JENS-PETER LOY AND PETER WEHRHEIM*

Spatial Food Market Integration in Russia

INTRODUCTION

This paper analyses the dynamics of food price relationships between several regions in the European part of Russia,[1] to determine whether the first sequence of reforms has led to better functioning and/or integrated regional food markets. The integration of markets is of particular importance in a country the size of Russia, with very different climatic conditions. Because of various comparative advantages, spatial trading is a prerequisite for balancing regional shortfalls in the supply of food items. Furthermore, well-functioning markets are necessary to enhance the allocative and distributive efficiency.

During the transition period, the Russian government first liberalized prices in January 1992, and later regulatory power was shifted to regional authorities. These reforms resulted in geographical price differences of significant magnitude for a wide range of food products. Koen and Phillips (1993, p. 10) expected that this regional dispersion of food prices in Russia would be 'largely dissipated after a few months'. Gardner and Brooks (1994) tested retail food prices by applying a modified Ravallion model for the period February 1992 to April 1993 and concluded that there was a lack of market integration in the Russian Federation during the first period of transition. In the meantime, the reform of food policies in Russia continued and further changed market conditions. The increasing independence of regional authorities contributed to a regionalization of food policies (Melyukhina and Wehrheim, 1996).

To address the question of regional food market integration in Russia, we proceed as follows. In the next section factors which are likely to have an important impact on the degree of spatial market integration (SMI) are considered. There is then a description of the link between regional market integration and spatial market efficiency. Use is then made of weekly price data for the period between January 1993 and December 1995, for 10 consumer products at five locations, in testing for integration, cointegration and causal relationships using bivariate and multivariate models. Finally, we draw some conclusions concerning the economic and political implications of the empirical results.

*Christian-Albrechts-University, Kiel, Germany. The financial support of the Deutsche Forschungsgemeinschaft and the Volkswagen Foundation is acknowledged.

FACTORS INFLUENCING SPATIAL MARKET INTEGRATION IN THE TRANSITION PROCESS

Regional markets must be linked by well-functioning trade institutions and transport infrastructures in order to communicate with each other. Within the reform period, public investment in transport declined significantly as a result of budget deficits. The share of federal government expenditures for transport infrastructure declined to less than 1 per cent in 1995 (IMF, 1995), resulting in a sharp fall in the amount of railroad freight carried. This drop suggests that transport of foodstuffs between regions also declined. Another vacuum was created by the lack of marketing institutions which could level out supply and demand shocks between different regions. Many of the former food processing and wholesale firms were restructured or collapsed. A substantial diversification of trade channels and trade arrangements including barter trade and payment-in-kind, and give-and-take operations took place in the Russian food sector (Wehrheim, 1996). Hence the old nationwide network of marketing institutions vanished, while a new one is slowly evolving. Additionally, the marketing chain for various food products evolved very differently during the transition period.

By the presidential decree of December 1991, price controls on most retail goods were eliminated. In March 1992, another decree empowered local governments to reintroduce price control on a regional level. Furthermore, some basic food product prices were not liberalized in order to protect the most vulnerable part of the population. This was achieved through a minimum binding list by the federal government, which authorized the regional governments to set minimum prices for bread, milk and dairy products, sugar, vegetable oil and baby food. Regional governments adopted a wide range of measures to control retail prices, such as limiting their marketing margins. The enforced measures and the products under price control vary to a large extent between these regions. In Orel (Rostov, Pskov) county, retail prices were controlled for 23 (35, 27) food products in 1994. Hence it is expected that the market integration for these products under regional price control will be weaker than for other products. It must also be noted that the regional governments were only able to regulate retail prices for formal outlets, such as state shops. Other retail outlets, such as town markets, where officials have little or no control over food prices, became more important (Tho Seeth, 1997).

In perfect markets, changes in the relative availability of goods and scarcity of resources result in price changes which are signals for consumers and producers. In the process of reform, however, markets in Russia were distorted by many macroeconomic developments. With respect to market integration, accelerating inflation in the first period of the Russian transition process was very likely to have been one of the central factors influencing SMI. First, inflation distorts the transmission of price signals between markets. Second, inflation also increases price variability and, hence, insecurity, while uncertainty increases if high inflation rates prevail. Third, this may result in risk-reducing strategies by consumers, such as increased stockholding, which itself accelerates the price spiral again as supplies fall. A fourth argument

claims that Russian firms are not familiar with market pricing and overestimate the required price increase to balance inflationary effects resulting in inventory accumulation. Fifth, inflation also has distributive effects. In Russia it has undermined the real income of pensioners and low-income groups, which also affects the allocative and distributive efficiency of markets.

All of this suggests that the macroeconomic environment for food markets in Russia was characterized by significant restructuring and uncertainty in 1993 and 1994. Only slight improvements in SMI are expected, given that the empirical analysis only covers the first three years of economic restructuring. Since market structures and policy interventions have evolved differently for various products, it is also likely that SMI will be rather different for various crops.

THE MEANING AND THE MEASUREMENT OF SPATIAL MARKET INTEGRATION

SMI is based on arbitrage pricing theory. Efficient spatial price spreads should not allow for expected profits by applying any kind of trading rules. In the first place, efficient price spreads are not directly related to SMI, which is defined as a significant statistical relationship between spatial price series (Monke and Petzel, 1984). However, time-varying cost structures can lead to unrelated spatial prices that are efficient (Fackler, 1994). Thus only in the case of more or less constant cost structures and trading relationships can long-run statistical relationships be expected. Furthermore, the measurement of SMI is mainly based on linear or log-linear relationships between prices, which implies that absolute or relative price changes should be related across markets. The exact parameterization of these relationships is generally undetermined because adjustment costs might vary between markets and/or products. Even if constant cost structures and stable trading relationships can be assumed, the rejection of long-run relationships does not imply inefficiency because the observed price differences might be unimportant from an economic point of view, even though they are highly predictable. Thus the results of SMI studies have to be combined with the knowledge of market experts who can assess predicted profit opportunities or compare the results with those for other markets or time periods.

The measurement of SMI in recent years has been strongly influenced by the introduction of cointegration theory, since many price series show non-stationary behaviour. Numerous studies provide a detailed explanation of the statistical background on this issue (Alexander and Wyeth, 1994; Von Cramon-Taubadel *et al.*, 1995). The general methodological procedure in this study is based on the following steps.[2]

(1) The hypothesis of integration is tested against stationarity for all price series using the test procedure developed by Phillips and Perron (1988).
(2) If the hypothesis of integration cannot be rejected, the hypothesis of cointegration is tested for all bivariate combinations of regional prices, applying the procedure developed by Johansen (1988).

(3) Bivariate error correction models (ECMs) are estimated for the cointegrated systems by ordinary least squares (OLS), and WALD tests are applied to test for exogeneity.
(4) Multivariate tests to prove cointegration and exogeneity are applied to the regional systems of markets for each product to determine the multi-market linkages (Johansen, 1988).

DATA AND ESTIMATION RESULTS FOR THE RUSSIAN FOOD MARKETS

The empirical evaluation of food market integration in Russia is based on weekly price data from January 1993 to December 1995 for beef, butter, milk, eggs, sausages, bread, potatoes, sugar, vegetable oil and wheat flour for five regional markets (Moscow, St Petersburg, Pskov, Orel and Rostov). Table 1 shows the distance matrix for these locations.

TABLE 1 *Distance matrix for the five spatial markets in Russia (km)*

	St Petersburg	Pskov	Orel	Rostov
Moscow	682	837	426	1262
St Petersburg		228	1065	1926
Pskov			1058	1972
Orel				1015

Source: Loy and Wehrheim (1996).

The analysed series relate to consumer prices, which were collected by regional branches of the Russian Statistical Office (Goskomstat, 1996). These were monitored for 'official' retail shops and town markets separately until December 1993. From January 1994, the price series reflect a weighted average of all registered market outlets. Because prices are significantly influenced by inflation, the series are deflated by a weekly food price index. Generally, the deflated price series still show significant movements in levels, which indicate non-stationary behaviour of the underlying data-generating processes (DGPs) (see Figure 1). The products under regulatory control, such as milk, bread and wheat flour, show the largest upward movements. This might be expected as regulation here often means cost-plus pricing which provides no incentives to reduce costs. The null hypothesis of non-stationarity (integrated of order one) cannot be rejected in most cases.[3] Except for some potato and vegetable oil prices, all series are integrated even if a trend is included. All first differences are stationary or more precisely integrated of order zero.[4]

In the second stage, cointegration is tested for all combinations of regional markets for all products. The existence of long-run linear price relationships is supported by testing for most of the bivariate regional market combinations of

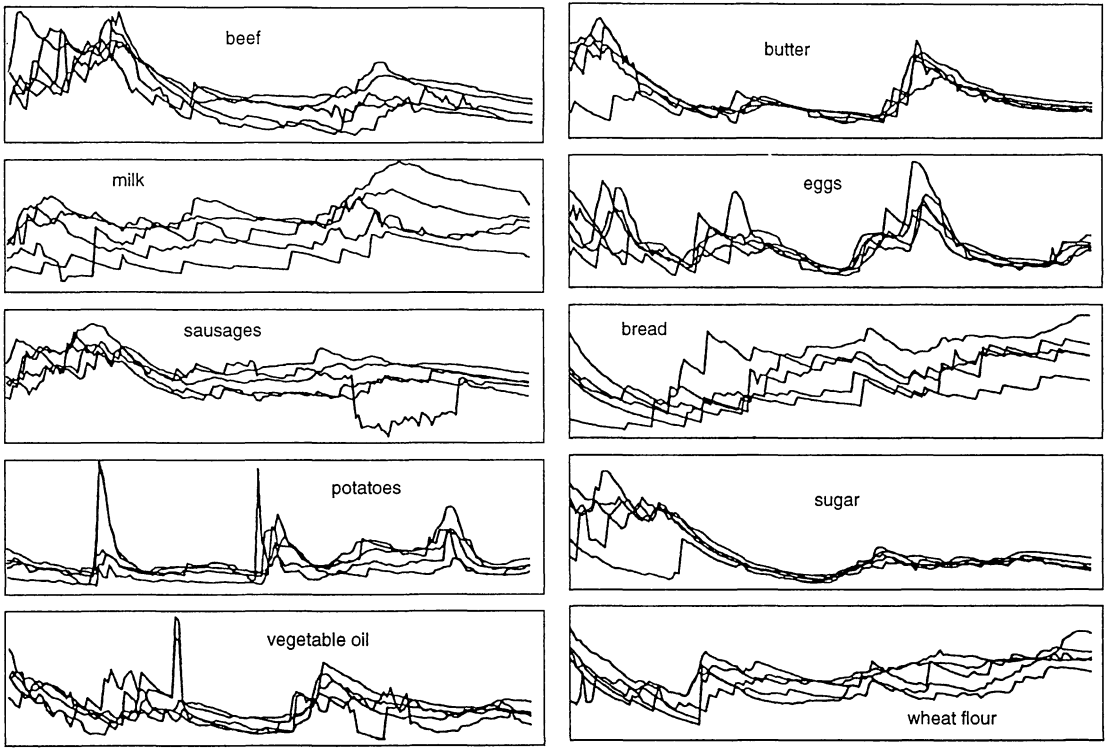

FIGURE 1 *Deflated weekly prices of food products for five regional markets in Russia, Jan. 1993 to Dec. 1995*

Source: Goskomstat (1996).

beef, butter, eggs, potatoes, sugar and vegetable oil prices. For milk, sausages, bread and wheat flour, no cointegration is indicated in most cases. Regional patterns could not be derived from the results.

In the next step for all bivariate combinations structural error correction models (ECMs) of the following type are estimated. In the notation used, i and j are indices for different spatial markets and p stands for the respective prices. In addition, α^* is the error correction coefficient (ECC), which indicates how deviations from the linear long-run relationship are reduced over time. β_0 is the parameter for the contemporaneous price adjustment, which describes the comovement of prices in the same period. As further difference lags are generally not found to be statistically significant, result documentation and discussion are focused on the ECC and contemporaneous adjustment parameters.[5]

$$\Delta p_t^i = \alpha_0 + \alpha^* p_{t-1}^i + \beta^* p_{t-1}^j + \beta_0 \Delta p_t^j + \sum_{k=1}^{p} \alpha_i \Delta p_{t-1}^i + \sum_{l=1}^{q} \beta_i \Delta p_{t-1}^j$$

Estimates for milk, sausage, bread and wheat flour prices reveal the lowest ECCs, potato prices the highest (see Table 2, column 3). But potato prices show a strong seasonal component that might have contributed to this result. As only three years of data are available, this problem could not be considered adequately, especially as the seasonal component does not seem to be constant in time (see Figure 1). The estimated contemporaneous adjustment coefficients are often not significant and, in addition, are relatively low in comparison to other results for the European Union, Poland or world agricultural markets (see Table 2, column 4, and Von Cramon-Taubadel *et al.*, 1995; Loy, 1995; Von Cramon-Taubadel and Loy, 1996).[6] The number of significant coefficients is relatively high for butter and potatoes compared with other products. Other lagged adjustments are generally not significant. For the products covered, it takes from eight weeks to a year for there to be reductions of price shocks by 90 per cent between spatial markets (Table 2, column 5). These results indicate very weak SMI, which is mainly driven by low ECCs. Furthermore, spatial price differences seem to be economically important. Average maximum differences between 40 and 250 per cent for the whole sample are observed. That means, for instance, that in the case of milk the highest spatial market price is 2.5 times higher than the lowest, on average.

The causal direction within the bivariate systems is determined by testing for weak exogeneity. If the null hypothesis cannot be rejected for both variables, it is not possible to identify the leading market. The hypothesis of weak exogeneity is rejected for most of the cointegrated price pairs. This implies, whenever a causal relationship is indicated, that it is based on a feedback relationship. Therefore the estimations of the ECM cannot be further interpreted with respect to the direction of information flows or price adjustment. Nonetheless, the magnitude of the estimated coefficients gives an idea of the way close spatial markets are linked.

In the last step, the maximum likelihood estimation method is used to determine the rank of the matrix of cointegrating vectors. In most cases the results with five lags are consistent with the results for 10 lags. For beef and sugar, four cointegrating vectors are revealed. Thus these markets show the

TABLE 2 *Estimation and test results for various deflated weekly food prices on five spatial markets in Russia from Jan. 1993 to Dec. 1995*

Product	Share of spatial cointegrated price series 1 (%)	Number of cointegrating vectors 2 (number)	Average error correction coefficient α^*(ECC) 3 (%/week)	Average contemporaneous adjustment β_0 4 (%)	Time for reduction of price deviations by 90% 5 (weeks)	Minimum, maximum of standard deviation 6 $std(\Delta p_t^i / p_t^i)$	Average maximum spatial price difference 7 $\left(\frac{Max(p_t^i)}{Min(p_t^i)} - 1\right) * 100$
Beef	90	4	11	17	20	3.0–8.3	58
Butter	90	2	10.5	19	20	4.2–11.7	50
Milk	70	1	7	4	33	4.0–39.2	248
Eggs	70	1	11	10	20	5.9–10.2	43
Sausage	30	2	5.5	1	43	3.0–55.1	140
Bread	20	1	4.8	7	47	8.2–19.2	183
Potatoes	90	1	24.5	35	8	24.7–75.3	174
Sugar	80	4	9	7	25	2.8–10.4	56
V. oil	80	1	13.5	18	16	6.3–12.2	57
W. flour	20	1	8	19	27	3.3–26.1	71

Notes: (1) Number of cointegrated bivariate price series divided by the number of all bivariate combinations of spatial markets. (2) Number of cointegrated vectors (Johansen procedure). (3) Average ECC for all bivariate combinations. (4) Average price transmission in the same week for all bivariate combinations. (5) Average time period for a reduction of a price shock by 90 per cent for all bivariate combinations. (6) Minimum and maximum of standard deviations of relative price changes on spatial markets. (7) Average of maximum relative spatial price differences for the respective period (in this case, Jan. 1993 to Dec. 1995).

Source: Own calculations; data from Goskomstat (1996).

highest degree of SMI. The lowest degree is for bread and wheat flour. Except for beef, sausages, butter and sugar, the number of cointegrating relationships is generally one. This means such market systems consist of four different non-stationary price movements; respectively, the system is driven by four different random walks. Systems with four cointegrating vectors are only driven by one common stochastic trend or random walk. To prove the causal directions within these systems, several restrictions on the weighting matrix have to be tested. The systems with four cointegrating vectors can indicate one market leader, or one weakly exogenous market. Those with one cointegrating vector can show four weak exogenous markets or one following market. None of the markets could be identified as a leader or follower. This supports results for the bivariate estimations because the hypothesis of weak exogeneity could not be rejected in most cases. The only exception is St Petersburg, which seems to be a leader in the beef market. Hence most multivariate estimations are not identified, and no information about impulse responses can be extracted.

Finally, an attempt is made to test whether SMI has improved over the reform period, by applying the methods outlined above to only the second half of the sample. Generally, it would be expected that SMI might improve after an adjustment period, because establishment of markets and traders would take considerable time, and gathering of information would increase and become faster over time. The results are summarized in Table 3. As for the whole sample, the hypothesis of integrated DGPs cannot be rejected for all price series. Cointegration is less observed even though one would expect markets to be linked more closely after an initial post-reform period. Also the speed of price adjustment processes between spatial markets has not increased, compared to the results for the whole sample, and spatial price differences are still rather important for most of the products. Thus SMI has not improved significantly in the second half of the observation period. This might be the result of a counterproductive influence of regional pricing policies, or the slow adjustment to more efficient spatial transaction arrangements which are taking place without yet leading to significant improvements.

CONCLUSIONS

Even though major economic reforms started in 1991 and 1992, the food marketing system in Russia seems to be restricted by the lack of well-functioning infrastructure and institutions. Additionally, the shift of policy decisions to the regional governments may have increased market segmentation. These hypotheses are tested by analysing weekly consumer prices for 10 food products for five locations in the European part of Russia, over the period from January 1993 to December 1995. Even though the material analysed covers a period of up to four years after the initial price liberalization, only low levels of regional market integration are revealed, which do not increase significantly in time. Long-run linear price relationships were found for nearly all bivariate regional market combinations of beef, butter, eggs, potatoes, sugar and vegetable oil. Contemporaneous adjustment is revealed for many bivariate market combinations for these products, even though levels of coefficients are mostly

TABLE 3 *Estimation and test results for various deflated weekly food prices on five spatial markets in Russia from May 1994 to Dec. 1995*

Product	Share of spatial cointegrated price series 1 (%)	Number of cointegrating vectors 2 (number)	Average error correction coefficient α^*(ECC) 3 (%/week)	Average contemporaneous adjustment β_0 4 (%)	Time for reduction of price deviations by 90% 5 (weeks)	Minimum, maximum of standard deviation 6 $std(\Delta p_t^i / p_t^i)$	Average maximum spatial price difference 7 $\left(\frac{Max(p_t^i)}{Min(p_t^i)} - 1\right) * 100$
Beef	40	1	14	4	16	1.5–5.8	63
Butter	83	2	24	26	9	4.7–9.5	30
Milk	10	2	6	8	37	2.8–15.0	184
Eggs	41	2	13	4	18	5.9–6.8	31
Sausage	30	2	9	–5	26	1.8–72.3	204
Bread	15	1	7	6	33	2.6–12.9	117
Potatoes	88	3	27	7	9	8.3–100	155
Sugar	26	1	11	12	20	2.7–4.6	22
V. oil	41	1	14	9	16	3.5–13.4	54
W. flour	4	1	7	10	32	1.8–6.5	57

Notes and source as for Table 2.

very low compared to other market integration studies. Milk, sausages, bread and wheat flour are in many cases not cointegrated at all. This can be explained by specific product properties such as non-tradability (for example, milk), different qualities (for example, sausages) and different government price settings (for example, bread and wheat flour). For bread and wheat flour prices, extremely low levels of cointegration are obtained. As quality standards for this category of bread are still rather homogeneous across Russia, the impact of political interference seems to be high. Deviations from the long-run equilibrium are reduced significantly for some products, but the speed of adjustment is relatively low. For instance, 90 per cent reductions of price shocks take up to a year for some products (such as sausage and bread). Potato prices reveal cointegration more often and even the speed of comovement is relatively high in the whole sample. Product-specific differences in the degree of cointegration may suggest that the interregional trade network is more advanced for beef, butter, eggs, potatoes and vegetable oil. With the exception of potatoes, this might imply that spatial cointegration in Russia is more advanced for food products that are characterized by a relatively high value density and which, therefore, have somewhat lower transport costs. Hence these products can be traded more easily and provide more incentives to arbitrage. At the same time, regional price regulation seems to lower spatial market integration for certain products, such as bread, wheat flour and milk. Both facts highlight important conclusions. First, not surprisingly, regional price policies tend to increase market segmentation. The regionalization of food policy should be reversed whenever it is linked to increased barriers to spatial trading. As political interests of the 89 sub-national regions in Russia are often conflicting, the issue of food price liberalization should be decided at the national level to avoid market segmentation. Second, weak spatial market integration could be reduced by offering firms in the food marketing chain the legal security and the technical infrastructure to exchange food products in bulk over long distances.

NOTES

[1]Food markets in Moscow and St Petersburg, Russia's two largest urban centres, are compared with three Russian counties. All three counties (Pskov, Orel and Rostov) are located in the European part of Russia. Pskov is the most northern county, located adjacent to Estonia and Belarus. Orel is located in the central region south of Moscow, the so-called 'red belt'. In contrast to other regions, the population of this industry-dominated oblast maintains a rather anti-reform government. Rostov, located on the Don, has the most liberal food policy.

[2]We use here the procedures by Phillips and Perron (1988) and Johansen (1988) as these have improved properties, especially in the case of more complex data generating processes and in small samples, compared to classical procedures such as the augmented Dickey–Fuller test or the Engle–Granger two-step procedure (see Engle and Granger, 1987; Banerjee *et al.*, 1993).

[3]All results are based on the 95 per cent significance level. The robustness of results is tested by using two different lag structures (5 and 10 lags). The maximum lag length of 10 ensured the absence of residual autocorrelation in most cases, but the 'white noise' properties of the error terms in the regression to test stationarity as well as to estimate the ECM are often not fullfilled with respect to homoskedasticity and normality. Thus the estimation results can be biased and have to be interpreted with caution.

[4]More details about the calculations are given in Loy and Wehrheim (1996) and can be obtained from the authors upon request.

[5]These are only included to ensure uncorrelated error terms.

[6]In these studies, contemporaneous price adjustments are often considerably above 0.5 or 50 per cent.

REFERENCES

Alexander, C. and Wyeth, J. (1994), 'Cointegration and Market Integration: An Application to the Indonesian Rice Markets', *The Journal of Development Studies*, **30**, 303–28.

Banerjee, A., Dolado, J.J., Galbraith, J.W. and Hendry, D.F. (1993), *Co-Integration, Error Correction and the Econometric Analysis of Non-Stationary Data*, Oxford: Oxford University Press.

Engle, R.F. and Granger, C.W. (1987), 'Cointegration and Error Correction: Representation, Estimation and Testing', *Econometrica*, **55**, 251–76.

Fackler, P.L. (1994), 'Spatial Equilibrium and Tests of Market Efficiency and Integration', mimeo, North Carolina University.

Gardner, B. and Brooks, K. (1994), 'Food Prices and Market Integration in Russia: 1992–93', *American Journal of Agricultural Economics*, **76**, 641–6.

Goskomstat (Statistical Office of Russia) (1996), *Weekly Food Prices*, Moscow: Official Publication.

IMF (International Monetary Fund) (1995), *Russian Federation – Statistical Appendix*, Staff Country Report No. 95/107, Washington, DC: IMF.

Johansen, S. (1988), 'Statistical Analysis of Cointegration Vectors', *Journal of Economic Dynamics and Control*, **12**, 231–54.

Koen, V. and Phillips, S. (1993), *Price Liberalization in Russia*, Occasional Paper 104, Washington, DC: IMF.

Loy, J.-P. (1995), 'Möglichkeiten zur Beurteilung der Markteffizienz – Theorie, Methodik und eine erste Evaluierung für polnische Agrarmärkte in der Transformationsphase', dissertation, Institut für Agrarökonomie der Christian-Albrechts-Universität, Kiel.

Loy, J.-P. and Wehrheim, P. (1996), 'Spatial Food Market Integration in Russia', Discussion Paper No. 6, Series: The Russian Food Economy in Transition, University of Kiel.

Melyukhina, O. and Wehrheim, P. (1996), 'Russian Agricultural and Food Policies in the Transition Period: Federal and Regional Responsibilities in Flux', Discussion Paper No. 5, Series: The Russian Food Economy in Transition, University of Kiel.

Monke, E. and Petzel, T. (1984), 'Market Integration: An Application to International Trade in Cotton', *American Journal of Agricultural Economics*, **66**, 481–7.

Phillips, P. and Perron, P. (1988), 'Testing for Unit Root in Time Series Regression', *Biometrika*, **75**, 335–46.

Tho Seeth, H. (1997), *Rußlands Haushalte im Transformationsprozeß – Einkommens-, Armuts- und Versorgungsanalyse*, Frankfurt/Main: Europäische Hochschulschriften, Peter Lang.

Von Cramon-Taubadel, S. and Loy, J.-P. (1996), 'Price Asymmetry in the International Wheat Market: A Comment', *Canadian Journal of Agricultural Economics*, **44**, 311–17.

Von Cramon-Taubadel, S., Loy, J.-P. and Musfeldt, E. (1995), 'Empirische Methoden zur Analyse der Marktintegration am Beispiel des EU-Schweinesfleischmarktes', *Schriften der Gesellschaft für Wirtschafts- und Sozialwissenschaften des Landbaues*, **31**, 119–37.

Wehrheim, P. (1996), 'Institutional Change in the Russian Food Marketing System', in *Proceedings of the 50th EAAE Seminar 'The Significance of Politics and Institutions for the Design and Formation of Agricultural Policy'*, Halle/Saale: IAMO.