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Price Transmission and Marketing Margins in the Slovenian Beef and Pork Markets During Transition

by

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Abstract

As in many other transition countries processing and marketing margins are also larger in the Slovenian meat market than respective margins in market economies. In addition, margin of the Slovenian pork chain is greater than in the beef chain. Its decline in the pork market indicates an adjustment to more competitive markets. Co-integration models are applied to estimate vertical price transmission and to examine margins and degree of competition in the meat marketing chains. Results indicate the existence of a long run equilibrium regarding vertical price transmission in the beef and pork sectors. Both the farm-gate beef and pork prices are identified as weakly exogenous in the long run. The structural tests imposing a homogeneity restriction suggest a mark-up long-run price strategy for beef and a competitive price strategy for pork after 1994 in the meat processing and marketing chains.

JEL classification: D4; L1; C3; Q1

Keywords: price transmission, marketing margin, co-integration, competition.

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1 INTRODUCTION

Over the last three decades several studies have examined competitive models in factor and product markets, and how various shifts in demand and supply affect the farm-to-retail price ratio and price transmission. Most of these studies, however, have been conducted for OECD economies, and very rarely for new emerging market economies (e.g. Gardner and Brooks, 1994; Wei, Guba and Burcroff, 1998). These studies largely rely on structural models to estimate price transmission (e.g. Hyde and Perloff, 1998). Initially, the econometric modelling work of price analysis in the food marketing chain largely followed Wolffram's (1971) studying irreversibility in supply, Houck's (1977) model specifications investigating asymmetric price transmission, and Gardner's (1975) theoretical work on the farm-to-retail price spread. Among the best known empirical studies of price transmission in the food marketing chain are Brorsen's et al. (1985) modelling of the effect of changes in output price risk on the marketing margin, Heien's (1980) investigation of the dynamic price adjustment by mark-up pricing rules, and Wohlgenant's (1985) examination of lead-lag relations between prices at different levels of the marketing chain. Moreover, following Ward's (1982) dynamic asymmetric mark-up model to study asymmetric price transmission, several studies have analysed the speed and the magnitude of a price transmission shock when the initial price is rising or falling, to establish whether price development in the food marketing chain is either symmetric or asymmetric (e.g. Boyd and Brorsen, 1988; Hahn, 1990; Appel, 1992). The common feature of these models is that they capture behaviour within static long-run equilibrium relationships by explaining structural relations and causes of price and margin determination. More recently, Bessler and Akleman (1998) have investigated vertical price transmission of the US pork and beef sector and examined the direction of information flows in linear models by using directed graphs relying on lagged relationships.

Our work was motivated by a rather large farm-to-retail price spread in the Slovenian meat markets (cf. Bojnec, 1999).[1] This indicates that the Slovenian meat market during transition from regulated economy to a market economy are likely non-competitive markets. In spite of important policy relevance, to date no study examines vertical price transmission, farm-to-retail price spread (margin), and degree of competition in the Slovenian meat market. Slovenia is one of the success stories among the transition countries, but agriculture and the food sector seem to lag behind in this general market orientation (e.g. Debatisse, 1998). It is important for policy design and formulation to investigate if price liberalisation and market deregulation during transition to a market economy is reflected in a more competitive and efficient price transmission. Therefore, the important objective of our article is to provide in-depth evidence on a vertical price transmission and on a magnitude and pattern in development of the processing and marketing margin for the Slovenian beef and pork markets during the 1990s. We analyse a long-run vertical price interrelationships at farm and retail stages in the vertical meat chain. We use a co-integration approach to study long-run relations and vertical-market integration effects of two commodity markets, namely beef and pork, using the multivariate Johansen maximum likelihood (ML) co-integration approach (cf. also Jumah and Kunst, 1996; Jumah, 1996; von Cramon-Taubadel, 1998).

[1] For a similar quality, the processing and marketing margins in the Slovenian meat market are greater than in more perfectly competitive markets in market economies. For example, the pork percentage margin defined as a percentage of margin in retail price was between 70 and 80 % in both Austria in the period 1973-1994 and in Slovenia in the period 1990-2000. However, in Austria, the margin is related to a greater share of more expensive processed products vis-à-vis in Slovenia where is the greater share of fresh meats. This clearly indicates that the processing and marketing margin for the similar quality of meat in Slovenia was higher than in Austria, which had a rather isolated and less efficient meat market during that time (Jumah, 2000).

The paper is structured as follows: First, we briefly present evidence on the Slovenian beef and pork markets such as agricultural policies, market structure and main features of the sectors. Then we describe the theoretical background underlying our analysis. In the next step we explain the methodology used and describe our data. The chapter dealing with empirical analysis consists of unit root tests, a multivariate Johansen ML co-integration approach and a testing procedure to analyse whether markets are competitive or not. Finally, we summarise the main empirical results and draw our main conclusions.

2 THE SLOVENIAN BEEF AND PORK MARKETS: AGRICULTURAL POLICY AND MARKET STRUCTURE

The Slovenian beef and pork markets have been regulated by trade measures and ad hoc price measures. The budgetary support has been allocated to cattle producers in less-favoured areas, and in 2000 the headage payments to cattle producers were introduced.

The ad valorem tariffs and specific import levies, which have been reduced gradually according to the World Trade Organisation (WTO) agreement, shield the Slovenian beef and pork markets from foreign competition. In 2000, the ad valorem tariffs amounted to 9% for beef and 10.9% for pork. The specific import levy varies by different meat cuts and processed meat products. For instance, according to the WTO agreement, the final bound specific import levy was agreed at 1,264 ECU per tone for beef carcass and at 356 ECU per tone for pork carcass. In the policy implementation, the specific import levies for beef and pork were often amounted less than the agreed ceilings in the WTO schedules.

The closer look in price policy measures reveals changes in price formation in the period 1990-2000. Initially, when Slovenia became independent from former Yugoslavia in 1991, there was a shift in price policy formation from the federal former Yugoslav institutions to the local Slovenian institutions. This was during the period 1990-1991 characterised by high market instabilities and high price volatility. With the disintegration of former Yugoslav markets, Slovenian beef and pork prices on the retail level as well as on the farm-gate level increased sharply. At the end of December 1991 and in the first quarter of 1992 the ceiling beef and pork prices at the farm-gate, wholesale and retail levels were set by the Slovenian government. The core of the price policy were ceiling parity coefficients. The ceiling parity coefficient between beef (1.0) and pork farm-gate prices was 0.9. The ceiling parity coefficient between beef farm-gate price (1.0) and beef retail price (for compensated quarter) was 2.5 plus 15% wholesale and retail trade margin which then determined ceiling retail prices of some pieces of beef by ceiling parity coefficients. The methodology for formation of retail pork prices was similar: the ceiling parity coefficient between the pork farm-gate price (1.0) and retail price of pork (warm half carcass) was 2.6 plus 15% wholesale and retail trade margin. Later, between the spring 1992 and the spring 1995, beef and pork farm-gate, wholesale, and retail prices were freely determined. The beef prices and the beef wholesale and retail trade margins have remained largely market determined. At the end of 2000 and the beginning of 2001, the government intervention in the beef market was imposed in a response to the BSE crisis in some the EU countries. On the contrary, there were several ad hoc price interventions in the fresh pork meat markets via setting the ceiling slaughtering price for pork half carcass and the ceiling 15% wholesale and retail trade margin for fresh pork as a basis for ceiling retail prices of some pieces of pork by ceiling parity coefficients.[2] The aim of ad hoc

[2] In March 1995, the ceiling price for pork half carcass was set at 550 Slovenian tolars (SIT) in nominal prices per kg and it was reintroduced in July 1995. In September 1996, the ceiling price for pork half carcass was set at 583 SIT per kg, and it was reintroduced in January, May and September 1997, and between January and February 1998. The ceiling wholesale and retail trade margin was set at 15%. The ad hoc policy intervention continued at the end of 2000 and at the beginning of 2001.

price policy in the pork market was through setting the ceiling price for fresh half pork carcass at the slaughtering level and ceiling wholesale and retail trade margin to regulate retail fresh pork prices when an up-ward tendency of fresh pork retail prices occurred.

Cattle and pig production in Slovenia differ in the sense that most cattle is produced by a large number of small-scale individual farms (for example, 95 % of total cattle production in 1997), while pig production is pursued on both small-scale individual farms (59 %) and on large-scale commercial farms (41 % of total pig production). Regarding the pork sector, there were eleven registered *slaughterhouses*, all of them were also engaged in cattle slaughtering. In comparison, there were 35 slaughterhouses for beef. As market shares indicate, cattle slaughtering were less concentrated than pig slaughtering. In 1997, the shares of the six largest pig and cattle slaughterhouses were 89 % and 48 %, respectively. *Wholesale* marketing of beef and pork is largely in the hands of slaughterhouses and meat processors. They are also the main exporters and importers of cattle, pigs and meats. *Retail trade* in beef and pork is rather dispersed among different kinds of retail shops and supermarkets.

3 THEORETICAL BACKGROUND ON VERTICAL PRICE TRANSMISSION

Similar to Cramon-Taubadel (1998) and Jumah (2000) vertical price transmission between farm and retail levels has been investigated within a linear model. The vertical price relationships at two different marketing levels in a certain meat chain is observed using three variables whereby the difference between a retail price (P_r) and a farm gate price (P_f) is the processing and marketing margin (M). The vertical price relationship can be described as:

(1) $$P_r = M + P_f \, .$$

The margin (M) can generally be seen as a linear combination of a constant absolute amount (a) and a percentage (mark-up) amount (b) of the retail price (e.g., Tomek and Robinson, 1995; Jumah, 2000):

(2) $$M = a + b\, P_r \, ,$$

with $a \geq 0$ and $0 \leq b < 1$.

Under a situation of perfectly competitive market b equals unity (b = 0) and the margin is constant (M = a), which denotes a marginal cost.[3] Under a situation of market power, the meat processors and meat traders influence margin in such a way that it will be above marginal costs by charging mark-up in an amount $0 < b < 1$ of the retail price. By substituting equation (1) into (2) it leads to:

(3) $$P_r = a + b\, P_r + P_f$$

or

(4) $$P_r = \frac{1}{1-b} a + \frac{1}{1-b} P_f \; .$$

If a market is a perfectly competitive there is no percentage mark-up in the market, i.e. $b = 0$, and hence only a constant absolute margin remains in equation (4):

[3] The constant (margin) is a constant multiplicative margin, which does not necessarily depend only on the farm component of the retail good, but may also depend on technology and other input prices. McCorriston et al. (2001) showed that price transmission elasticity could be greater or less than one depending on the offsetting influences of market structure and market power and increasing returns to scale. They listed several factors, which determine the extent of price transmission. Among the most important factors, which affect price transmission, they found characteristics of market structure by exerting market power and non-constant returns to scale as well as some other factors such as mark-up changes and convexity of demand shift, technological and cost changes.

(5) $$M = a = P_r - P_f \ .$$

Equation (4) can be rewritten in the reduced form as:

(6) $$P_r = \hat{a} + \hat{b}\, P_f$$

with $\hat{a} = \dfrac{1}{1-b} a$ and $\hat{b} = \dfrac{1}{1-b}$.

If P_r and P_f are non-stationary, the tested relationship can be described as:

(7) $$P_{r,t} = \hat{a} + \hat{b}\, P_{f,t} + \varepsilon_t$$

where ε_t must be stationary if the above tested model is true in the long run. If the two prices are only linked by a constant absolute margin, then $\hat{b}$ has to be equal to unity ($\hat{b} = 1$). If $\hat{b} \neq 1$, one can assume that the margin consist of two components: an constant absolute amount (â) and a percentage amount ($\hat{b}$) of the retail price. In this case it can be assumed that intermediate traders and/or retailers charge a mark-up.

4 METHODOLOGY

4.1 Unit root tests

To test the number of unit roots in each time data series we applied the Augmented-Dickey-Fuller (ADF) test (Dickey and Fuller 1979, 1981) and the Phillips-Perron (PP) test (Phillips, 1987; Phillips and Perron, 1988). Since monthly data are used seasonal unit root can occur. According to Schwert (1989), the ADF test is valid only for non-seasonal data and the shorter the time series, the more difficult it is to reject the hypothesis of non-stationary time series. However, Gyhsels et al. (1994) show that the usual ADF test is still valid as long as a sufficient number of lagged terms are included to take into account seasonal unit roots in the data. But they also show that the test leads to serious size distortion. So one faces a difficult choice either to use unadjusted data resulting in the test with the wrong size or to use adjusted data with adjustment procedures having adverse effects of power (Harris 1995, p. 43). The zero frequency unit root tests including 12 lags were used to capture seasonal structure.

4.2 Co-integration analysis

Long-run vertical price relationships and reactions to deviations to the long run equilibrium in the Slovenian beef and pork markets are investigated using the multivariate Johansen (1988) ML co-integration approach, which allows testing for the presence of multiple co-integrating vectors and the speed of adjustment parameters. In the long run, we expect the equilibrium price relationships in the form of a co-integrating equilibrium relationship and a co-integrating vector to describe the speed of adjustment toward equilibrium. Co-integration refers to a linear combination of two or more integrated (i.e. difference-stationary) variables, which implies that stochastic trends of variables are linked over time, where there is also a link with the current deviation from the equilibrium relationship.

We use the vector autoregressive error correction model (VECM), which takes the following reduced form:

(8) $$\Delta z_t = \Gamma_1 \Delta z_t + \ldots + \Gamma_{k-1} \Delta z_{t-k+1} + \Pi \tilde{z}_{t-k} + \Theta D_t + \varepsilon_t$$

where z_t is a two-dimensional vector consisting of a retail and a farm-gate price, $z_t = \left(p_{i,t} \quad p_{j,t}\right)'$, $\widetilde{z}_{t-k}$ is defined as $\widetilde{z}_{t-k} = \left(z'_{t-k} \quad 1\right)'$, D_t are centred seasonal dummies, and ε_t is the stochastic term (ε_t are $\text{niid}(0, \Sigma)$). This VECM contains information on both the short- and long-run adjustments to changes in z_t. The estimates of Γ_i provide the short-run and the estimates of Π the long-run parameters. The latter matrix can be written as $\Pi = \alpha\widetilde{\beta}' = \alpha(\beta' \quad \mu)$, where α represents the speed of adjustment to the long-run equilibrium and $\widetilde{\beta}'\widetilde{z}_{t-k}$ is the matrix containing long-run coefficients and represents the co-integrating vectors. According to equation (7) the constant μ is restricted to the co-integration space and represents the constant absolute component of the marketing and processing margin.

The estimation and testing procedure is the following: Estimating the number of co-integration vectors using trace and maximal eigenvalue tests. Tests on residuals are used to determine the lag length of the models (according to the procedure described by Boswijk and Franses, 1992). Weakly exogeneity is tested to find out whether farm gate or retail prices adjust to the long run equilibrium after a price shock. The condition for a variable to be weakly exogenous for the long run parameters is that the alpha (α) vector of the weakly exogenous variable equals zero. If a price variable ($p_{j,t}$) is found to be weakly exogenous, then a partial model is re-estimated:

(9) $$\Delta p_{i,t} = \Gamma_0 \Delta p_{j,t} + \Gamma_1 z_{t-1} + \ldots + \Gamma_{k-1} z_{t-k+1} + \widetilde{\Pi}\widetilde{z}_{t-1} + \Theta D_t + \varepsilon_t \ .$$

It is worth mentioning that the $\widetilde{\Pi}$ does not contain any information on the factor loadings α of the weakly exogenous variable $p_{j,t}$. The re-estimation of equation (8) as partial model shown in equation (9), i.e. conditioning on weakly exogenous variables, is very likely to lead to improved statistical properties of the model (Johansen, 1992).

To test whether beef and pork markets are competitive, we carried out structural tests, i.e. imposing restrictions on the $\widetilde{\beta}$ vector. A market is considered to be competitive, if the long run coefficients of retail and farm gate prices are equal in absolute terms but with opposite signs. This means that we impose the following homogeneity constraint:

(10) $$H_0 : \beta_{p_i} = -\beta_{p_j} \ .$$

The restricted co-integration vector $\widetilde{\beta}^* = H\varphi$ is defined as:

(11) $$\widetilde{\beta}^* = H\varphi = \begin{bmatrix} 1 & 0 \\ -1 & 0 \\ 0 & 1 \end{bmatrix} \varphi \quad , \varphi \ (2x1)$$

where H is the matrix containing homogeneity restrictions and unrestricted parameters and φ is a matrix with unknown parameters. Linear restrictions are tested using a likelihood ratio test.

The co-integration analysis and testing procedures are carried out by use of CATS (Hansen and Juselius, 1995) a program that runs in RATS.

5 Data

Due to problems constructing data series of higher frequency (e.g. weakly) for Slovenia, farm-gate and retail beef and pork prices used in this analysis are monthly observations (January 1990 to August 2000). Farm-gate prices are represented by average purchase prices in Slovene tolars (SIT) per kg of slaughter weight for beef (BF) and pork (PF), while a comparable set of retail prices of beef (BR) and pork (PR) is constructed from prices for meat cuts.[4] Data on nominal prices are deflated using the Slovenian monthly consumer price index (CPI) with the base period in January 1990 to obtain a series of real prices. From this point onwards, whenever the word *price* is used in the paper, it means real prices. The deflation procedure does not cause changes in the farm-to-retail price ratio, and neither does it result in a different price transmission model.[5] Therefore, we assume the absence of money illusion (see e.g. Deaton and Muellbauer, 1980), i.e. inflation does not affect relative price structures. The source of the monthly price and CPI data is the Statistical Office of the Republic of Slovenia (SORS).

Price data analysis showed erratic price movements in the years 1991-1992 (Figure 1). The retail pork prices per kg are higher than the retail beef prices, while the farm-gate beef prices are higher than the farm-gate pork prices.[6] Consequently, the processing and marketing margin in the pork market is greater than in the beef market. Lower farm-gate prices for pork compared to beef can be explained by supply side factors, especially better cost efficiency in the conversion of feed into pork than into beef. Higher pork retail prices compared to beef retail prices can be explained by demand side factors, especially consumer preference for pork in contrast to beef.[7] In general the farm-gate beef and pork prices are more stable than the retail beef and pork prices. The period 1990-1992 includes a shock which followed the secession from the former Yugoslavia, when farm-gate beef and pork prices and retail beef and pork prices sharply increased. Whereas price instability in the pork market was much lower in the period 1994-2000 than in the period 1990-1993, instability at the retail and producer levels in the beef market did not change substantially.

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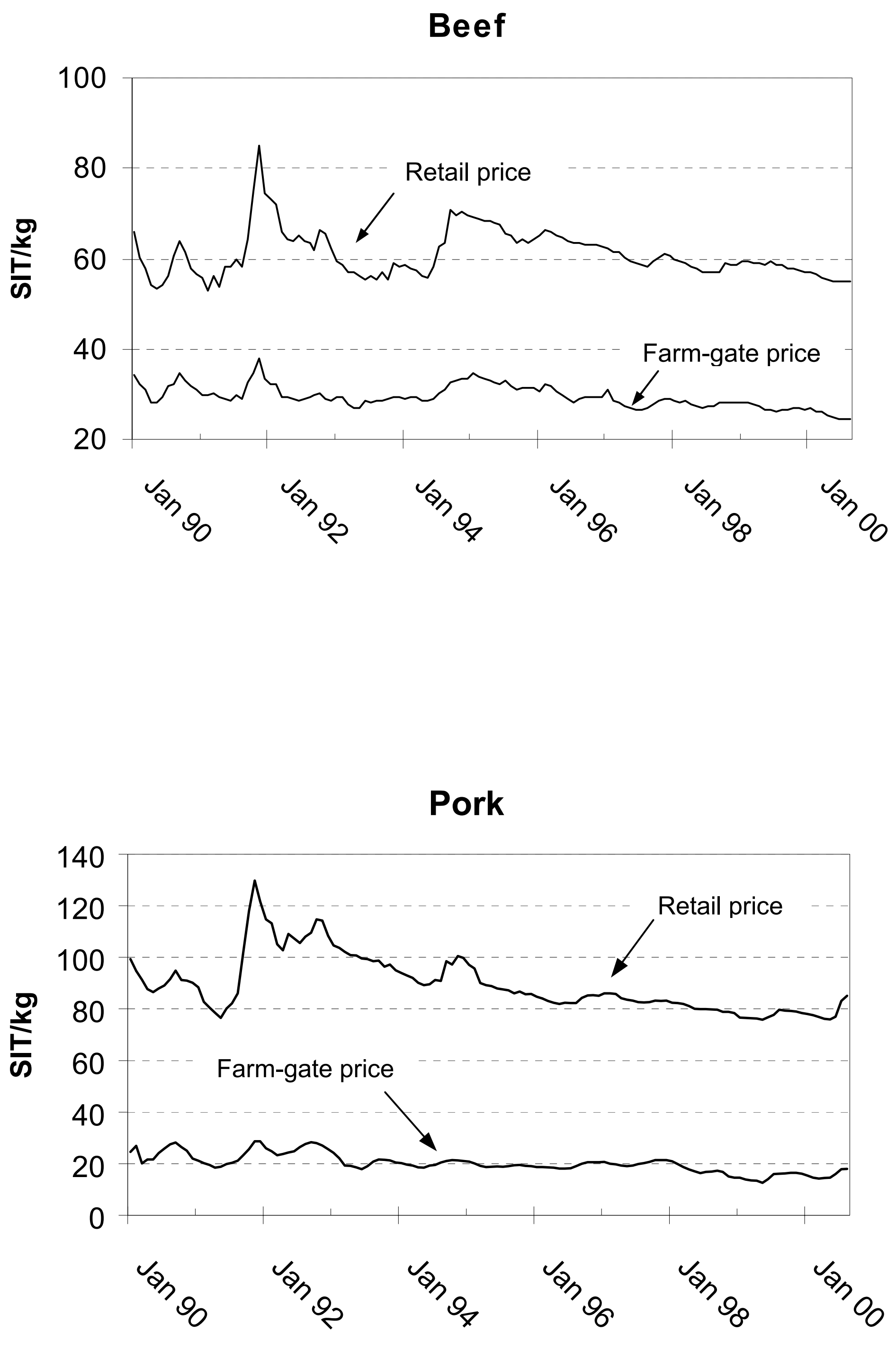
4 The average slaughter conversion factor of a 0.54 for beef and 0.72 for pork were used when converting farm-gate prices from a live weight in a slaughter weight. The retail price of beef (BR) is constructed as the arithmetic average of retail prices for "young boned beef" and "young unboned beef". Therefore, our retail beef price consists of only of fresh meats. The retail price for pork (PR) is constructed as the weighted average of retail prices of "boned pork" (weighted by 0.45), "pork without bones" (0.4), "ham, no fat no skin" (0.05), "smoked bacon" (0.05) and "rolled ham" (0.05). Note that beef and pork are sold in a wide variety of products at the retail level. This is important to note for cross-country and across market comparisons.

5 It is assumed that inflation transmission through the price structure and thus its effect on relative intra-market and inter-market price volatility is equal to zero (i.e. inflation does not distort price structure). Loy and Weaver (1998) modelled the relationship between inflation and relative price volatility for Russian food prices during a time of high inflation and hyperinflation. The anticipated - and to a lesser extent unanticipated - rates of inflation were found to cause price volatility by induced changes in the relative price structure as a result of sticky prices, which differentially transmit inflation between products within a particular market and across markets. However, during the period 1993-2000 the inflation rate in Slovenia was much lower than in Russia, as the annual inflation rate was reduced substantially from 32.3% in 1993, to 19.8% in 1994, to 12.6% in 1995 and to below 10% afterwards.

6 This holds also when only fresh beef and pork prices at the retail level are considered.

7 According to the Slovenian meat market balances, per capita pork consumption was at least 50 percent greater than beef consumption during the 1990s. Between 1992 and 1999, annual per capita meat consumption increased from 77.8 kg in 1992 to 92.3 kg in 1999. The annual per capita beef consumption increased from 22.6 kg in 1992 to 28.3 kg in 1993, but a steady declined afterwards to 22.1 kg in 1999. The annual per capita pork consumption increased from 32.2 kg in 1992 to 41.5 kg in 1999. In 1992, beef (29.1%) and pork (41.4%) represented 70.5% of meat consumption. The share of other meats was 29.5% (22% poultry, 0.2% sheep and goats, 1.3% horse meat, and 6% meat of offal). In 1999, the structure of meat consumption in Slovenia was the following: 69% beef (24%) and pork (45%), and 31% other meats (26.1% poultry, 0.6% sheep and goats, 0.3% horse meat, and 4% meat of offal) (AIS, 2000).

Figure 1. Monthly real meat prices in Slovenia, 1990:1 – 2000:8



Source: Own calculations on the basis of data from the Statistical Office of the Republic of Slovenia.

The slightly lower volatility of the pork margin could indicate more long-term arrangements throughout the pork chain. Higher stability of the farm-gate pork prices after 1993 could be explained by a rather high market share of pigs on large-scale commercial farms, which are likely to have a better and more successful bargaining position with slaughterhouses for delivery of pigs at rather stable prices. Finally, this difference could also be due to differences in government trade and intervention policies, and due to an increase in the volatility of beef retail and farm-gate prices in response to the BSE crisis in some the EU countries.

6 EMPIRICAL ANALYSIS

In this chapter the results of the unit root test, co-integration analysis, weak exogeneity and structural test are presented.

Since the period 1990-93 was influenced by strong shocks, we analysed two periods.[8] First, we estimated the long run price transmission for the total period 1990:1-2000:8 and in a second step, data of the first four years were omitted to avoid that the models are strongly influenced by high volatility in the years 1990-1993. Therefore, we additionally estimated beef and pork models for the period 1994-2000.

Thus, we started with investigating the order in which the four price series are individually integrated. With applying zero frequency ADF unit root tests including 12 lags and the PP test with four truncation lags to the 1990-2000 series we found - on a 0.90 significance level - that (using unit root tests with trend) 7 out of 8 tests indicate the time series to be trend stationary (Table 1). On a 0.95 significance level the two farm-gate prices are seen as I(0), i.e. trend-stationary variables.

Table 1. Results of unit root tests 1990-2000

Tests	BR	BF	PR	PF
ADF test with trend	-2.82*	-1.60	-3.19*	-3.32*
ADF test with constant	-2.38	-0.62	-1.54	-1.39
PP test with trend	-3.17*	-3.47**	-2.86	-3.63**
PP test with constant	-3.13**	-2.78*	-2.30	-2.50

*,** denote a 0.90 and 0.95 significance level, respectively.

Note: To capture seasonal structure the models include 12 additional lags in Augmented-Dickey-Fuller (ADF) test. For the Phillips-Perron (PP) test we applied the Newey-West correction (4 truncation lags). Based on Fuller (1976) critical values on a 0.95 (0.90) significance level for ADF and PP tests with trend are -3.45 (-3.15) and for ADF and PP tests with constant are -2.89 (-2.58).

Applying the same tests to the period 1994-2000 all price series are found to be stationary on a 0.95 significance level (Table 2). Only the series PF is found to be trend-stationary on a 0.90 significance level. Based on this results all four series in the period 1994-2000 are considered as I(1) variables.

[8] We started our analysis with the 1990-2000 period as a whole to empirically clarify whether and how market intervention and break away from traditional markets cause the result? It was revealed that the result is biased due to government intervention in the initial period. So the results for the second subperiod 1994-2000 are presented in more detail, while the result for the 1990-2000 period as a whole is only provided for a certain comparison.

Table 2. Results of unit root tests 1994-2000

Tests	BR	BF	PR	PF
ADF test with trend	-1.76	-2.15	-1.53	-3.42*
ADF test with constant	-0.54	-0.91	-1.66	-2.07
PP test with trend	-2.80	-2.79	-1.73	-2.06
PP test with constant	-1.41	-0.80	-1.71	-1.76

* denotes a 0.90 significance level.

Note: To capture seasonal structure the models include 12 additional lags in Augmented-Dickey-Fuller (ADF) test. For the Phillips-Perron (PP) test we applied the Newey-West correction (3 truncation lags). Based on Fuller (1976) critical values on a 0.95 (0.90) significance level for ADF and PP tests with trend are -3.45 (-3.15) and for ADF and PP tests with constant are -2.89 (-2.58).

Since there is a near equivalence between trend-stationary and difference-stationary processes it is difficult to distinguish between them in finite samples. A crucial problem in applying unit root tests is their tendency to over-reject the null hypothesis when it is true (poor size property) and to under-reject when it is false (poor power property). Thus, it is not possible to state that a variable is stationary or non-stationary, but to state that a certain finite sample exhibits stationary or non-stationary attributes (Harris 1995, p. 47). This was the reason we also applied co-integration analysis to the 1990-2000 period, although the unit root tests for that period suggested most of the variables to be trend-stationary.

The relative number of agents between pork and beef markets do not necessarily imply a stronger probability of finding price transmission in the market with a higher number of agents (the beef market in our case). Namely, price transmission can be influenced by some other factors such as government policies, bargaining and different contractual arrangements. To test vertical price transmission in the beef and pork chains, respectively, the co-integration analysis is carried out within the same vertical meat market chain (i.e., separately for beef and for pork) evaluating the size and relationship between farm-gate price on one side and retail-price on the other.

Results of the co-integration analysis are presented in Tables 3, 4 and 5. Based on the trace statistics, the results of the rank (r) test indicate one co-integrating vector in the beef market in both periods 1990-2000 and 1994-2000 and one in the pork market in the period 1994-2000. In the 1990-2000 pork model no co-integration relationship was found. The test for the unit roots within the multivariate Johansen ML approach suggest that all data series used in our models with one co-integrating vector are non-stationary. This holds also for the beef price series in the 1990-2000 model.

As can be seen from the test results on the residuals the model selection was mainly based on two out of four tests applied.[9] The co-integration vector is presented in a normalised form, in such a way that the first element (retail price BR) of the vector $\tilde{\beta}'$ is set equal to unity. The coefficients of BF and the constant are presented in column 5 and 6 in Table 3.

[9] The models can potentially be improved implementing other unobserved input variables influencing the processing and marketing margin such as labour or energy costs. But these data were not available at the time of calculation.

Table 3. Results of co-integration analysis[10]

Model $P_i - P_j$	Lags	Seasonal dummies	Trace statistics	Normalised β_{p_j}	Normalised Constant	Tests on the residuals LB p-value	LM(1) p-value	LM(4) p-value	Normality p-value
BR-BF *1990-2000*	11	No	23.51 ** 3.79	-1.403	-17.532	0.10	0.73	0.03	0.00
BR-BF *1994-2000*	10	No	25.63 *** 3.25	-1.541	-15.933	0.00	0.55	0.77	0.02
BR-BF[a] *1994-2000*	10	No	-	-1.547	-15.868	0.37	0.61	0.77	0.49
PR-PF *1990-2000*	No co-integration								
PR-PF *1994-2000*	12	Yes	22.20 ** 6.61	-1.234	-58.985	0.00	0.26	0.67	0.00
PR-PF[a] *1994-2000*	12	Yes	-	-1.120	-61.154	0.00	0.49	0.76	0.00

,* denote a 0.95 and 0.99 significance level (trace statistics), respectively.
[a] Partial model.
Note: The beef model is estimated for the periods 1990:1-2000:8 and 1994:1-2000:8, respectively. The pork model is estimated for the periods 1991:1-2008:8 and 1994:8-2000:8, respectively.

Table 4 presents the α parameters for the speed of adjustment of retail and farm-gate prices to the long-run equilibrium. Except in the case of DPF, the α parameter is of the negative sign. As can be seen from the α parameter, retail prices reacted more intensively to unanticipated shocks than farm-gate prices. The responses in the beef market were faster than in the pork market. The greatest magnitude in the α parameter is found in the case of DBR. It ranged between –0.360 and –0.634 suggesting the intensive and significant adjustment in retail beef price to unanticipated shocks away from the long-run equilibrium. The α parameter associated with farm-gate prices are less than with retail prices. Except for the DBF in the 1990-2000 model, the α parameters associated with farm-gate prices were not found as statistically significant.

Table 4. Factor loading matrix

Model	Variable	α	t value
Beef, 1990-2000	DBR	-0.371	-4.610
	DBF	-0.094	-2.826
Beef, 1994-2000	DBR	-0.634	-5.012
	DBF	-0.039	-0.515
Beef, 1994-2000 [a]	DBR	-0.360	-5.105
Pork, 1994-2000, seasonal dummies	DPR	-0.217	-3.320
	DPF	0.035	0.987
Pork, 1994-2000, seasonal dummies [a]	DPR	-0.246	-4.126

[a] Partial model.
Note: The beef model is estimated for the periods 1990:1-2000:8 and 1994:1-2000:8, respectively. The pork model is estimated for the periods 1991:1-2008:8 and 1994:8-2000:8, respectively.

[10] Table reports only the trace test since it shows more robustness to skewness and excess kurtosis in the residuals than the maximal eigenvalue test (Cheung and Lai, 1993).

Based on the estimated coefficients in columns 5 and 6 in Table 3 the long run price relationship (ECT) for beef (1990-2000) can be formulated as:

(12) $ECT = BR - 17.532 - 1.403 * BF$.

As illustrated in equation (12) we cannot determine whether beef price changes were mainly induced by demand or supply side factors (see Table 5). For pork, we did not find any co-integration vector in the period 1990-2000. This suggests an absence of long run price relationship between retail and farm gate price level during the 1990-2000 period as a whole.

The results of the weak exogeneity tests (Table 5) indicate that in the 1994-2000 models the farm-gate prices (BF and PF) are weakly exogenous and the retail prices (BR and PR) react to changes in the farm-gate prices. This means that the price changes were mainly induced by producer side factors as only BR and PR respond to deviations from the long run equilibrium. Due to this, these models were re-estimated as partial models where the farm gate price entered the model as weakly exogenous variable.[11]

The long run price relation between retail and farm gate prices for the period 1994-2000 can be described as:

(13) $BR = 15.868 + 1.547 * BF$

(14) $PR = 61.154 + 1.120 * PF$.

Table 5 Test results for weak exogeneity

Model	Variable	Test	LR statistics	p-value
Beef, 1990-2000	BR	$\alpha_{BR} = 0$	$\chi^2(1) = 15.78$	0.00
	BF	$\alpha_{BF} = 0$	$\chi^2(1) = 6.30$	0.01
Beef, 1994-2000	BR	$\alpha_{BR} = 0$	$\chi^2(1) = 18.37$	0.00
	BF	$\alpha_{BF} = 0$	$\chi^2(1) = 0.23$	0.63
Pork, 1994-2000	PR	$\alpha_{PR} = 0$	$\chi^2(1) = 5.95$	0.01
	PF	$\alpha_{PF} = 0$	$\chi^2(1) = 0.58$	0.44

Note: The beef model is estimated for the periods 1990:1-2000:8 and 1994:1-2000:8, respectively. The pork model is estimated for the period 1991:1-2008:8 and 1994:8-2000:8, respectively.

To test whether markets are competitive or non-competitive structural tests have been carried out. Results are presented in Table 6. As can be seen only in the case of the 1994-2000 pork model the restricted model is not significantly different from the unrestricted model. This means that the margin in the pork model is a constant absolute margin, while the margin in the beef market is a mixture between a constant and a percentage margin. The short 1994-2000 pork model depicts a competitive market while the long 1990-2000 beef model and the short 1994-2000 beef model are identified as a market where additional mark-ups are charged.

[11] As can be seen in Table 3 estimating a partial model usually improves the stochastic properties of the model.

Table 6. Results of the structural test

Model	Test	Coefficients β_{p_i}	Coefficients β_{p_j}	Coefficients constant	Statistics LR	Statistics p-value
Beef, 1990-2000	$\tilde{\beta}^* = \tilde{\beta}$	1	-1	-31.786	$\chi^2(1) = 3.89$	0.05
Beef, 1994-2000	$\tilde{\beta}^* = \tilde{\beta}$	1	-1	-30.780	$\chi^2(1) = 10.93$	0.00
Pork, 1994-2000	$\tilde{\beta}^* = \tilde{\beta}$	1	-1	-63.279	$\chi^2(1) = 0.34$	0.56

Note: The beef model is estimated for the periods 1990:1-2000:8 and 1994:1-2000:8, respectively. The pork model is estimated for the periods 1991:1-2008:8 and 1994:8-2000:8, respectively.

Price transmission in the beef sector in the period 1990-2000 and long run margin equation can be described as:

(15) $\hat{b} = \dfrac{1}{1-b} = 1.403 \quad \Rightarrow \quad b = 0.287$

(16) $\hat{a} = \dfrac{a}{1-b} = 17.532 \quad \Rightarrow \quad a = 12.496$

(17) $\text{Margin}_{\text{Beef}} = 12.496 + 0.287 * \text{BR}$,

which clearly indicates the mark-up processing and marketing margin in the beef sector.

Price transmission in the beef sector in the period 1994-2000 and long run margin equation can be described as:

(18) $\hat{b} = \dfrac{1}{1-b} = 1.547 \quad \Rightarrow \quad b = 0.354$

(19) $\hat{a} = \dfrac{a}{1-b} = 15.868 \quad \Rightarrow \quad a = 10.257$

(20) $\text{Margin}_{\text{Beef}} = 10.257 + 0.354 * \text{BR}$,

which clearly reveals the mark-up processing and marketing margin in the beef sector.

Price transmission in the pork sector in the period 1994-2000 and long run margin equation can be described as:

(21) $\text{Margin}_{\text{Pork}} = 63.279$

(22) $\text{PR} = 63.279 + \text{PF}$,

which indicates a competitive processing and marketing margin in the pork sector.

7 CONCLUSION

One of the most striking finding of our analysis is that protected and regulated/controlled markets may perform as competitive markets, but it is less likely to be an efficient market in terms of the size of the margin. This is revealed by a greater processing and marketing margin for a provided similar quality of marketing service than in more perfectly competitive markets in market economies. The processing and marketing margin in the Slovenian pork market is greater than in the beef market owing to the higher retail pork price compared to the lower retail beef price on the one side, and due to the lower farm-gate pork price compared to the higher farm-gate beef price. The decline of the processing and marketing margin in the pork market indicates an adjustment to more competitive markets.

The results of the vertical price transmission using the multivariate Johansen ML co-integration approach suggest, except for the 1990-2000 pork model, a long-run price relationship in both the beef and pork markets. Co-integration results indicate that there is a long-run vertical price transmission between the farm-gate beef and the retail beef prices in the analysed period 1990-2000 as a whole and also in the pork market in the period 1994-2000. The results of the weak exogeneity tests in the period 1994-2000 identify the farm-gate beef and pork prices as weakly exogenous, while the retail beef and pork prices react to changes in the farm-gate beef and pork prices. Therefore, one could assume that efficiency improvements and lower costs arising from producer side factors were crucial for the retail price changes in the Slovenian meat market.

The structural test imposing the restrictions implied by competition indicates that processors and traders in the beef market charged a mark-up of the retail price for beef plus an absolute constant margin. This indicates the existence of market power in the beef processing and marketing in the long-run. For pork, the empirical results indicate that even in an isolated and ad hoc regulated market the processors and traders charged a constant absolute margin suggesting absence of market power and competitive processing and marketing margin formation. This more smooth input price and margin transmission in the pork processing and marketing chain seem to be due to the rather vertically integrated pork market in Slovenia. Contractual arrangements between farms and slaughterhouses seem to work better in the pork market, where large-scale commercial farms are the main supplier of pigs, while small-scale farms predominantly produce pork for home consumption. Small-scale farms mainly produce cattle, and unlike pork, most of it is marketed to the slaughterhouses. As the processing and marketing margins in the Slovenian meat markets are still much greater than in market economies, further adjustments and restructuring towards more competitive markets are expected with trade liberalisation and meat processing and marketing deregulation.

Our co-integration results clearly suggest that even in a situation of an externally isolated and internally regulated meat markets, as it was the case in Slovenia during the 1990s, the meat market may behave like a competitive market. However, it is less likely that the existent market structures and equilibrium situations which occurred within protectionist trade policies and policy induced transfers prevail in the future. As in some other Central and East European countries (e.g. Hungary and Poland), functioning agricultural and food markets have developed quickly, but further reforms, restructuring, quality and cost efficient measures to reduce farm, processing and marketing inefficiencies in the beef and pork meat chains are required.

7 CONCLUSION

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