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“Global commodity price peaks and governmental interventions: The case of the wheat-to-bread supply chain in Serbia - Who benefited and who lost?”

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“Global commodity price peaks and governmental interventions: The case of the wheat-to-bread supply chain in Serbia - Who benefited and who lost?”

Abstract

We analyze how the governmental market interventions during the commodity price peaks 2007/2008 and 2010/2011 have affected the transmission of price changes along the wheat-to-bread supply chain in Serbia. We aim to investigate if consumers benefitted from the wheat and flour export restrictions, which were supplemented by governmental wheat purchases in the domestic market, or if other members along the supply chain were able to gain advantage. Our analysis of price dynamics between wheat and flour prices within a Markov Switching Vector Error Correction Model suggests that the mills increased their margin and thus profits in the aftermath of the governmental interventions. The simulation of bread production costs makes evident that bakeries and even more retailers profited substantially from the crisis policy. We find that consumers benefitted from the governmental interventions only to a limited degree and experienced overall welfare losses. Compared with laissez-faire policy, the bread price increase was dampened by the governmental market interventions only at the beginning of the crisis. The additional strong bread price increase in April 2008 indirectly resulted from the governmental wheat purchases from the Serbian market.

Keywords: governmental interventions, Markov-Switching Vector Error Correction Model, Serbia, vertical price transmission, wheat-to-bread supply chain

1 Introduction

In recent years significant commodity price increases were observed on world markets which impacted end consumer prices and had severe consequences for poor people, particularly in developing countries. By implementing a wide range of short-run policy measures, many governments of importing as well as exporting countries tried to mitigate the impact of the high global food prices on their local markets. Nevertheless, the outcome was not always as intended. In the case of Serbia, which is studied in this paper, the governmental interventions on the wheat market led to local wheat prices which even exceeded world market prices.

The majority of the worldwide governmental interventions were trade oriented and based on controlling export or import flows of a country's primary commodities (DEMEKE *et al.*, 2011). Even Russia and Ukraine, one of the largest grain producers in the world heavily intervened on their wheat markets during the food crisis (GÖTZ *et al.*, 2010).

Faced with soaring international wheat prices, especially in 2007/2008 and 2010/2011, the Serbian government intensively intervened on wheat, flour and bread markets with the official aim to secure sufficient stocks for domestic utilization and to mitigate the significant increase of bread prices. In 2007/2008 as well as in 2010/2011 the government intervened on wheat market mainly by posing a wheat export ban and an export quota system on the flour market.

In this paper we analyze how prices are transmitted from the farms, via the mills, to the end consumers in the Serbian wheat-to-bread supply chain. We account for the possible impact of the

governmental policy measures implemented on wheat, flour and bread markets in Serbia during the periods of high commodity prices peaks in 2007/2008 and 2010/2011. Our research questions are: How fast and to which extend are wheat price changes transmitted to flour and bread prices? Are increases of the wheat and/or flour prices of major impact for bread prices? We aim to investigate if consumers benefitted from the wheat export restrictions or if other members along the wheat-to-bread supply chain were able to gain advantage. Welfare economic analysis suggests that consumers benefit from an export ban or export quota by the decrease in domestic prices, whereas producers loose from the price decrease.

To the best of our knowledge, the effects of export restrictions on the price transmission along the supply chain have not yet been investigated comprehensively. An exemption is the WORLD BANK (2008) which finds that the margin between milling wheat prices and flour prices rose significantly with the implementation of the wheat export system in Ukraine. VON CRAMON and RAISER (2006) find that flour and feed producers and not consumers gain from the grain export quota in Ukraine.

Our analysis consists of two parts. First we analyze price dynamics between wheat and flour prices within a Markov Switching Vector Error Correction Model (KROLZIG, 1997; BRÜMMER *et al.*, 2009). In addition, we simulate flour production costs and the mills' profits for two scenarios. Since data on bread wholesale prices and retailers' margin are not available, first we estimate bread production costs for different scenarios in order to obtain bread producer price, bread wholesale price and retailers' margin. Later, we simulate the obtained results for the whole observed period in order to identify their development and if the governmental market interventions had any influence. We include the bread production costs based on the world market wheat price as our reference case. Based on our empirical results we identify who benefitted and who lost from the governmental market interventions within the wheat-to-bread supply chain.

The paper is organized as follows. Section 2 describes the chronology of the governmental policy interventions implemented on the wheat, flour and bread markets in Serbia during the global commodity price peaks in 2007/2008 and 2010/2011. Section 3 briefly describes theoretical backgrounds. Section 4 explains the methodology and data used for the empirical analysis. Section 5 contributes to the empirical analysis by providing the simulations of flour and bread production costs and mills' and retailers' profits. Section 6 provides a discussion about who won and who lost from the governmental interventions, and section 7 provides conclusions.

2 Chronology of the governmental policy interventions on the wheat, flour and bread markets

The Serbian government was radically intervening on the wheat and flour markets by numerous ad hoc policy measures through the Ministry of Agriculture, Forestry and Water Management (MAFWM) during the price peaks in 2007/2008 and 2010/2011. The governmental interventions were triggered by rapidly increasing wheat exports and strongly increasing wheat prices on domestic, regional and world markets. The government justified its interventions by the danger to run out of wheat emergency stocks, which would potentially bring Serbia into a wheat importing position, and by high food prices which would negatively affect consumers.

The Serbian government started to intervene on wheat and flour market on August 4, 2007, by introducing quantitative export controls on wheat and other grains (Figure 1, WA¹). The wheat export ban was first announced to last for 3 months until December 2007 (USDA, 2007).

The wheat export ban was triggered by record wheat exports in June and July 2007, which led to a sharp increase in domestic wheat prices by 21 % and the increase in domestic flour prices also. Since export demand for flour increased substantially, flour prices increased even stronger than wheat prices. Therefore, the price difference (margin) between flour and wheat prices even doubled (Figure 1).

Though, a strong increase in domestic wheat prices could be observed again at the end of September caused by increased domestic demand and reduced supply. Demand was increasing due to significant flour export while domestic supply decrease since wheat traders did not involve much on the domestic market expecting the export ban to be lifted. Thus they could export wheat for much higher price than on the domestic market. Since wheat prices reached record levels in October 2007, the Serbian government decided to extend the wheat export ban for another 125 days until March 5, 2008 (WC) on October 26, 2007. Concurrently, a flour export quota of 80,000 t was introduced for the same time period (Figure 1, FA²). The extension of the export ban until June 15, 2008 was decided on February 29, 2008 (WD). In addition, a flour export quota of 20,000 t was issued (FB). Finally, the wheat export ban (WG) and flour export quota system (FC) were removed on June 15, 2008. However, the flour export quota was at no time binding since only 84,461 t was exported from 100,000 t quota (November 2007/May 2008).

Concurrently to the export ban, the Serbian government engaged twice in the purchase of wheat from the domestic market through the Directorate of the Commodity Reserves (DCR). In order to ensure sufficient wheat stocks, the DCR announced the purchase of 60,000 t of wheat on the domestic market. The purchase period was from September 24 until October 3, 2007 (WB). The government again announced the purchase³ of about 50,000 t of wheat at the beginning of March 2008 (WE) when the wheat price reached its highest historical level of 23,000 RSD⁴/t (about 438 U.S. Dollar/t). The purchase period was fixed until March 21, 2008.

Finally, the wheat import tariff of 30 % was abolished in the middle of March 2008 along with the implementation of an import quota of 200,000 t (WF). Import supposed to be realized not later than April 30, 2008. According to the Statistical Office of the Republic of Serbia, there was no wheat import realized during the observed period.

The Serbian government again intervened on the domestic wheat and flour markets at the beginning of 2011. The wheat and flour export ban was introduced on March 17, 2011 by the new agricultural minister who came into office on March 14, 2011. The export ban was announced to last for 90 days for wheat as well as for flour, which was not the case during the 2007/2008 grain export ban (WH and FD). Similar to 2007/2008, the market interventions were justified by the strong increase in wheat exports and high domestic, regional and world wheat prices.

Two weeks later, the government announced the introduction of an export quota for flour of 33,000 t on March 31 (FE) starting from April 1, 2011. As it was the case in 2007/2008, quota

¹ W - wheat market, A – alphabetical order of implemented policy measures.

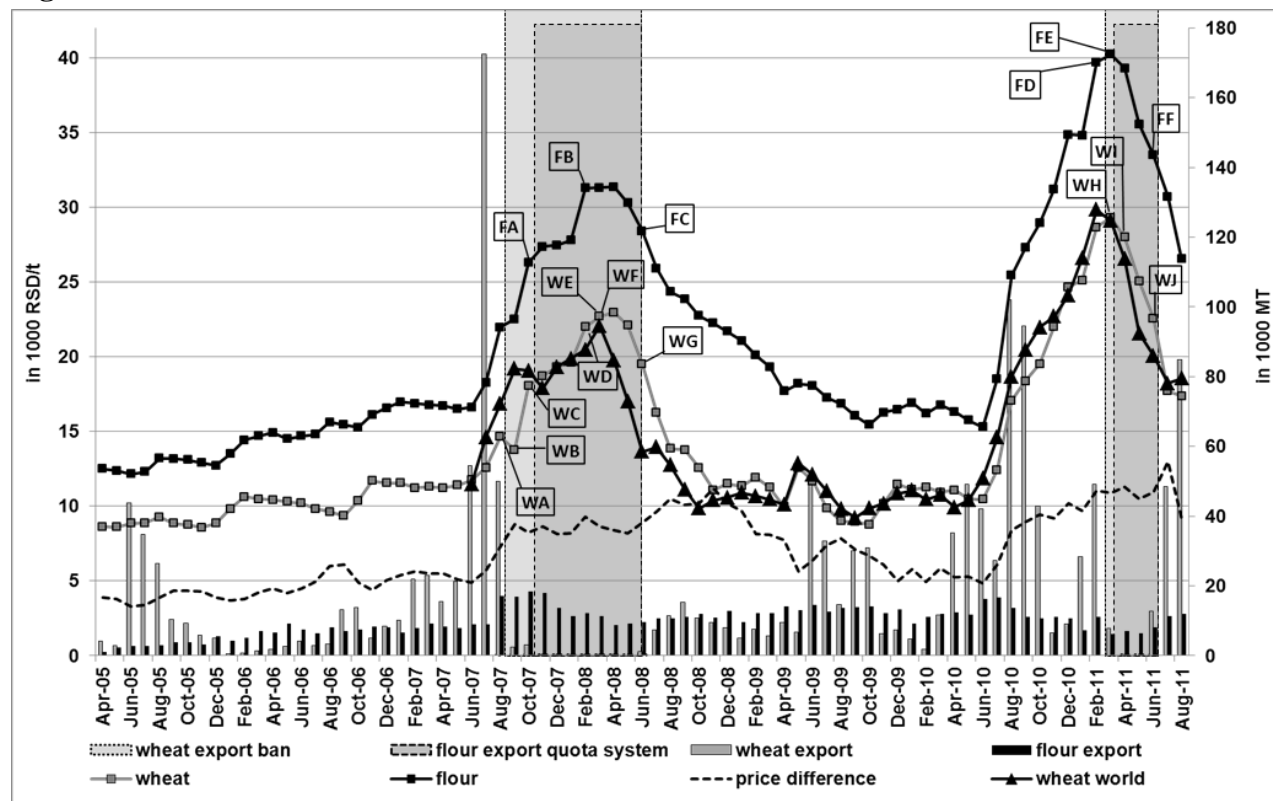
² F – flour market, A – alphabetical order of implemented policy measures.

³ According to experts, wheat traders offered about 40,000 t of wheat to the DCR.

⁴ Republic of Serbia Dinar (Serbian Dinar) – official currency in the Republic of Serbia.

was not binding since 21,378 t of 33,000 t quota was exported (April/Jun 2011). On the same day, a wheat import quota with tariff⁵ exemption of 100,000 t was implemented and supposed to be valid until June 15, 2011 (WI). Though, Serbian flour exporters who had signed contracts with foreign partners before March 16, 2011 were allowed to fulfill their contracts. Finally, the wheat export ban and flour export quota system were cancelled on June 15, 2011 (WJ and FF).

Figure 1: Governmental interventions on wheat and flour markets 2007/2008 and 2011



Source: Serbia's Grain Fund (wheat prices) and GEA Info Center (flour prices), own illustration

Note: Labels in Figure 1 are explained within the text. World market price (Hungary) starts from June 2007.

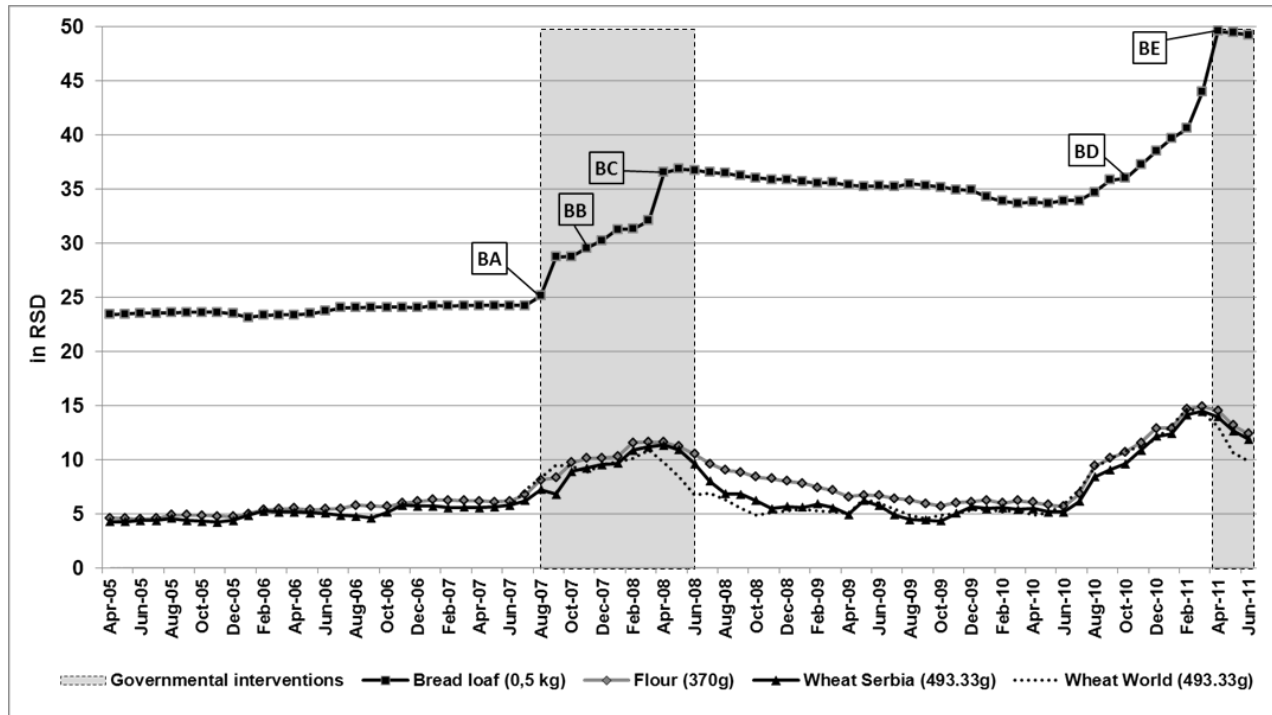
Besides wheat and flour markets, the Serbian government intervened indirectly (2007/2008) and directly (2010/2011) on the bread market. The main reason was the significant increase in bread prices, which bakers were justifying by rapidly increasing wheat and flour prices on the domestic spot market. Bread prices changed three times in 2007/2008. The bread price was first increased at the end of August 2007 as a result of an unofficial agreement between the Ministry of Trade and Services (MTS), Serbian Bakery Union, and the largest representatives of the milling industry of Serbia (Figure 2, BA⁶). Bread prices increased again in the middle of November 2007, justified by bakeries and retailers with increasing wheat and flour spot market prices in the media (BB). The third substantial bread price increase was realized in April 2008, again justified by bakers and retailers with historically high wheat and flour spot market prices (BC). In 2010 the MTS obligated the bread producers to produce at least 40 % of bread (of their total bread

⁵ Under the normal circumstances wheat import tariff is 30%. The level of import tariff varies depending on the different bilateral agreements.

⁶ B – bread market, A – alphabetical order of implemented policy measures.

production) from wheat flour type 500 (BD). Concurrently, the wholesale bread trade margin was fixed to at most 2 % and the retail trade margin to at most 7 %. Thus, the total trade margin, (including bakers' and retailers margin, rebate, cash discounts, etc.) should not exceed 9.14 % of the bread producer price. These measures were prolonged in 2011 and additionally the price of a bread loaf was fixed to 54.22 RSD (BE).

Figure 2: Governmental policy interventions on bread market



Source: Serbia's Grain Fund (wheat prices), GEA Info Center (flour prices), Statistical Office of the Republic of Serbia (bread prices), own illustration

Note: Labels in Figure 2 are explained within the text

To summarize, the Serbian government intervened on the domestic market during the commodity price peak in 2007/2008 by implementing a wheat export ban, twice announcing the significant purchase of wheat from the domestic market, cancelling the wheat import tariff for the quota of 200,000 t, introducing a flour export quota system (which was not binding), and indirectly influencing the price of bread. In 2011 the government first introduced a wheat and flour export ban. Later on, the flour export ban was changed to an export quota system. Concurrently, the government cancelled the wheat import tariff for the quota of 100,000 t. Also, the government directly intervened on the bread market by regulating the bakers' and retailers' margin and fixing the price of bread.

3 Theoretical backgrounds

The wheat and flour export restrictions were implemented in response to strongly increasing world market prices with the aim to increase wheat supply on the domestic market and to dampen the increase in domestic wheat prices.

In order to identify the impact of wheat and flour export restrictions on wheat-to-bread supply chain we conduct our analysis in two parts. The first part of our analysis refers to the vertical price transmission between wheat producer prices and wholesale flour prices. The second part refers to the analysis of welfare effects of the wheat export ban for consumers and producers.

Concerning price transmission, the adjustment of price shocks from wheat producers to flour producers, and vice versa, can give us the insights into the functioning of these markets. The process of price transmission within the wheat-to-bread supply chain in Serbia is of great interest for policy makers especially during the periods of high price peaks, such as in 2007/2008 and 2010/2011, characterized with extremely high commodity prices which are commonly associated as the main cause of the high food prices. The common concern of policy makers is that due to the imperfect price transmission, a price reduction at the producer level (e.g. wheat producers) is not fully transmitted through the supply chain. On the other hand, price increase at the producer level is thought to be passed more quickly on to final consumer (Vavra and Goodwin 2005).

Theoretically, vertical price transmission is characterized by the magnitude, speed, nature and direction of the adjustments through the supply chain to market shocks that are generated at different levels of the supply chain. Magnitude refers to the size of the response at each level of the supply chain caused by the certain size of the shock at another level. It is one of the central concerns when analyzing vertical price transmission. Beside the size of the response speed of adjustment has an important role and it refers to the time lag needed for the price shock from one level of the supply chain to be transmitted (partially or fully) to another level of the supply chain. The speed of the adjustment to the shock mainly depends on the actions taken by the market agents at different levels of the supply chain. If some of constraints are present, the transmission of shocks may take place only with certain time delay or, in the extreme case, they can be completely prohibited. Nature of price transmission refers to the fact if price adjustment is following positive or negative shocks, or in other words if there is symmetrical or asymmetrical price adjustment. Asymmetrical price adjustment can occur in any of vertical price transmission aspects (magnitude, speed and direction). According to Peltzman (2000), asymmetric price transmission is the rule, rather than exception. Further, Mayer and von-Cramon Taubadel (2004) are pointing out the importance of the asymmetric price transmission for the welfare and policy implications, arguing that asymmetric price adjustments can cause that consumers are not benefiting from the reduced prices on the producers' level of the supply chain, or that producers might not benefit from the price increase on the retailers' level of the supply chain. They conclude that distribution of welfare effect across different levels of the supply chain will be altered relative to the case of the asymmetric price transmission. Finally, direction is showing whether the price shock is transmitted upwards or downwards within the supply chain.

Beside the analysis concerning the transmission of price signal through the wheat-to-bread supply chain we also aim to identify the welfare effects of the wheat export ban for consumers and producers. To judge if consumers really benefitted from the wheat export restrictions, or if other

members along the wheat-to-bread supply chain were able to gain advantage, we analyze the laissez-faire policy case without any governmental crisis interventions in comparison.

Figure 3 shows the short-run welfare effects of the wheat export ban implemented in a small wheat exporting country.

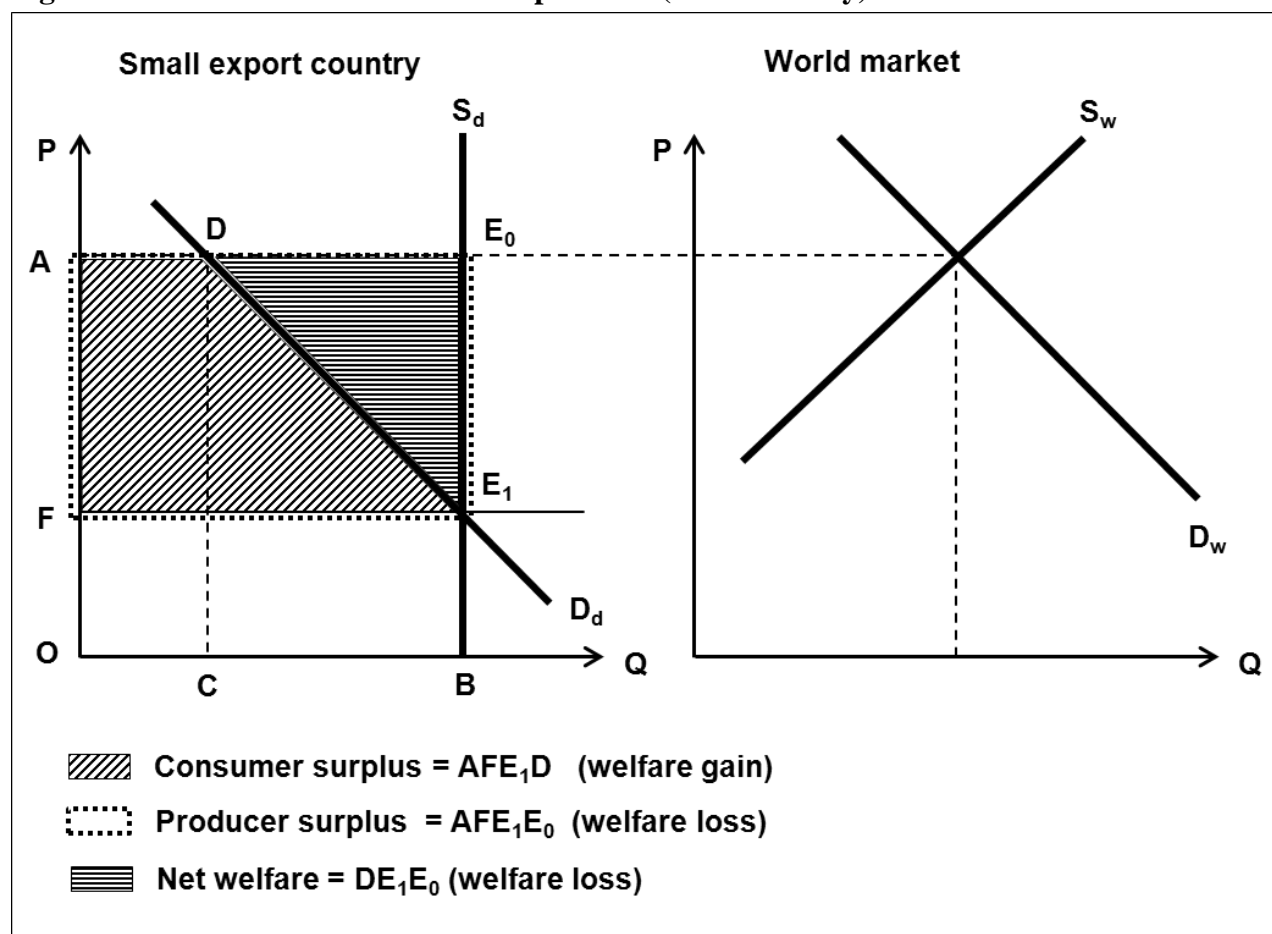
First, we observe the situation in the case of a free trade, meaning that there are no constraints affecting wheat exports from a small exporting country to the world market. In this case we assume that the world wheat market price is determined according to the equilibrium between the world market supply (S_w) and world demand for wheat (D_w), and that domestic wheat supply (S_d) is completely inelastic in the short-run. Thus, E_0 is the point of intersection between the domestic short-run supply curve (S_d) with the world demand curve (D_w). OB represents the quantity of wheat produced domestically. OC is quantity of wheat demanded domestically at the world market price (OA), and CB is amount of wheat exported.

Second, we introduce the case of an export ban. In this case the amount of wheat previously exported to the world market (CB) is shifted to the domestic market. Thus, the domestic wheat price will be reduced. Consequently, the quantity of wheat demanded domestically will increase from OC to OB. Finally, new equilibrium between domestic supply (S_d) and domestic demand (D_d) is reached in E_1 .

Concerning welfare effects, the implementation of the export ban will increase the consumers' surplus (AFE_1D) in the short-run which represents the welfare gain for the consumers. On the contrary, since the domestic wheat price is reduced (from OA to OF), growers need to sell their wheat on the domestic market at a lower price. Due to the domestic price decrease and the forgone exports to the world market at a price exceeding the domestic market price, growers lose from this policy measure in the short-run. This welfare loss is presented by the area AFE_1E_0 . Consequently, since the welfare loss of the producers is greater than the welfare gain of the consumers, the overall net welfare effect of the wheat export ban is negative in the short-run. The net welfare loss is shown as the area DE_1E_0 in Figure 3.

Price decreasing effects on the domestic market can be expected from a flour export quota as well. This supposes that the export quota is binding, meaning that the quota is filled and exports are reduced. However, the flour export quota in Serbia 2007/2008 was not binding, and thus flour exports were actually not restricted.

Figure 3: Short-run welfare effects: export ban (small country)

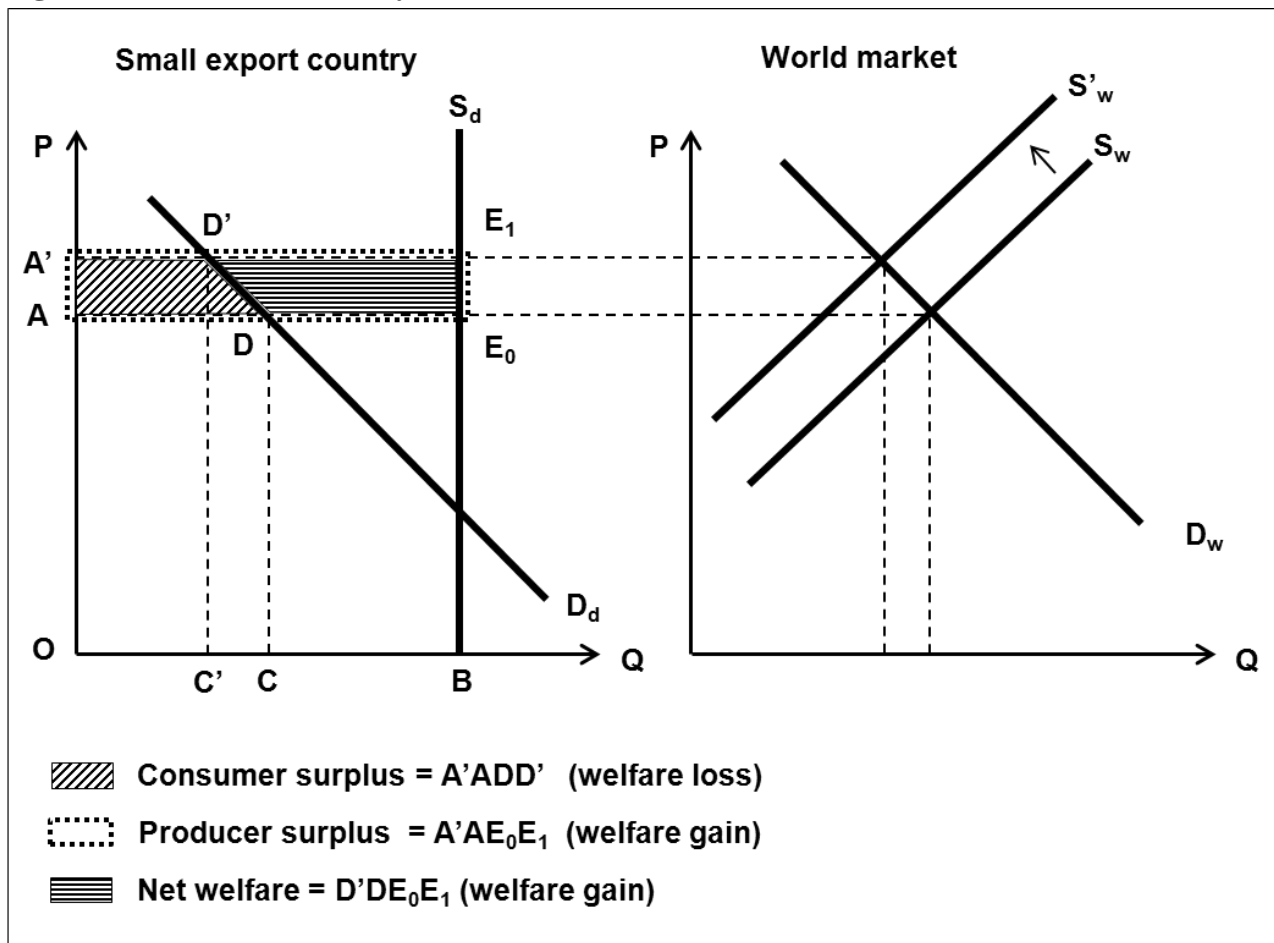


Source: own illustration

For comparison, assume that the Serbian government would not intervene on the market and wheat trade would be fully liberalized (*laissez-faire* policy case). This situation is presented in Figure 4. If we assume that the world wheat supply is reduced, this shock on the market will cause world supply curve (S_w) to shift to the left (S'_w). Consequently, world wheat market price (OA) will increase to the new level (OA').

Given perfectly competitive and efficient markets, the price increase on the world market will be transmitted completely to the domestic wheat market and thus the domestic wheat price would increase to the world market price level. The quantity of wheat demanded on the domestic market will decrease from OC to OC' , whereas producers would increase export from CB to $C'B$. Therefore, Serbian consumers would experience short-run welfare losses ($A'ADD'$), whereas producers would realize welfare benefits ($A'AE_0E_1$). Under the assumption of fully inelastic domestic supply, the overall net welfare will be positive ($D'DE_0E_1$) since the welfare gain of the producers is greater than the welfare loss of the consumers.

Figure 4: Laissez-Faire Policy



Source: own illustration

Summarizing, from theory we can see that the implementation of the wheat export ban has a negative welfare effect for the whole economy in the short-run, although the consumers might benefit due to temporarily reduced prices on the domestic market. In laissez-faire policy case, and under the assumptions of perfectly competitive and efficient markets and completely inelastic domestic supply, full transmission of prices from the world market to domestic market should result with positive net welfare effects for the whole economy. In the case of increasing world market price, welfare gains of the producers will be greater than the welfare loss of the consumers, and vice versa in the case of the reduced world market price.

4 Analysis of price transmission from wheat to flour

We start investigating the transmission of wheat price changes along the wheat-to-bread supply chain in times of comprehensive governmental market interventions by analyzing the transmission of domestic wheat price changes to the flour price.

4.1 Methodology and data

We choose a regime-switching model framework to analyze price transmission. We assume that the price transmission regime might alter due to the manifold changes in wheat and flour market policy, as explained in section 2. Even though the exact dates of the implementation of the policy measures, as e.g. the grain export ban, are known, market participants might react at different points of time. Market actors can change their behavior according to their expectations before the new policy measure is introduced or abolished, or may react with a certain delay. Therefore, we choose a Markov Switching price transmission model which can be applied even when the state of the market changes and several price transmission regimes prevail. It allows distinguishing different price transmission regimes even if the state variable, which governs the regime switches, cannot or can only incompletely be observed.

The Markov-Switching model is tracing back to HAMILTON (1989) who extended the approach of GOLDFELD and QUANDT (1973) about the switching regression model. A characteristic of the Markov-Switching model is that the parameter changes are governed by a Markov Chain. KROLZIG (1997) developed the MSVECM as a special case of the more general Markov-Switching Vector Autoregression Model. The MSVECM is widely used in the analysis of business cycles and financial research. Recently BRÜMMER *et al.* (2009) introduced this model in price transmission analysis.

We choose the unrestricted Markov Switching Vector Error Correction Model as model framework for our price transmission analysis:

$$\Delta p_t^f = \nu(S_t) + \alpha(S_t)p_{t-1}^f + \delta(S_t)p_{t-1}^w + \varepsilon_t \quad (1)$$

where Δ is the first difference operator, p_t^f gives the price of flour, p_t^w represents the price of wheat, ν is the intercept terms, α and δ are the speeds of adjustments, i.e. the speed with which deviations from the long-run equilibrium between flour and wheat prices are corrected by the price adjustments of the flour or wheat prices, respectively. The core element of the MSVECM specification is the state variable $S_t = 1, \dots, M$. This is an unobserved variable indicating which of the M possible regimes governs the MSVECM at time t . Terms $\nu(S_t)$, $\alpha(S_t)$ and $\delta(S_t)$ show the dependence of these parameters on the state variable S_t . The intercept of the long-run equilibrium (β_0) and the long-run price transmission parameter (β_1) are estimated indirectly according to

$$\beta_0 = -\frac{\nu}{\alpha} \quad (2)$$

$$\beta_1 = -\frac{\delta}{\alpha} \quad (3)$$

The basic assumption of the Markov Switching model is that the data generating process underlying the state variable S_t follows a Markov-chain implying that the probability of switching to a new state t only depends on the state of the proceeding period $t-1$ and thus is independent of the regime's history.

The estimation of a MSVECM is based on maximizing the likelihood function with the Expectation-Maximization algorithm developed by DEMPSTER *et al.* (1977). Later, this algorithm was significantly improved by HAMILTON (1990) and KIM (1994). A detailed explanation of the solution algorithm is given by KROLZIG (1997).

In general, the estimation procedure is divided in two steps. First, the parameters characterizing the unobserved state variable and transition probabilities are estimated conditional on the starting values of the coefficients being estimated. In the second step the starting values are updated based on the estimated parameters in the first step within an iterative procedure. The procedure is stopped when the estimated parameters of two consecutive estimations do not differ significantly. The estimation procedure is available in the MSVAR package (KROLZIG, 2006) for the matrix programming language Ox (DOORNIK, 2002).

We use weekly wheat grower prices (milling quality) measured as the F.C.A.⁷ silo selling price, obtained from Serbia's Grain Fund, and weekly F.C.A. wheat flour⁸ mill selling prices as a measure for the flour wholesale price obtained from GEA Info Center (Figure 1). Prices are presented in RSD/t since we are observing vertical price transmission on the Serbian domestic market. For the analysis we use both price pairs in natural logarithms. Our dataset covers 335 observations from April 2005 until August 2011.

4.2 Empirical Results

The empirical analysis is based on a logarithmic transformation of price series. Prior to the co-integration analysis and model estimation we conducted the Augmented Dickey Fuller (ADF) test (DICKEY and FULLER, 1979) and KPSS test (KWIATKOWSKI *et al.*, 1992) in order to identify the order of integration of the price series. For selecting the proper lag length of the of the autoregressive process we used Akaike Information Criterion (AIC) as well as Schwarz Criterion (SC). Both, ADF and KPSS, tests are indicating the presence of a unit root in wheat and flour prices in levels since we could neither reject the null hypothesis of a unit root (ADF-test) or the null hypothesis of level stationarity (KPSS test). Thus, using the first differences of price series both tests provide us with strong evidence of stationarity (Table 1). Hence, both series are found to be integrated of order 1.

Further on we test time series for co-integration. We used Johansen's test (JOHANSEN, 1995) on co-integration, based on a reduced rank regression of the vector autoregressive representation with two lags⁹, suggests that the wheat and flour price series are co-integrated (Table 2) This can be interpreted economically that a long-run equilibrium between the wheat and the flour market exists, and that the markets are integrated. Thus, the preconditions for utilizing a Vector Error Correction Model (VECM) are given.

⁷ F.C.A. – Free Carrier – (named place) – The seller hands over the goods, cleared for export, into the custody of the first carrier (named by the buyer) at the named place (INCOTERMS, 2010).

⁸ Wheat flour type 500 mainly used for bread production.

⁹ Number of lag length is selected according to Schwarz Criterion (SC).

Table 1: Unit root tests

Series	Augmented Dickey-Fuller test			KPSS test		
	Test statistic	Specification	5 % critical value	Test statistic	Specification	5 % critical value
$\ln p_t^f$	-2.1881	10 lags, constant	-2.86	1.3806	10 lags	0.463
$\ln p_t^w$	-1.5517	1 lag, constant		1.0498	10 lags	
$\Delta \ln p_t^f$	-3.7139	9 lags	-1.94	0.1025	10 lags	
$\Delta \ln p_t^w$	-12.1708	1 lag		0.0793	10 lags	

Note: 5 % critical value in KPSS test is the same for levels and first differences

Source: own calculation

Table 2: Co-integration test results

Johansen's co-integration test					
Number of co-integrating vectors		Specification	Rank test	p-value	5 % critical value
H_0	H_1				
0	1	2 lags,	28.83	0.0020	20.16
1	2	constant	2.85	0.6160	9.14

Source: own calculation

We used the following VECM formulation:

$$\Delta p_t = \alpha \beta' p_{t-1} + \sum_{i=1}^{k-1} \Gamma_i \Delta p_{t-i} + \varepsilon_t \quad (4)$$

where p_t represent a vector of prices of products at the different level of the supply chain. Δ donates the first difference operator ($\Delta p_t = p_t - p_{t-1}$). The matrix β contains the coefficients of linear combinations of the prices p_t interpreted as stationary long-run relationships between the prices. Thus, β donates the co-integration vector. Term $\beta' p_{t-1}$ is equal to ect_{t-1} which quantifies the equilibrium errors of each co-integration relationship for each point in time. α donates the matrix containing the rates at which the price differences Δp_t react on the deviations from the long run equilibrium which are quantified by $\beta' p_{t-1}$. Thus α presents the speed of adjustment which means the time lag needed for a shock at one stage of the supply chain to be transmitted (partially or fully) to another stage. Matrices Γ_i contain the short-run reactions of the price differences on past differences and ε_t donates an error term.

The results of VECM estimation are given in Table 3. We conducted the diagnostic tests for the linear VECM by performing Lagrange-multiplier (LM) test for residual autocorrelation and Jarque-Bera test for normal distribution of disturbances. The presence of serial correlation was identified $\chi^2(2)=12.62$ ($p=0.01$), as well as non-normality of disturbances ($p=0.00$). Thus, we checked the system for the stability by using a Chow breakpoint test (CHOW, 1960). The null hypothesis assumes that all parameters in the system remain constant over the entire time period. Contrary, alternative hypothesis assumes that all coefficients except β and residual covariance

matrix change. The bootstrapped procedure¹⁰ was used in order to calculate the empirical ρ -values for different breakpoints¹¹ since the Chow test statistic is asymptotically distributed as χ^2 , whereas the actual distribution under the null hypothesis is non-standard (Brümmer et al., 2009 citing Candelon and Lütkepohl, 2001). The obtained bootstrapped ρ -values are presented in Figure 5. Since some of the ρ -values of the breakpoints lie below 0.05 it indicates that there might be several structural breaks in the linear VECM. Additional to the Chow test we conduct the τ -Test (HANSEN and JOHANSEN, 1999) which is used for testing the stability¹² in the co-integrating vector. The test results are suggesting that the long-run equilibrium relationship is stable throughout the whole time period underlying our analysis (Figure 6).

Table 3: Estimated coefficients of the long-run equilibrium regression (VECM)

Coefficient	Estimated value	t-value	P-value	Standard deviation
Intercept				
β_0	-0.677	-1.223	0.221	0.553
Loading coefficients				
α_{p^f}	-0.070	-3.366	0.001	0.021
α_{p^w}	0.046	1.733	0.083	0.027
Estimated co-integration relation				
β_1	-0.974	-16.698	0.000	0.058
Lagged endogenous terms				
Δp_{t-1}^f	-0.119	-2.145	0.032	0.055
Δp_{t-1}^w	0.166	3.666	0.000	0.045
Δp_{t-2}^f	-0.062	-1.121	0.262	0.055
Δp_{t-2}^w	0.082	1.836	0.066	0.045

Source: own calculation

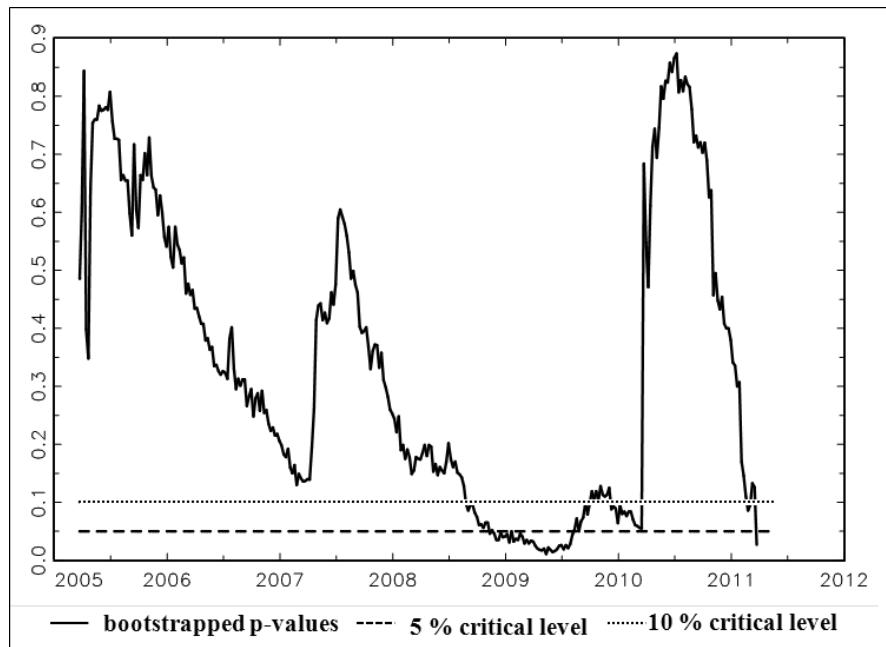
Since all previously described tests are indicating that the linear VECM is not an appropriate representation for our data, we decided to use a regime-switching model framework. Thus, we decided to estimate a MSVECM within an unrestricted framework, which allows not only the short-run price transmission parameters but also the parameters specifying the long-run equilibrium to change during the observed time period.

¹⁰ We account for 1000 bootstrap replications.

¹¹ We used every week as a possible breakpoint.

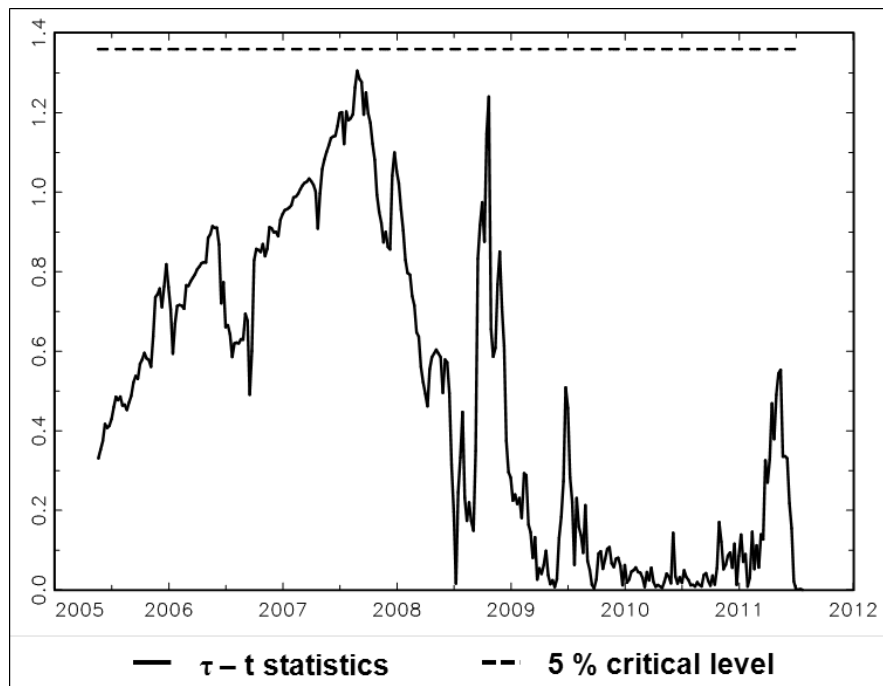
¹² Potential instability could originate from the speed of adjustment α , the slope coefficient β , or both (Brümmer et al., 2009).

Figure 5: Bootstrapped Chow breakpoint tests p -values for the wheat and flour price VECM



Source: Own calculation based on data

Figure 6: Recursive τ -statistic



Source: Own calculation based on data

We select the final specification of the MSVECM according to the Akaike Information Criterion (AIC), Schwarz Criteria (SC) and Hannan and Quinn (HQ) model selection criteria. All three criteria suggest a model with 2 regimes and 2 autoregressive parameters (MS(2)VECM(2)). Our optimal model is of the type MSIAH¹³ which allows all model parameters to switch between the regimes. The model diagnostics indicate that autocorrelation and heteroscedasticity are not present. Nevertheless, non-normality of the residuals prevails.

Our model results are illustrated by Figure 7. It shows the smoothed regime probabilities and indicates the probability of the most likely regime to which one observation is attributed. Our model identifies 2 regimes. We call one regime “normal” regime, and the second regime “market power” regime. Our model is in the “normal” regime with a probability of 84 % during the observed period. The model attributes 278 observations to this regime with an average duration of 15 weeks. In certain periods, the “normal” regime is supplemented by the “market power” regime comprising 54 observations with a regime probability of 16 % and an average duration of almost 3 weeks.

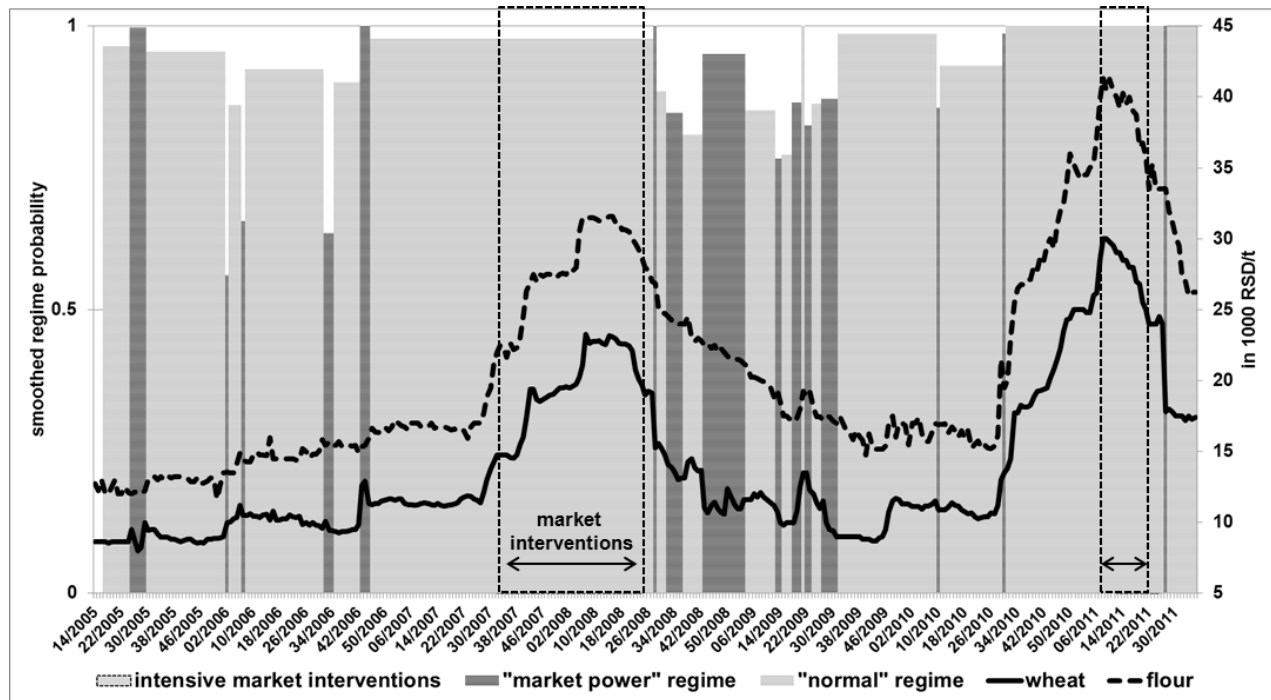
The “normal” regime prevails during the entire time period underlying our analysis and is characterized by an estimated long-run price transmission parameter (elasticity) of flour prices with respect to wheat prices of 0.908 (Table 4). Also, the speed of adjustment in the normal regime is statistically significant and it has the correct negative sign. This suggests that the wheat and flour market are integrated, and that the equilibrium errors are adjusted in the expected direction.

Figure 7 shows that the “normal” regime prevails in times of the intensive governmental interventions in 2007/2008 and 2011. Thus, our results indicate that the governmental market interventions did not affect price transmission between wheat and flour markets.

The estimated long-run price transmission parameter in the “market power” regime is smaller than in the “normal” regime with a long-run price transmission parameter of about 0.6 (Table 4). Also, the speed of adjustment in this regime is not statistically significant indicating that the integration between wheat and flour market is disrupted. The “market power” regime mainly prevails in the aftermath of the commodity price peaks in 2007/2008 as well as 2010/2011, when wheat prices are retrieving back to their pre-crisis level. However, the downstream trend in wheat prices is obviously not transmitted to the flour prices in this regime (Figure 7). We suspect that the dampened transmission of wheat price decreases to flour prices might result from market power exerted by the milling industry. This is also reflected in the regime-specific average ECT term.

¹³ This means that we allow the intercept (I), the short-run price transmission, the autoregressive parameters (A), and the variances/heterogeneity (H) to switch between the regimes.

Figure 7: Regime classification



Source: own illustration based on the model specification

Table 4: Selected parameter estimates of the MS(2)-VECM(2)

Market	Indicator	"normal" regime	"market power" regime
Long-run price transmission	Elasticity (β_1)	0.908 (9 %) ^a	0.598 (40 %) ^a
	Constant (β_0)	1.293	4.142
Equilibrium			
Deviation from equilibrium	Regime specific Avg. ECT	-0.0179	0.1136
Adjust. dynamics	Speed of adjustment	-0.1126*	-0.0181
Stability			
Price fluctuation	Residual standard error	0.0354	0.0115

^a difference from the perfect price transmission ($\beta=1$);

* indicates statistical significance at 1%.

Source: own illustration

5 Simulation of flour and bread production costs and mills' and retailers' profits

Our price transmission analysis suggests that the mills might have increased their profits in the context of the price peaks 2007/2008 and 2010/2011. To further investigate how the mills' profits developed, we estimate flour production costs for different scenarios and compare them to the mills' revenues. In addition, we calculate bread production costs to assess the development of the bakeries' and retailers' profits. The bread production costs are also estimated based on the relevant world market price which serves as our reference case to assess who benefitted and who lost from the crisis policy in section 6.

In proceeding analysis we assume that wheat can be transformed by 78 % to flour (different types and qualities) and by 22 % to other by-products such as fodder flour, bran, grits, etc. We further assume that 2.8 bread loaves of 500 g can be produced out of 1 kg of flour.

5.1 Development of flour production costs and mills' profits

The flour production costs and the mills' profits strongly depend on the flour extraction technology. According to PRPA (2004), more than 30 different flour production technologies are used in Serbia, differing in the type of the extracted flour and the generated by-products. The primary flour types are T-500 and T-400, which are mainly used for the production of bread and confectionary products, respectively. Therefore, our calculations are based on the flour extraction technology which extracts 53 % flour type T 500, 15 % of flour type T 400, 10 % of flour type 850, 20 % of fodder flour and 2 % other by-products. We calculate the revenue of the flour production at each point of time as the sum of the four kinds of extracted flour valued by the respective weekly spot market prices which are retrieved from the GEA Info Center.

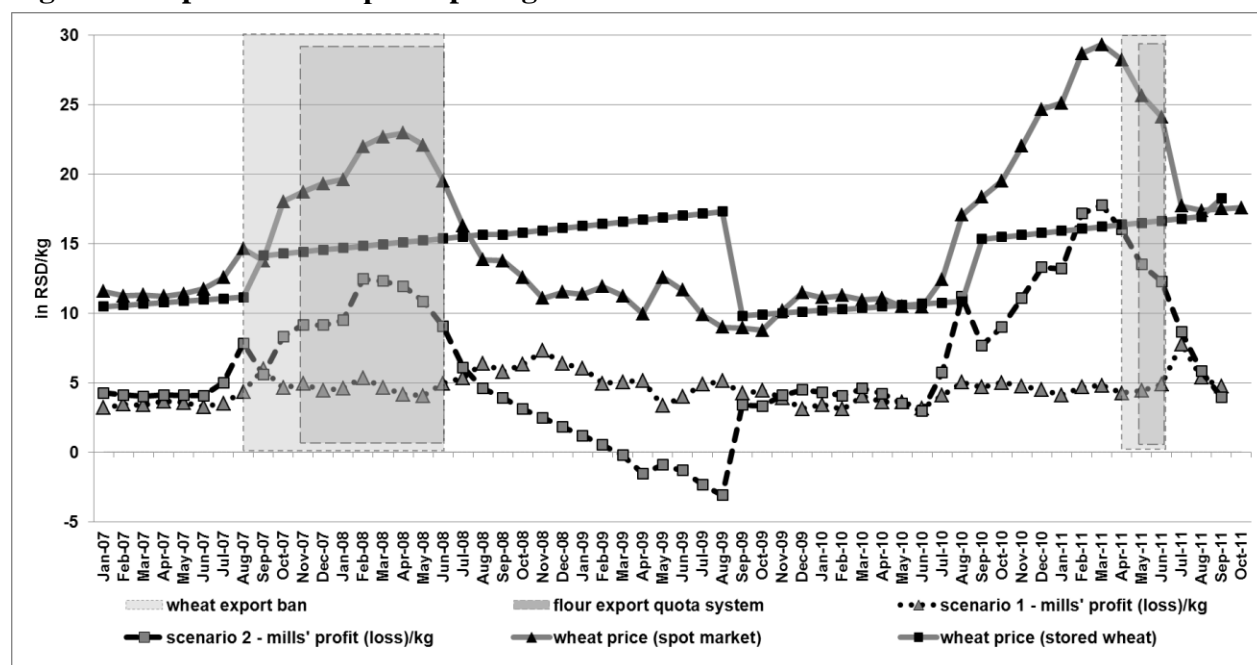
The flour production costs are calculated for two scenarios¹⁴. Scenario 1 refers to mills which do not have access to large silos and continuously buy wheat in the spot market. Thus, the flour production costs are simulated based on the wheat spot market price (Figure 8). This scenario is relevant for the numerous small mills which are dominant in villages in the rural areas of Serbia. Scenario 2 refers to mills which buy wheat only once, mainly during or right after the harvest and store it in silos, mostly owned by the mill itself. Scenario 2 is based on the wheat spot market price prevailing during the previous harvest (July/August) and the relevant wheat storage costs. This scenario refers to large industrial mills in urban areas, particularly in Belgrade. Besides the wheat costs, the simulated flour production costs account for other costs as e.g. electricity and gross wages.

The mills' profit is calculated as the difference between the revenues and the simulated production costs of flour. Figure 8 shows the simulated mills' profits for scenario 1 and 2. It becomes evident that the profits in scenario 2 are substantially higher than in scenario 1 in times of governmental market interventions. Particularly, the mills average profit was up to more than 2 times higher at some points of time during the first crisis period (August 2007 to June 2008), and up to almost 4 times higher during the second crisis period (March 2011 to June 2011). Nevertheless, the mills also experienced some losses from March to August 2009 according to

¹⁴ We did not simulate flour production costs based on the wheat world market price as the reference case since we expect that if world wheat market prices would have prevailed on the domestic market in Serbia, this would have influenced domestic flour prices. To calculate the expected mills' profits for this scenario, flour spot market prices have to be simulated as well. This requires strong assumptions and is therefore of limited informational value.

scenario 2, which is relevant for the majority of the mills in Serbia. Though, our simulations suggest that mills profited overall from the governmental crisis policy.

Figure 8: Expected mills' profit per kg of flour



Source: GEA Info Center and Serbia's Grain Fund, own illustration

5.2 Development of bread production costs, bread end consumer prices and retailers' margin

We simulate the average production costs¹⁵ of one bread loaf (500 g) for three possible scenarios, differing in the underlying flour price. Scenario 1 refers to mainly industrial bread producers which buy wheat during the harvest, have access to silos, and produce flour, which can only be stored for about 4 weeks, in their own mills. In this scenario, flour is produced from stored wheat according to the bakery's production plan. Therefore, additional monthly wheat storage costs (September 2007 until August 2008) are added to the wheat spot market price prevailing during harvest of the particular marketing year, respectively.

Scenario 2 is a hypothetical scenario based on a bread production cost structure as given in scenario 1. However, we assume that flour is produced from the actual wheat spot market price. We estimate this scenario since large bakeries in Serbia generally justify bread price increases, particularly those in August 2007 and April 2008, by increases in the wheat spot market price.

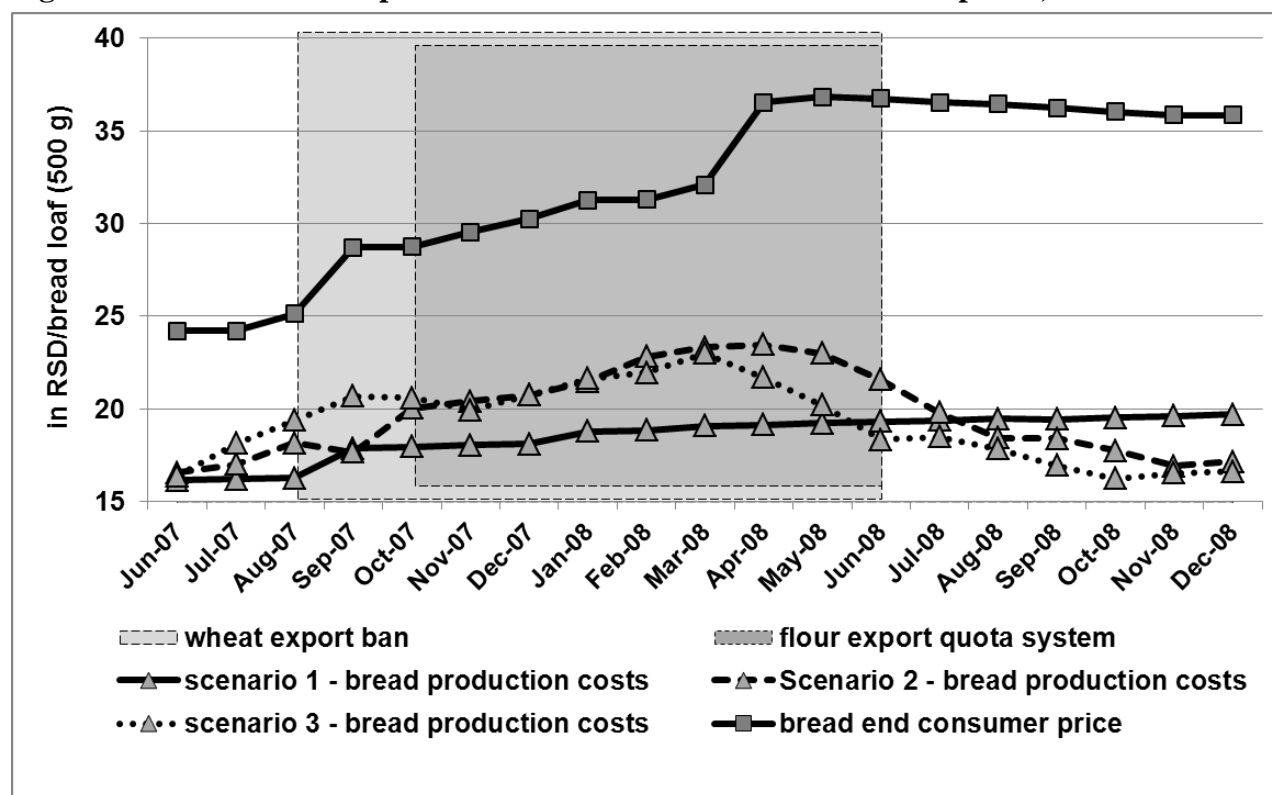
Scenario 3 is a hypothetical scenario for the average bread production costs which is based on the world wheat market price. We choose the Hungarian wheat market price as the relevant world market price since Hungary is the dominant wheat exporter in the region. Hungary did not intervene on the wheat market during the observed period. This scenario serves as our reference

¹⁵ This calculation is based on the assumption that the production of one bread loaf (500g) required 370 g of flour as input. We also account for the costs of energy, wages and other specific costs. Further details are available from the authors upon request.

case representing bread production costs in the laissez-faire policy case, thus without any policy interventions in the wheat and flour market.

Figure 9 shows that the bread production costs in scenario 1, which represent the “actual” production costs, are significantly lower than the “pretended” production costs given by scenario 2 during the whole time period of governmental interventions. Even, bread production costs of large bakeries with own silos are influenced by wheat price increases on the domestic as well as the world market (scenario 3) only during harvest times. Thus, in contrast to the bakeries’ argumentation, the bread production costs of bakeries with own silos and mills were not at all affected by the wheat price changes on the Serbian spot market (September 2007/June 2008).

Figure 9: Simulated bread production costs and end consumer bread prices, 2007/2008



Source: Own calculations, Zitovojvodina and Serbia’s Grain Fund, own illustration.

Additionally, we simulate the distributable surplus (potential profit) of bakers and retailers for the three possible scenarios. Figure 10 shows the average achievable margin¹⁶ in all three scenarios with corresponding baker’s loss¹⁷ and distributable surplus¹⁸. The results are showing that bakers were making loss, in average, during the period of significant wheat and flour price increase

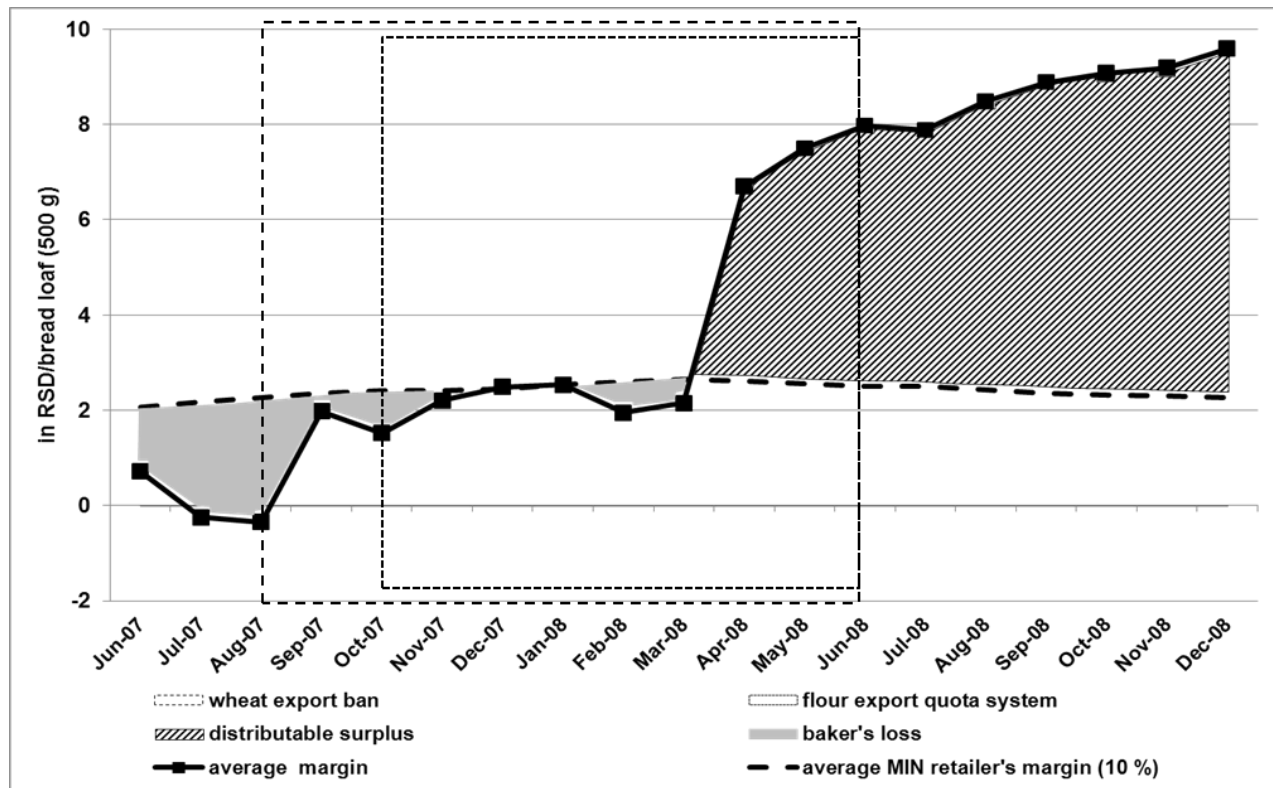
¹⁶ Margin is calculated as the difference between the end consumer bread price (reduced by the value added tax) and the estimated wholesale bread price.

¹⁷ According to experts, minimum retailer’s margin is about 10 %. Thus, if the calculated margin is below the value of 10 %, than bakers are bearing this loss.

¹⁸ Distributable surplus refers to the possible profit made from selling one bread loaf. According to experts this value is distributed between retailer and baker. Though, baker’s margin usually is not higher than 6 % of the end consumer bread price. Thus, the biggest part of the distributable surplus is gained by retailer.

(before the governmental interventions). According to experts, by producing the so called “social” bread, bakers were always at the edge of the profitability. Thought, potential loss on this type of bread was covered by the profit on other bakery products. After the governmental interventions and two significant bread price increases (August and November 2007), bakers improved their situation. After the bread price increase in April 2008, bakers were able to achieve significant profit. According to experts, retailers were always making profit out of selling bread. The minimum retailers’ margin is about 10 % of the bread wholesale price. Thus, after the bread price increase in April 2008 retailers were able to increase their margin and achieve up to four times higher profit.

Figure 10: Simulated retailer’s margin



Source: own calculation

6 Discussion - who benefitted who lost?

Welfare analytical considerations suggest that consumers benefit from an export ban in response to large increases of world market prices as observed during 2007/2008 and 2010/2011. In particular, consumers experience welfare gains from this policy measure. In contrast, theory suggests that consumers lose welfare if a world market price increase is fully transmitted to the domestic market in the case of a laissez-faire policy. This hypothesis was tested by analyzing how prices developed at different stages of the wheat to bread supply chain. Besides, we simulated flour and bread production costs, bread end consumer prices and profits of the mills, bakeries and retailers for different scenarios. We assess if consumers really benefitted from this

policy intervention and how the welfare gains/profits were distributed along the wheat-to bread supply chain.

The wheat to flour price transmission analysis made evident that the mills increased their margin in the aftermath of the food crisis, after the governmental market measures were lifted in 2008 as well as in 2011. Our analysis of the development of the flour production costs show that the margin increase cannot be justified by an increase of flour production costs. Furthermore, the analysis of the flour production costs and the mill's margin shows that the mills with own wheat storage capacities increased their profits even during the crisis when the wheat export ban and the flour export quota system were effective. In contrast, the mills which had to buy wheat from the wheat spot market could not profit from this situation. Thus, although the mills experienced some losses at some points of time, the small and large mills could both benefit overall from the governmental market interventions during the food crisis.

The bread production costs simulations in the 3 scenarios show that the big industrial bread producers (scenario 1) were affected by the significant wheat and flour price increases on the spot market only during the harvest in July and August. However the export restrictions for wheat and flour were implemented in the aftermath of the harvest 2007. Nevertheless, the bakeries (together with the retailers) were successful in increasing the end consumer price wrongful justified by the increases in the wheat and flour spot market prices. Without the governmental market interventions and thus with world market prices prevailing on the Serbian spot market, the bakeries (and retailers) would not have been able to realize particularly the second dramatic bread price increase in April 2008. Thus, the large bakeries and retailers profited substantially from the export restrictions on wheat and flour.

According to the results from the previously described analysis we can say that, in general, consumers did benefit from the governmental interventions only to a limited degree. The main reason is that bread prices rose significantly during the food crisis. Our results suggest that compared with laissez-faire policy, the bread price increase was dampened by the governmental market interventions only at the beginning of the crisis (August and September 2007), when the Serbian wheat spot market price was lower than the world wheat market price due to the wheat and flour export restrictions. However, it induced an additional bread price increase in April 2008 due to the dramatic increase in the wheat spot market price beyond the world market price caused by the governmental wheat purchase from the Serbian market. Overall, our results suggest that the consumers experienced welfare losses from the governmental crisis policy. Consumers which also pay taxes to the Serbian government had to cover the costs of the governmental purchase on the Serbian wheat market as well.

Thus, our results do not confirm the hypothesis that consumers benefit from the export ban and achieve welfare gains. In contrast consumers experience welfare losses from the wheat export ban during the world market price peaks 2007/2008 and 2011. We see the main reasons in policy failure and in the (temporary) change of market behavior of major actors along the wheat-to-bread supply chain. In particular, the Serbian wheat price increased at some points of time even stronger than the world market price which we trace back to the two governmental wheat purchases on the domestic market and in keeping up the import barriers for wheat too long. Also, wheat warehousing had a price increasing effect on the domestic wheat price. Besides, price changes were transmitted along the wheat-to-bread supply chain at differing speeds by using

market power by the mills and building upon market in transparency, which was increased by the governmental market interventions, and incomplete information by bakeries and retailers.

7 Conclusions

In this paper we analyze vertical price transmission within the wheat-to-bread supply chain in Serbia. The special focus of our research is on the periods of global commodity price peaks in 2007/2008 and 2010/2011.

During the observed period the Serbian government was directly and very intensively intervening on wheat and flour markets, which was mainly justified by the ability to assure normal domestic supply and to mitigate the increase in bread prices which were affecting consumers. Interventions on bread market were rather indirect until 2011 when the government introduced fixed prices of the most commonly consumed type of bread.

We used the Markov Switching Vector Error Correction Model with 2 regimes and 2 lags included in order to identify the price transmission between wheat and flour prices. Our results suggest that price transmission was significantly reduced and integration between wheat and flour markets was disrupted during the second regime which we called “market power” regime. This regime was appearing right after the cancellation of market interventions in June 2008 and June 2011. We observed that during this regime flour prices were not adjusted to very volatile wheat prices and that milling industry might use its market power to keep high margin for several months.

Also, our results suggest that significant price peaks in wheat and flour prices were mainly used as an excuse of baking industry to correct bread prices upwards. We observed that big industrial bread producers improved their situation in the aftermath of the bread price increase and that they manage to start gaining profit out of producing “social” bread for the first time in last couple of years. Increase in profit appeared after the wheat and flour prices started to record significant downstream trend which was not followed by the decrease of bread prices. The main arguments of baking industry were switched from wheat and flour to the other production costs such as electricity, fuel, wages, etc.

Overall, our results suggest that consumers benefited from the governmental interventions only in the first two weeks. Nevertheless, they experienced the biggest welfare loss compared to the other participants in the supply chain in the long-run.

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