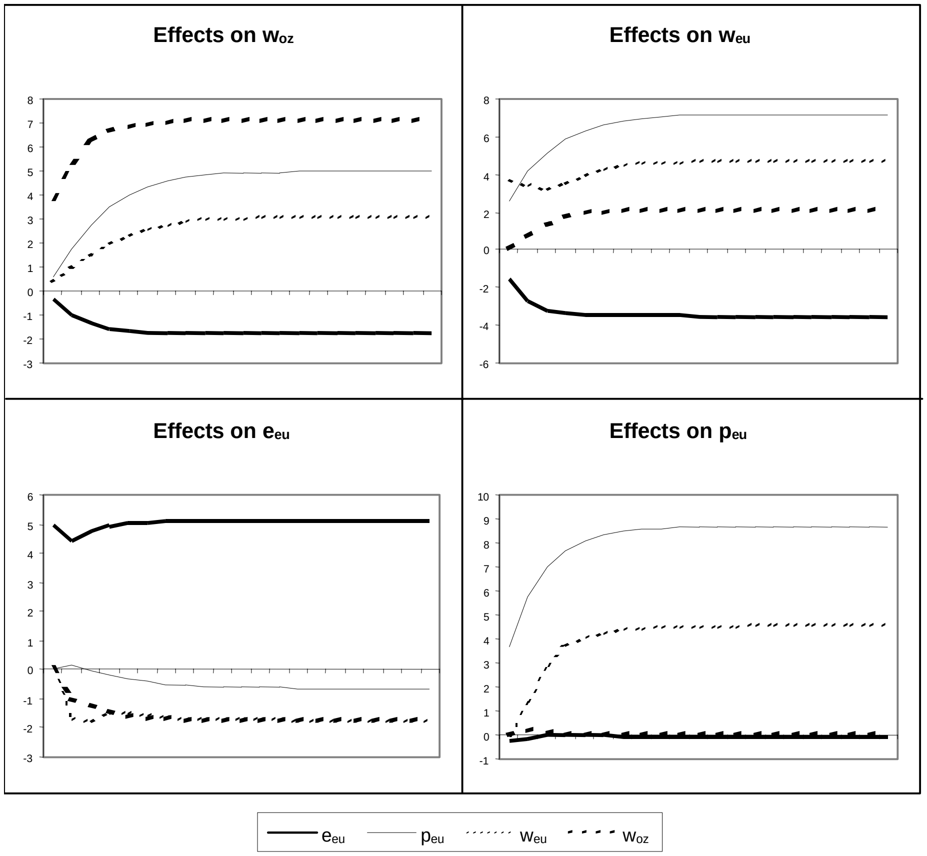
Source: own estimates.

Table 3: Parameter estimates and residual analysis

		Δe_{eu}	Δp_{eu}	Δw_{eu}	Δw_{oz}
parameter estimates					
lagged endogeneous	Δe_{eu}(t-1)	-0.069	-0.103	0.013	-0.062
	Δp_{eu}(t-1)	0.201*	0.564***	0.203*	0.176*
	Δw_{eu}(t-1)	-0.158	-0.025	0.282**	0.115
	Δw_{oz}(t-1)	-0.293**	0.091	0.11	0.403***
Constant		0.81	-1.925**	1.8*	0.418
loading matrix		-0.173*	0.255***	-0.244**	-0.009
co-integration vector		1.	-1.114***	1.583***	-0.219***
residual analysis					
nonnormality (Jarque-Bera-test)		JB = 77,7; p =0.0	JB = 4.52; p =0.11	JB = 2,46; p = 0.29	JB = 39.9; p = 0.0
homoskedasticity (ARCH LM test)		LM = 14.9; p =0.53	LM = 13.9; p =0.61	LM = 15.7; p =0.47	LM = 19.0 p =0.27
autocorrelation		Portmanteau test		Q_{18} = 236.1; p =0.49	
		Breusch Godfrey test		LM_2 = 121.9, p=0.00	

Source: own estimates

Figure 5: Orthogonal impulse response functions



Source: own estimates