Studies on the Agricultural and Food Sector in Transition Economies

Ivan Djuric

Impact of policy measures on wheat-to-bread supply chain during the global commodity price peaks

The case of Serbia

Leibniz Institute of Agricultural Development
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Abstract

The aim of this study is to analyze the impact of governmental market interventions in Serbia, among them a wheat export ban, on the country's integration into the international wheat market and the domestic wheat-to-bread supply chain during the global commodity price peaks in 2007/08 and 2010/11. By applying two regime-dependent price transmission models (i.e. Markov-switching models), we help to clarify the impact of the governmental market interventions on two different price transmission contexts: the horizontal one, where we analyze the price transmission and market integration between the Serbian and the world wheat markets; and the vertical one, where we analyze the price transmission mechanisms within the Serbian wheat-to-bread supply chain. Furthermore, we conducted simulations of flour and bread production costs and the bakers' and retailers' profits in order to identify who benefited from and who lost due to the extensive governmental interventions.

The empirical results of our first price transmission model are based on the weekly wheat grower prices in Serbia and the free on board (FOB) wheat prices in France (Rouen), which are used as a measure of the world wheat price. The data covers a period from January 2005 until November 2009. In our second price transmission model, we use weekly wheat grower prices and weekly flour prices in Serbia covering the period from April 2005 until August 2011. For additional simulations, we use the monthly spot market prices for different flour types and monthly retail bread prices from April 2005 until October 2011.

First, we analyze the impact of governmental policy interventions, especially the wheat export ban, on the Serbian wheat market and its integration with the world market within the spatial price transmission model. Our results suggest that inconsistent policy measures and their faulty sequence counteracted the expected price-dampening effects of the export ban. The market equilibrium was disrupted and market instability increased, particularly after the cancellation of the export ban.

Second, we conduct the vertical price transmission analysis to identify the impact of the policy interventions on price dynamics along the wheat-to-bread supply chain in Serbia. Our results suggest that both small and large industrial mills increased their margins, and thus profits during and especially in the aftermath of the market interventions.

Third, we simulate the bread producer price, the bread wholesale price and the distributable bread margin in order to identify whether the significant wheat and flour price increases during the observed period were the main driving factors for the increase in retail bread prices. Our results indicate that large bread producers and retailers used the extensive governmental interventions to increase the price of bread, which was wrongly justified by the increase of wheat and flour spot market prices. Thus, our results suggest that the large bread producers and retailers profited even more substantially from the crisis policies.

Fourth, considering the obtained results from each level of the supply chain and taking into account the consumers' expenditures for food (especially for bread consumption), we analyze whether the consumers benefited from the governmental interventions. Contrary to expectations, our results indicate that the consumers bore the largest burden during the period of the governmental interventions by being confronted with increasing bread prices.

Finally, the obtained empirical results allowed us to identify alternative policy measures that the Serbian government could use in a possible future crisis. Accounting for the theoretical welfare considerations and plausible policy options, we argue that the Serbian government should concentrate mainly on the most vulnerable consumers by strengthening existing safety nets. In addition, trade liberalization (e.g. cancellation of the wheat import tariff) should be the first, best option, rather than export restrictions (i.e. an export ban as in 2007/08 and 2011).

ZUSAMMENFASSUNG

Das Ziel dieser Studie ist es, die Auswirkungen der Marktinterventionen der serbischen Regierung während der Agrarpreisspitzen 2007/8 und 2010/11, darunter ein Weizenexportverbot, auf die serbische internationale Weizenmarktintegration und die heimische Weizen-Brot-Wertschöpfungskette zu analysieren. Durch die Anwendung zweier regime-dependenter Preistransmissionsmodelle (z.B. Markov-Modelle), helfen wir, die Auswirkungen der Marktinterventionen auf zwei verschiedene Preistransmissionskontexte zu verstehen: Den horizontalen, wo wir die Preistransmission und die Marktintegration zwischen dem serbischen und den globalen Weizenmärkten untersuchen, und die vertikale Preistransmission, wo wir die Preistransmissionsmechanismen innerhalb der serbischen Weizen-Brot-Wertschöpfungskette analysieren. Darüber hinaus unternehmen wir Simulationen der Produktionskosten von Mehl und Brot sowie der Gewinne der Bäcker und Einzelhändler, um zu identifizieren, wer von den extensiven politischen Interventionen profitierte und wer darunter litt.

Die empirischen Ergebnisse unseres ersten Preistransmissionsmodells basieren auf den wöchentlichen Weizenanbaupreisen in Serbien und den Weizenpreisen frei Schiff (FOB) in Frankreich (Rouen) als Maß für den globalen Weizenpreis. Die Daten decken die Zeit von Januar 2005 bis November 2009 ab. In unserem zweiten Preistransmissionsmodell benutzen wir die wöchentlichen Weizenanbaupreise und die wöchentlichen Mehlpreise in Serbien in der Zeit zwischen April 2005 und August 2011. Für weitere Simulationen nutzen wir die monatlichen Spotmarktpreise für verschiedene Mehlsorten und die monatlichen Brotpreise des Einzelhandels in der Zeit zwischen April 2005 und Oktober 2011.

Zuerst analysieren wir die Effekte der politischen Interventionen, insbesondere des Weizenexportverbots, auf den heimischen Weizenmarkt und seine Integration mit dem Weltmarkt innerhalb des räumlichen Preistransmissionsmodells. Unsere Ergebnisse deuten an, dass die inkonsistenten politischen Maßnahmen und ihre mangelhafte Reihenfolge den erwarteten preissenkenden Effekten entgegen wirkten. Das Marktgleichgewicht wurde gestört und die Marktinstabilität stieg insbesondere nach dem Aufheben des Exportverbots.

An zweiter Stelle führen wir die vertikale Preistransmissionsanalyse durch, um die Auswirkungen der politischen Maßnahmen auf Preisdynamiken entlang der serbischen Weizen-Brot-Wertschöpfungskette zu identifizieren. Unsere Ergebnisse zeigen, dass sowohl kleine als auch große industrielle Mühlen ihre Gewinnmarge und so auch ihre Profite steigerten, sowohl während als auch insbesondere in der Folgezeit der Marktinterventionen.

Drittens simulieren wir den Erzeugerpreis und den Großhandelspreis für Brot und die verfügbare Brotmarge, um heraus zu finden, ob die signifikanten Preisanstiege von Weizen und Mehl in der untersuchten Periode die wichtigsten Faktoren für den Anstieg des Brotpreises für die Endverbraucher waren. Unsere Ergebnisse weisen darauf hin, dass große Brotproduzenten und Einzelhändler die Situation der extensiven staatlichen Interventionen ausnutzten, um den Brotpreis zu erhöhen, fälschlicherweise gerechtfertigt durch den Anstieg der Spotmarktpreise von Weizen und Mehl. Demnach zeigen unsere Ergebnisse, dass große Brotproduzenten, und Einzelhändler sogar in stärkerem Maße, von der Krisenpolitik profitierten.

An vierter Stelle berücksichtigen wir die Ergebnisse jedes Levels der Wertschöpfungskette und die Lebensmittelausgaben der Konsumenten (insbesondere für Brot) und analysieren, ob die Konsumenten von den staatlichen Interventionen profitierten. Entgegen der Erwartungen zeigen unsere Ergebnisse, dass die Konsumenten in der Zeit der staatlichen Eingriffe durch die steigenden Brotpreise die größte Last trugen.

Schließlich ermöglichen uns die empirischen Ergebnisse, alternative politische Maßnahmen zu identifizieren, die die serbische Regierung in einer möglichen zukünftigen Krise einsetzen könnte. Unter Einbezug der theoretischen Wohlfahrtsüberlegungen und plausiblen Politik-Optionen argumentieren wir, dass die serbische Regierung sich hauptsächlich auf die am meisten gefährdeten Konsumenten konzentrieren sollte, indem sie die existierenden Sicherheitsnetze/Sicherheitsmechanismen verstärken. Außerdem sollten Exportrestriktionen (z.B. Ausfuhrverbote) nicht die erstbeste politische Strategie sein (wie 2007/8 und 2011), sondern eher eine Handelsliberalisierung.

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Abbreviations

ADF	Augmented Dickey-Fuller test
AERS	Energy agency of the Republic of Serbia
AIC	Akaike Information Criterion
CAP	Common Agricultural Policy
CEFTA	Central European Free Trade Agreement
CIS	Commonwealth of Independent States
DCR	Directorate of Commodity Reserves
EU	European Union
EUROSTAT	Statistical Office of the European Union
EXW	ex works
FAO	Food and Agriculture Organization of the United Nations
FCA	free carrier named place
FOB	free on board
FOR	free on rail
GDP	Gross Domestic Product
GTIS	Global Trade Information System
HACCP	Hazard Analysis and Critical Control Points
HGCA	Agriculture Development Board (United Kingdom)
HQ	Hannan, Quinn criterion
IGC	International Grain Council
KPSS	Kwiatkowski-Phillips-Schmidt-Shin test
LM	Lagrange-Multiplier
LOP	Law of One Price
MAFWM	Ministry of Agriculture, Forestry and Water Management
MATFWM	Ministry of Agriculture, Trade, Forestry and Water Management
MFN	Most Favored Nation
MSECM	Markov-switching error-correction model
MSVECM	Markov-switching vector error-correction model
MTS	Ministry of Trade and Services
OLS	Ordinary Least Squares
PWHS	Public Warehouse System
RSAR	regime-switching autoregressive process
RSD	Republic of Serbia Dinar
RSVECM	regime-switching vector error-correction model
SBU	Serbian Bakery Union
SC	Schwartz Criterion

SORS	Statistical Office of the Republic of Serbia
STVECM	smooth transition vector error-correction model
TVECM	threshold vector error-correction model
U.S.	United States of America
USDA	United States Department of Agriculture
VAT	Value Added Tax
VECM	vector error-correction model
WHR	Warehouse Receipt
WTO	World Trade Organization

1 Introduction

The world market prices of agricultural commodities have risen dramatically in recent years, leading to global commodity price peaks in both 2007/08 and 2010/11. The dramatic price changes increased food prices for consumers and caused severe consequences for the poor, particularly in developing countries (Headey, 2011; Tiwari and Zaman, 2010; de Hoyos and Medvedev, 2009). This situation forced numerous governments to coordinate their policy actions on national and international levels in order to address domestic food availability and food security concerns.

The majority of the world wide governmental interventions was trade-oriented and based on controlling the export or import flows of a country's primary commodities (Demeke et al., 2011). Several net exporting countries implemented some kind of export restriction (e.g. export bans, export taxes, or export quotas) in order to secure a sufficient domestic supply. Some of the world's largest wheat exporters, such as Russia and Ukraine, heavily intervened on their wheat markets. The Russian government, for example, imposed an export tax in 2007/08 and an export ban in 2010/11, while the Ukrainian government's strategy was to control wheat exports by imposing an export quota in both 2006/08 and 2010/11 (Götz et al., 2013; Welton, 2011). In addition to the large wheat exporters, small wheat exporting countries like Serbia also restricted their exports. The Serbian government intended to dampen the transmission of rapidly increasing wheat prices on the world market, to inhibit extensive wheat exports in order to secure a sufficient supply on the domestic market, and to protect consumers from high food prices. This aim was followed by the implementation of a wheat export ban combined with a wheat flour export quota (both in 2007/08 and 2010/11), several governmental purchases of wheat on the domestic market (in 2007/08), and the removal of the wheat import tariff for a certain import quota (in both periods). Nevertheless, the local wheat prices even exceeded world wheat prices during the observed period of governmental interventions. Consequently, all other wheat-related products experienced a significant price increase.

Concerning the frequency of their implementation, export restrictions have received considerable attention in the literature. The majority of the studies recognize them as one of the most important factors influencing the global commodity price peaks (Martin and Anderson, 2012; Abott, 2012; Baffes and Haniotis, 2010; Bouët and Laborde, 2010; Von Braun and Torero, 2008). However, the effects of the export restrictions on the price transmission along the supply chain have not yet been investigated comprehensively, with the exception of several studies[1].

1 See chapter 3, section 3.1.5.

The main objective of this study is to identify the impact of Serbia's crisis policies on the domestic wheat market and the wheat-to-bread supply chain during the global commodity price peaks in 2007/08 and 2010/11. We selected the wheat-to-bread supply chain because it represents one of Serbia's most important strategic agricultural sectors. Besides corn, wheat is one of the most exported agricultural products, and it also represents the basis for both the feed industry and cattle production. Furthermore, it is the basis for the milling industry, which in turn impacts the bread production and food processing industry. Thus, substantial fluctuations of wheat prices, together with inadequate or wrongly sequenced policy measures, could have a significant impact on the entire agricultural and food processing sector, and particularly on high food prices for end consumers.

The expectations derived from the theoretical welfare effects of the export ban suggest that consumers should benefit in the short run (see section 6.2). Nevertheless, our main assumption is that the governmental crisis policies might have influenced the price dynamics at different levels of the supply chain by reducing price transmission and thus invoking different welfare distribution effects. Thus, our research questions are: Which crisis policies did the government use to intervene on the domestic wheat, flour and bread markets, and in which sequence? Were the equilibrium, stability and integration of the Serbian wheat market with the world market influenced by the crisis policies? How did the crisis policies affect the domestic wheat and flour markets, particularly the market prices and trade volumes? How fast and to which extent are wheat price changes transmitted to flour and bread prices? Do the price increases of wheat and/or flour have a major impact on bread prices? Who benefited and who lost from the governmental interventions? What are the alternative policy measures?

Considering the complexity of the research, we divided the estimation approach into two parts. In the first part, we focus on the price transmission analysis. First, we analyze the price relationships between the Serbian and the world wheat markets (spatial price transmission context). Second, we focus on the price relationship between the milling and the baking industries (vertical price transmission context). More precisely, the price transmission analyses are conducted within a Markov-switching (vector) error-correction model (MS(V)ECM), which allows us to capture possible regime changes resulting from export restrictions. Furthermore, we analyze how the flour production costs and profits of mills developed during the crisis periods. Based on the estimated price transmission parameters, we simulated the mills' flour production costs and profits assuming a laissez-faire policy, and compared it to actual price developments.

In the second part of the analysis, we focus on the price relationship between the baking industry, the retailers, and the end consumers. We investigate the actual development of the bread production costs by taking into account that large industrial bread producers have their own silos to store wheat and are thus not affected by the wheat price developments beyond harvest time. We further assess the development of the bread margin, which is distributed between the baking industry and the retailers. Finally, based on our empirical results, we identify who benefited from and who lost because of the governmental market interventions in the wheat-to-bread supply chain.

The main contribution of this study is that it provides a comprehensive analysis of price development within the wheat-to-bread supply chain, explicitly accounting for the impact of the governmental policy interventions. The study provides methods for analyzing the impact of the crisis policy on each member of the supply chain, which is important for policy makers in their evaluation of certain policy measures and their alternatives. Furthermore, this study provides insights about the functioning of the wheat market in the case of a wheat exporting country, which represents one of the most important wheat and flour suppliers in the Western Balkans and South Eastern Europe. The importance of this study is even greater when accounting for the fact that Serbia is a major wheat and flour supplier for the countries within the Central Eastern Free Trade Agreement (CEFTA), and that Serbia is a candidate country for accession to the European Union (EU).

The study is structured as follows: Chapter 2 provides an overview of the Serbian wheat market and the wheat-to-bread supply chain. Chapter 3 presents facts about the global commodity price peaks in 2007/08 and 2010/11, and the Serbian crisis policy response on the domestic market. Chapter 4 presents the study's essential theoretical concepts and constructs the methodological approach necessary for answering the research questions. The data sets used for the analysis are also described in more detail. Chapter 5 then presents the empirical results of the price transmission analysis and the simulations. Chapter 6 summarizes the empirical results in the form of a discussion and provides alternative policy measures that could be considered by the Serbian government in the event of a future crisis. Lastly, Chapter 7 derives the overall conclusions of the study.

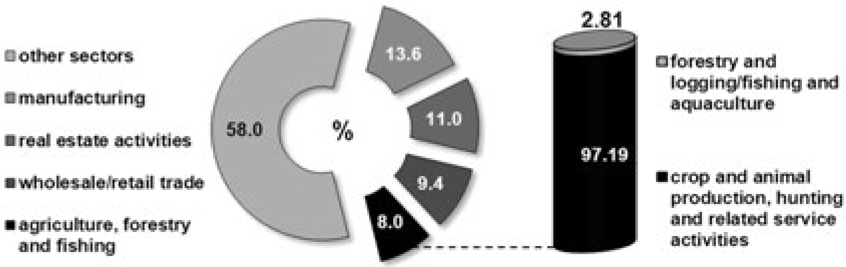
2 Overview of the Serbian wheat market and the wheat-to-bread supply chain

The Serbian agricultural sector has been systematically reformed since political change came about in 2000[2]. The main reforms concentrated on market liberalization, the privatization of large state-owned companies ("kombinati"), the activation of agro-financial markets, the introduction of market information systems, and building the institutions necessary for legal business environment.

The agricultural sector is extremely important for the overall Serbian economy, which can be seen through its contribution to the Gross Domestic Product (GDP)[3], overall employment and total Serbian exports.

The percentage share of the agricultural sector in the GDP has been declining since 2000, and was 8 % in 2009 (Figure 2.1). Crop and animal production, and hunting and related activities comprise 97 % of the agricultural sector. Although it exhibits a relative reduction in the share of total GDP, the agricultural sector is important for other industrial sectors that use agricultural products as raw materials.

Figure 2.1: Share of economic sectors in the GDP, 2009



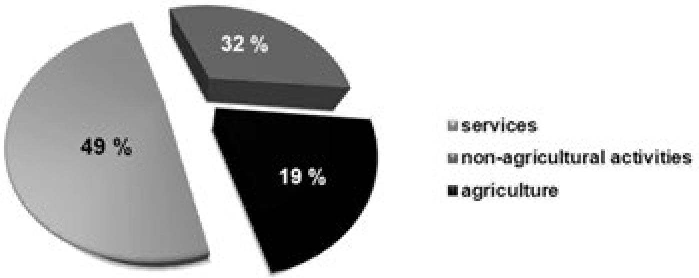
Source: Statistical Office of the Republic of Serbia (SORS), own illustration.

2 On October 5, 2000, the political regime in Serbia changed from socialism to a democracy. From that point on, instead of centrally planned agriculture, the whole sector was based on open market principles.

3 The Gross Domestic Product (GDP) is calculated by the production approach. It represents the result of production activities of residential institutional units and is equal to the sum of value added at basic prices by activities and total taxes on products, minus the amount of subsidies on products and financial intermediation services indirectly measured on the level of overall economy (SORS, 2011).

The importance of the agricultural sector for overall employment in Serbia is still very significant. According to a Labor Force Survey from October 2010 (SORS, 2010), 19 % of the employed population in Serbia were working in agriculture, which is about 15 % of the total active population, or 7 % of the total population (Figure 2.2). The number of people working in agriculture is characterized by a declining trend.

Figure 2.2: Share of economic activities in total employment, 2009



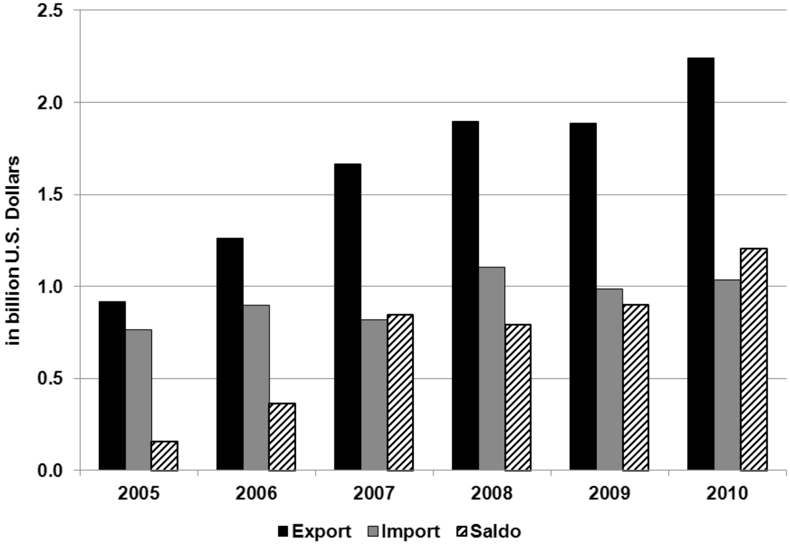
Source: SORS, own illustration.

The amount of Serbian agricultural[4] exports has been growing significantly since the liberalization of the agricultural market in 2001. Indeed, the first surplus of about 154 million U.S. Dollars in agricultural exports was recorded in 2005. Since then, Serbian agricultural exports have been growing significantly compared to agricultural imports, and reached a surplus of 1.2 billion U.S. Dollars in 2010 (Figure 2.3). The percentage share of agricultural exports in total Serbian exports is about 20 % on average, which is twice as much as in other transitional countries (Miljkovic, et al., 2010). The significant growth in Serbian agricultural exports is mainly driven by preferential trade status with the EU, as well as several bilateral free trade agreements (i.e. CEFTA, a bilateral agreement with the Republic of Belorussia, the Russian Federation, Turkey and Kazakhstan)[5].

4 According to the Statistical Office of the Republic of Serbia (online database), agriculture consists of the following sectors: 0 and 1 (food, live animals, beverages, and tobacco); part of sector 2 (raw materials except fuels), subsectors 21, 22 and 29 (rawhide, oil from seeds, animal and plant raw materials); part of sector 4 (animal and plant oils and fats), subsectors 41, 42 and 43.

5 For more details see appendix A.

Figure 2.3: Serbian agricultural exports and imports, 2005 to 2010



Source: SORS, own illustration.

The export of cereals[6] accounts for 25 % of total agricultural exports. Among different types of cereals, corn and wheat represent the most traded products; they account for 64 % and 13 % of total cereal exports, respectively. Although Serbian cereals are not completely competitive with major European cereal exporters such as Hungary, or with the major CIS[7] exporters such as Russia and Ukraine, they are more competitive in the Balkan region, and especially in neighboring countries such as Croatia, Bosnia and Herzegovina, Montenegro, Macedonia, and Albania. All these countries, except Croatia, have a large structural cereal deficit (Van Berkum and Bogdanov, 2012).

In the following sections we provide a detailed description of the wheat-to-bread supply chain since it represents the main focus of this study and strategically is one of the most important agricultural sectors in Serbia. First, we describe the wheat production structure and utilization in section 2.1. Second, we describe the wheat-to-bread supply chain in section 2.2.

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6 More details about Serbian wheat and flour exports are provided in appendix A.

7 Commonwealth of Independent States (CIS). The CIS is comprised of 9 members (Armenia, Azerbaijan, Belarus, Kazakhstan, Kyrgyzstan, Moldova, Russia, Tajikistan and Uzbekistan), one participating associate member (Ukraine) and one unofficial associate member (Turkmenistan).

2.1 Wheat production structure and utilization

In a five-year average, 2005/09, about 60 % of the total arable land in Serbia is used for grain production. Thus, grain crops represent the most important agricultural sector in Serbia, with corn and wheat representing the most common crops. The main reasons for this are:

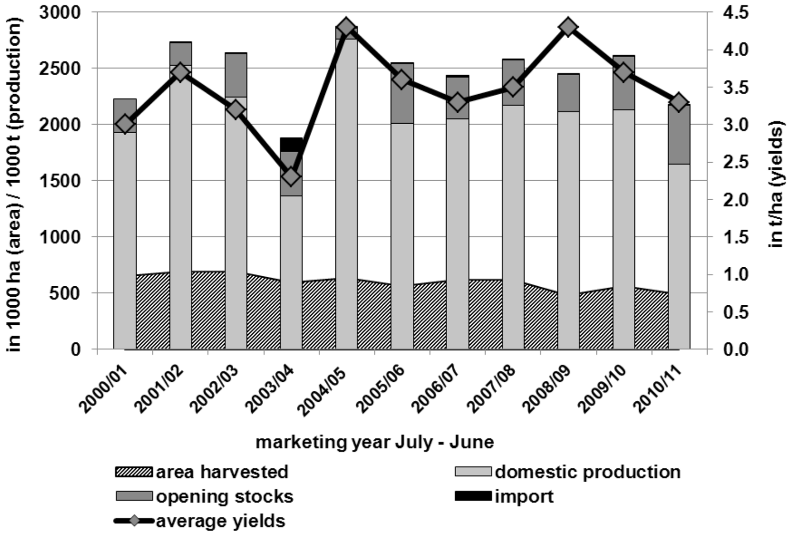
- a long tradition of wheat and corn production;
- favorable soil and weather conditions for wheat and corn production;
- wheat and corn are good preceding crops;
- wheat and corn are the most important inputs for the milk and meat production industries in Serbia;
- wheat and corn production does not require significant investments (financial, mechanization or labor).

Of the total arable land in Serbia, 28 % is used for wheat production, or 545,000 ha over a five-year average (2005/09). Concerning the observed period, the smallest area sown by wheat was in 2008, about 488,000 ha (10 % less than the five-year average). The largest area planted was in 2009, with 568,000 ha(4% more than the five-year average). If we observe the years 1999/2009, we can see that the area sown by wheat has a downward trend, especially after 2005 (Figure 2.4). One of the main reasons is that the Serbian government introduced a Value Added Tax (VAT) of 8% for agricultural inputs and final products, and 18% for fuel and machinery in 2005. Since wheat did not secure much of the profit for the farmers because of the increased costs of inputs, nor higher prices for wheat on the market, more and more farmers started to use their land for seeding more profitable crops like soybeans, sugar beet or sunflowers.

According to the five-year average of wheat production from 2005 to 2009, Serbia is ranked 13th among EU member countries (Figure 2.5). Additionally, Serbia is ranked 19th among the EU 27 if we consider average yields of 3.7 t/ha.

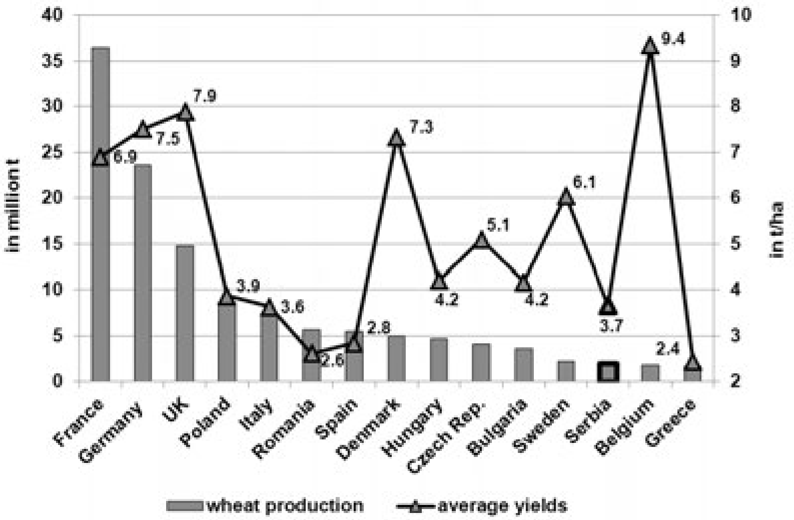
The spatial wheat production can be divided in two main areas, Central Serbia and Vojvodina (Autonomous Province of Vojvodina). The average percentage share of ha used for wheat production in these areas is 49 % and 51 %, respectively. Although the percentage share in land used for wheat production is almost equally spread, the quantity of wheat produced, yields, and wheat production organization (enterprises/cooperatives or family production) is not the same.

Figure 2.4: Serbian domestic wheat supplies, 2001 to 2011



Source: Serbian Ministry of Agriculture, Trade, Forestry and Water Management (MATFWM), own illustration.

Figure 2.5: Top 15 wheat producers in the European Union, 2005 to 2009

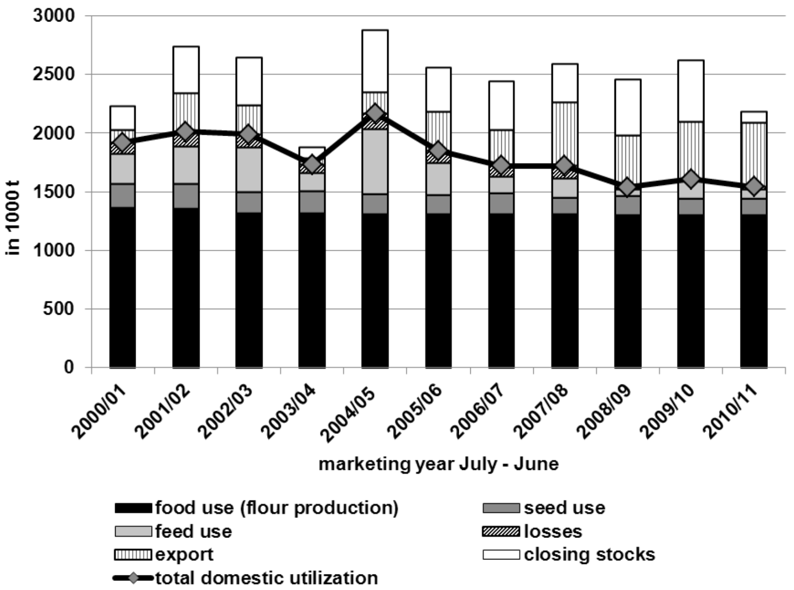


Source: EUROSTAT (EU) and MATFWM (Serbia), own illustration.

Concerning production and yields, the percentage share of wheat produced in Central Serbia was about 43% (846,868 t) from 2005 to 2009, with average yields of 3.9 t/ha. The five-year average percentage share in wheat production in Vojvodina was about 57 % (1,134,965 t) with average yields of 4.2 t/ha. These facts are not surprising considering that the Vojvodina region is mostly flat, has the best soil quality, and agricultural producers from this region have a long tradition of producing grains (especially wheat and corn). On the contrary, the Central Serbian region is mainly covered with mountain areas more suitable for cattle breeding.

Concerning wheat, the ten-year average total domestic wheat consumption in Serbia is about 1.8 million t. Nevertheless, since 2006 the annual consumption has been shrinking from year to year. On average, it has decreased by about 200,000 t during the last five years and is now about 1.6 million t. This means that the monthly wheat consumption in Serbia is 133,000 t. The main reason for the decline in domestic consumption is the reduced utilization of wheat for animal feeding and seeding (Figure 2.6).

Figure 2.6: Serbian domestic wheat utilization, 2001 to 2011



Source: MATFWM, own illustration.

The wheat used for animal feed mainly depends on the ratio between the prices of wheat, corn and meat (end product) on the market. Usually, corn prices are lower than wheat prices, and thus the meat producers and feed producing companies mainly use corn for making feed. However, when corn prices are much higher than wheat prices, corn is replaced with wheat. The amount of wheat used for animal feed ranges between 50,000 t (2.4 % of total wheat production in 2009) to 549,000 t (20 % of total wheat production in 2005). The average utilization of wheat for seeding is about 172,000 t, and it varies according to the amount of seeded arable areas. Generally, the trend is negative and the last five-year average has decreased by about 10 % (16,000 t), which complies with the decrease in harvested areas of about 7 % in the last five years compared to the ten year's annual average of 601,000 ha. Since the technology for wheat production has been improved, the total loss of wheat since 2008 has decreased to an annual average of 20,000 t, which is 77 % lower than the ten-year average of 81,000 t. The wheat used for population nutrition is almost fixed at the level of 1.3 million t, which is mainly milled into the flour. Estimated per capita consumption is 180 kg.

2.2 Wheat-to-bread supply chain

Before political change occurred at the end of 2000, the wheat-to-bread supply chain in Serbia was characterized by very strong vertical integration between individual households and governmental enterprises. These vertically well-integrated systems were based on local and regional levels covering markets of inputs, primary production, processing, product placement and services. These systems had a monopoly on the Serbian market and were heavily supported by governmental funds.

During the 1990s, most of these complex systems collapsed, causing a disruption of the entire Serbian agricultural market. In the late-1990s and especially after the political change in October 2000, the revitalization of this sector became possible by the privatization of the processing industry (today it is in its final stage), and by the strengthening of the retail sector (MAFWM, 2009).

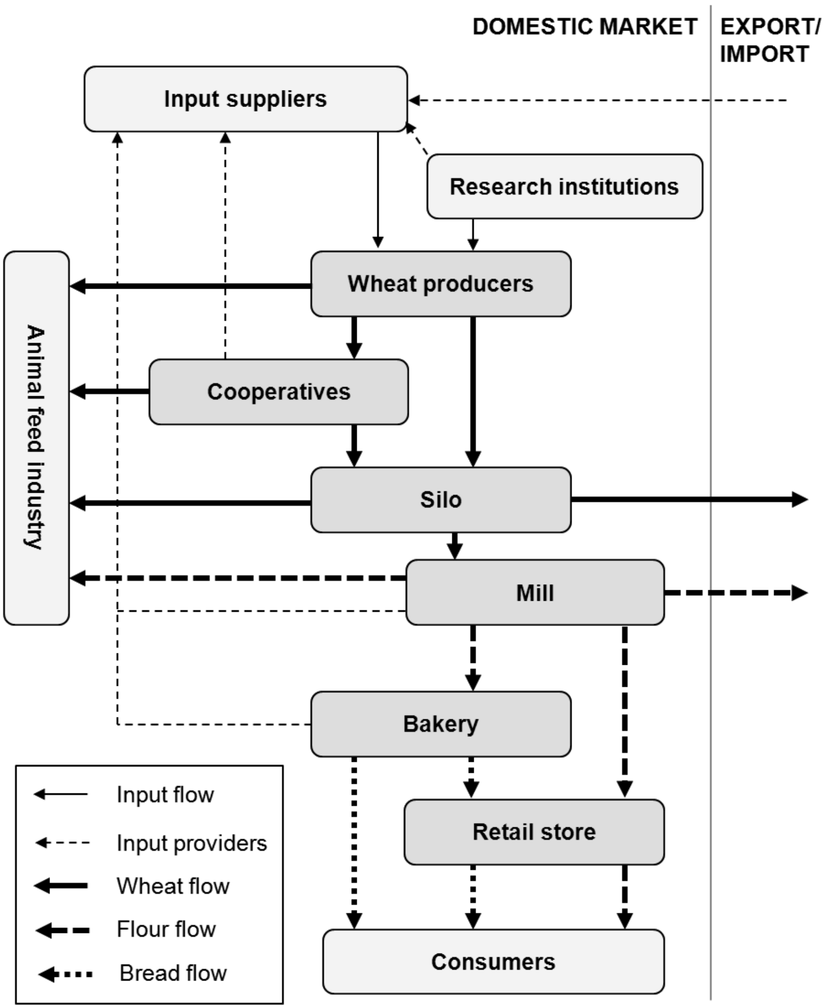
Within the process of becoming a potential candidate country for the EU, much legislation has been adopted by the Serbian government in order to implement quality standards within the food industry. Two of the most important laws in this respect, which directly refer to the wheat-to-bread supply chain, are the Veterinary[8] and the Food Safety[9] Laws. According to these laws, all participants involved in the food supply chain had to implement quality standards (Hazard Analysis and Critical Control Points – HACCP) beginning on June 1, 2011. These laws were enacted in 2005. Prior to this, quality standards within the wheat-to-bread supply chain had been neglected completely.

Concerning the wheat-to-bread supply chain structure (Figure 2.7), there are two main levels that differ in the contractual relations between the participants and the formation of wheat prices. The first level refers to the wheat producers and silos where wheat's first market price is formed (section 2.2.1). The second, very important level refers to the silos, mills and baking industry. This level is charac-

8 Serbian official Gazette, No. 91/05.
9 Serbian official Gazette, No. 41/09.

terized by complex interconnected links between the participants, and by the formation of the spot-wheat market price, which is used as the basis for calculating the Serbian wheat export price (section 2.2.2).

Figure 2.7: Wheat-to-bread supply chain structure



Source: own illustration.

2.2.1 Wheat producers and storage capacities

The wheat producers in Serbia can be divided into two groups. There are small wheat producers who are not specialized in wheat production, and large specialized wheat producers who are usually vertically well-integrated within the supply chain.

In general, the wheat producers are mainly connected with large industrial mills in the region. They can have different contractual relations, meaning that they get seeds and fertilizers from mills, or they negotiate the price "on green[10]" meaning during the harvest (usually June/July). Also, the relation between wheat producers and the silo/mill is characterized by mutual trust built up over decades. Most small producers do not have their own silos and thus need to store their wheat in local silos that charge monthly prices for storage.

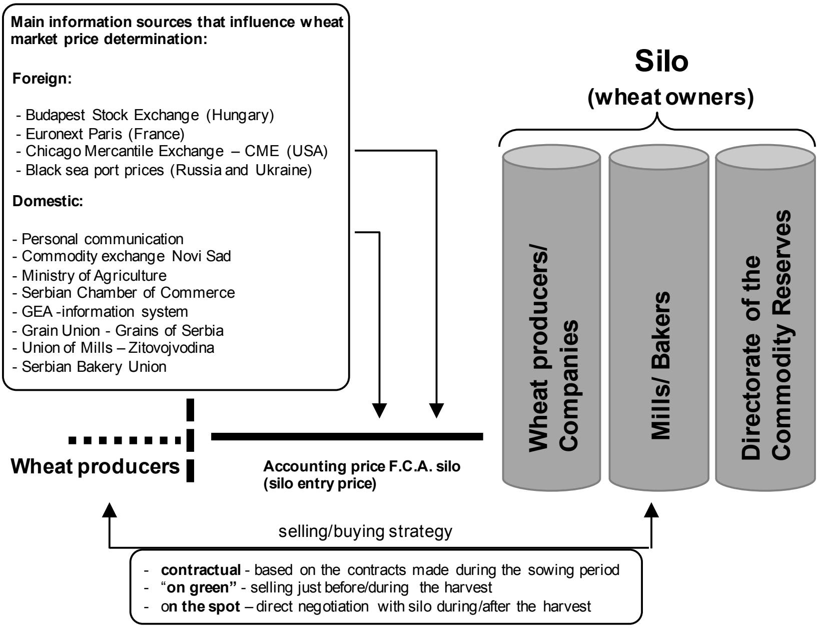
Price formation on the producer-silo/mill level functions as follows: During the harvest, the wheat producers bring their wheat to the local silo. They have two possibilities: One is to use the service provided by the silo and keep their wheat there until they decide to sell it to a mill or another buyer. The second possibility is to sell their wheat immediately to the silo for the negotiated price. Thus, the actual price of wheat in Serbia is firstly defined at the silo. This is called the silo selling price. This price includes the producer's price, transport from farm to silo, the silo input handling costs (about 3 %), and about 1 % of the storage costs per month. When delivering wheat to a silo, wheat producers must negotiate with the silo because silos always adopt the strategy of lowering the price based on the quality of the wheat. Considering that silos are spatially well-distributed all over Serbia, the costs of transport from field to silo is negligible. Hence, the first price of wheat is defined at the silo entry level mainly during the harvest (Figure 2.8).

The main influence on the wheat price formation is defined by supply and demand, and by information coming from the regional and world markets. There are two usual scenarios. The first scenario refers to the "normal" condition, meaning that the harvest will be as expected and there is no misbalance in the domestic and global supply and demand. In Figure 2.9 we can observe that the wheat price from the new harvest is set a bit lower than the one from the previous harvest. The main reason is that the wheat from the old harvest is burdened with storage costs throughout the year. As supply from the new harvest grows, both prices decrease until the point where the wheat from the new harvest is "technically mature" and able to be used[11]; this is mainly at the end of August or the beginning of September.

10 Expression used to indicate that wheat price is negotiated before or during the harvest when actual quality is not known and before wheat is technically treated for further use.

11 For theoretical considerations see Koester and Zaric (2009, p.192).

Figure 2.8: Wheat price formation at producer-silo level

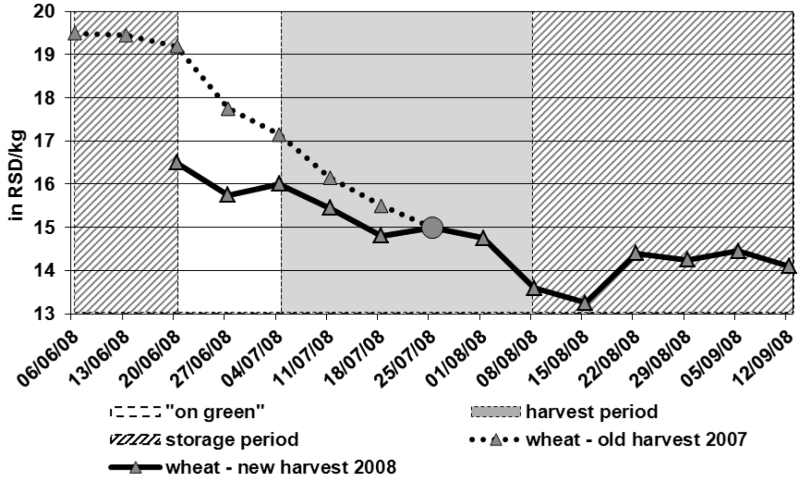


Source: own illustration.

The second scenario refers to the situation when the harvest is lower than expected and when there are significant price peaks on the domestic, regional and world markets, as was the case in 2007/08 and 2010/11. In Figure 2.10 we can observe that due to the reduced supply, wheat from the new harvest has an upward trend even when it is sold “on green”. Depending on the situation, the price of new wheat can even exceed the price of wheat from the old harvest, which is burdened with storage costs.

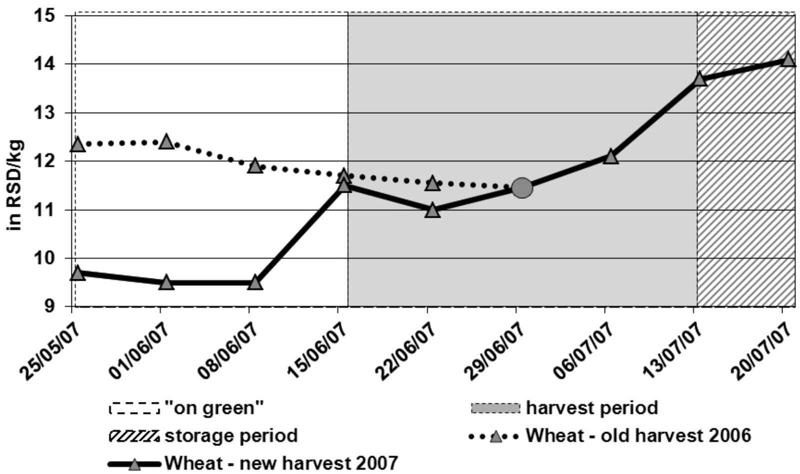
Another significant factor in price formation is the flow of information. For example, forecasts of the new harvest (April/May) have a significant influence on the settlement of the wheat price sold “on green” (or the starting price of the new harvest). Some of the most important institutions providing first estimations are the Ministry of Agriculture, the Serbian Chamber of Commerce, and the Commodity Exchange in Novi Sad. Besides these institutions, there are some other unions and companies that provide information about price and trend developments that can have a significant influence on the spatial price transmission between different areas in Serbia. Some of these are the GEA-Info Center, the Serbian Grain Fund (for commodity sectors), the Union of Mills – Zitovojvodina, the Serbian Bakery Union, the Bakery Union of Vojvodina (for processed and final products), and many more.

Figure 2.9: Scenario 1: new harvest price formation



Source: SERBIAN GRAIN FUND, own illustration.

Figure 2.10: Scenario 2: new harvest price formation



Source: SERBIAN GRAIN FUND, own illustration.

Concerning storage capacities, there are about 300 registered storage facilities with a total capacity of about 3.8 million t of grain. About 3.4 million t of this are silo capacities, and about 400,000 t are floor storage capacities. About 71 % of storage facilities are located in the Vojvodina Province (Northern part of Serbia), while the rest are spread over Central Serbia. Considering the study of VUJOVIC

(2002, p. 18), all grain storage facilities are divided into five major types: receiving storages, collecting storages, reloading storage facilities, silos and underground storage.

- **Receiving storage**. This type of storage is mainly located on private property and is used during the harvest. The wheat is collected in this storage before being sent to larger silos. Above-the-ground receiving storage is mainly used by small cooperatives, while underground receiving storage is mainly used by individual wheat producers.
- **Collecting storage**. This type of wheat storage is more similar to silos but is mainly used for short-run storage. The main purpose of this type of storage is that the wheat is being cleaned, sorted by quality and weighed.
- **Reloading storage facilities**. This type of warehouse is mainly constructed at river ports or rail terminals. The main characteristic is that they have very large capacity of loading or reloading wheat, which can be about 1,000 t/hour.
- **Silo**. This is the most common wheat storage facility in Serbia (about 92 % compared to other types). Silos in Serbia are mainly made of steel (small capacity), which account for about 700,000 t of total grain storage capacity. The second type of silos is made of reinforced concrete (large capacity), and account for about 2.7 million t of total grain storage capacity.
- **Underground storage**. This type of wheat storage is a simpler construction and cheaper than silos. There are three different types: simple (similar to hangars), multi-level and specialized.

In general, the biggest storage owners are agro-industrial and milling enterprises. It is common for the wheat stored in silos to have three types of owners (Figure 2.8). First, most of the millers are silo owners, and thus have their wheat in silos. Second, almost all wheat producers need to store their wheat in silos since it has to be dried and treated during the year. Besides wheat producers, there are also different cooperatives and companies involved in wheat production and/or trade. The third type of owner is the Serbian Directorate of Commodity Reserves[12] (DCR), which is obliged to keep a certain amount of wheat in stocks to secure domestic supplies. The DCR has only one official silo in Novi Pazar, and the rest of the wheat is stored in many private silos all over Serbia for strategic reasons. Prior to 2005, the DCR was one of the main players on the Serbian grain storage market. After the grain market liberalization, the DCR lost its status of the public stock-keeper (CEECAGRIPOLICY, 2005).

12 The DCR is the official governmental body responsible for national commodity reserves. The Serbian Ministry of Trade and Services (MTS) has direct control over this institution. After 2011, the MTS was merged with the MAFWM, and the new Ministry of Agriculture, Trade, Forestry and Water Management (MATFWM) was formed. All the responsibilities of the MTS were transferred to the MATFWM.

Concerning further price formation, wheat has to be adequately treated since it is delivered by farmers. These first wheat treatment costs are called input handling costs, and they account for: handling costs (physically putting the wheat to silo); quality control; protecting the seeds; elevation; etc. These costs account for about 3 % of the wheat entry price. Once the wheat is stored in a silo, one can account for monthly storage costs of about 1 % (Figure 2.11). Most of the time storage costs are paid in kind. This means that if a wheat owner has to pay 10% of the wheat value to the silo, he will give 10 % of his wheat to the silo. It is interesting to observe that a silo owner has to pay 18 % VAT every month for the stored wheat, although he will be paid for his services only at the end of the storage period, which can be as long as a year. When the wheat owner decides to take his wheat out, he must pay an additional 1 % for output handling costs (physically taking the wheat from the silo). Usually, wheat is stored for about 9 months. If the wheat from the old harvest is not sold, there will be no space for the new harvest.

The critical point in wheat price formation is when a wheat owner decides to sell his wheat on the market. He needs to account for about 10 to 13 % of additional costs when he is calculating his price on the spot market. Usually, wheat is sold at the silo selling price. Depending on the market situation in the observed moment, he can gain profits or incur losses (Figure 2.11). The price on the spot market is governed by the domestic demand and supply, the general wheat quality from the current harvest, the price development on the regional and world commodity exchanges, and many additional factors.

2.2.2 **Milling and baking sectors**

The second level in the wheat-to-bread supply chain is the silo-to-mill level. The total installed capacity for milling wheat in Serbia is about 3.2 million t for the whole year. About 62 % of this capacity is owned by large industrial mills. However, about 47 % of the installed mill capacity is used for satisfying the domestic demand for flour, while the rest is used for export (MAFWM, 2010). According to BOGDANOV (2010), the facilities and technology used in this sector are very old, often dating from the 1950s. A very small number of large industrial mills have been modernized, mainly by investments from foreign companies.

There are about 177 active mills involved in flour production and trade (in 2010), which is about 65 % of the total traders involved. The number of mills has decreased by 50 % over the last couple of years, for numerous reasons: Most of the mills that are not active were small artisanal mills mainly working in non-legal channels; because of the financial crisis of 2008/09, some of the large industrial mills have been closed; some of the mills are not working temporarily because there is no adequate economic reason for them to be involved in the flour trade. Another significant factor influencing the reduction of non-registered flour traders was the system of excise stamps[13]that was introduced by the government on Au-

13 SERBIAN OFFICIAL GAZETTE, No. 69/06.

gust 18, 2006. Before this system, there were about 6,500 companies involved in the flour trade, where only 300 were officially registered (ARCOTRASS, 2006).

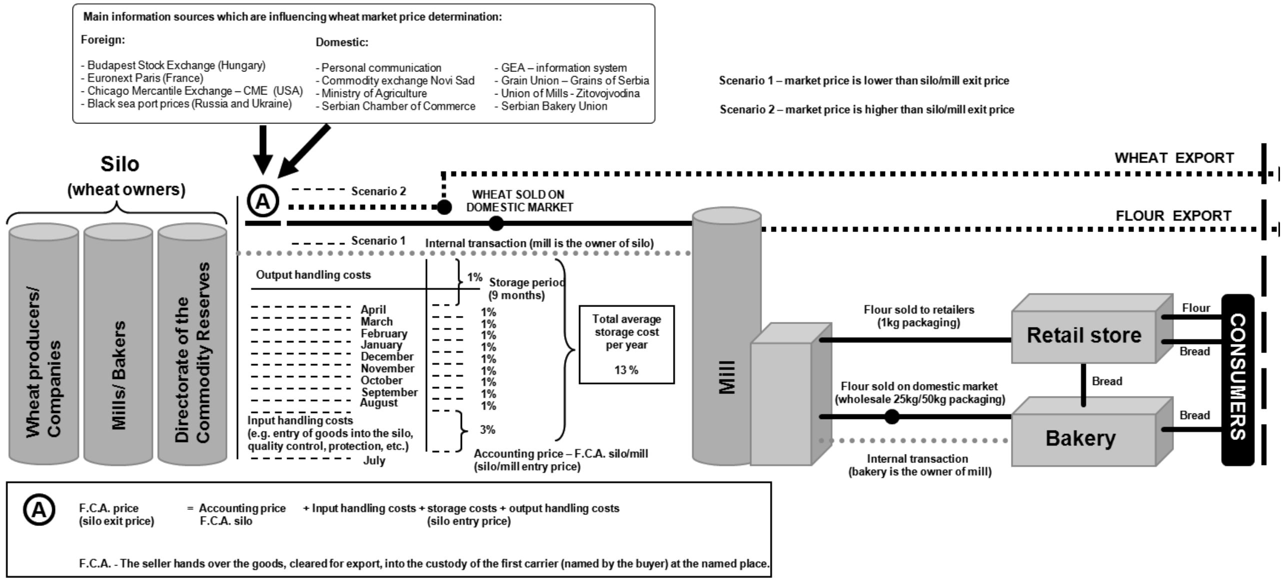
It is well known that from 100 kg of wheat, one can obtain about 75 kg of flour and 20 kg of bran. This means that the price of flour is mainly determined by the price of wheat. Large industrial mills with their own silo can manage to hedge the risk of volatile wheat prices during the year, and thus mill cheaper flour. Even if they have some shortages of wheat during the year, they usually buy wheat for prices that are much lower than on the spot market. The main reason is that, since they are the silo owners, they can reduce the price of wheat by calculating the storage costs for the wheat owners. As we said before, these costs are usually compensated.

Several types of flour are produced in Serbia: flour made from grits (T400), white flour (T400 and T500), semi-white flour (T700 and T850), black flour (T1100 and T1600), flour from whole grain (integral), and flour from durum wheat. After the flour is produced, it can be used either directly in the bakery or confectionary industry, it can be sold wholesale (packages of 25 or 50 kg), or it can be sold directly through retail shops in small packages of 1 kg (Figure 2.11).

Concerning the baking sector, bread carries the biggest share in baked goods (about 93 % in terms of value). There are about 7,000 bakeries in Serbia, about 2,000 of which are concentrated in the capital city, Belgrade[14]. The three biggest bread producers "Beogradska Pekarska Industrija", "Hleb" and "Klas" control ¼ of the bread market in Belgrade. When it comes to the overall Serbian bread market, they control about 5 %, 3 % and 3 %, respectively, because of the fact that most of the bread is produced and sold by independent small bakeries. There are about 50 different types of bread (e.g. "monastery", "integral", "diet", "farmer's bread", etc.) which vary in price, quantity and quality. Most of them are very expensive compared to the "social" bread[15], which is produced from wheat flour T500.

14 The capital city of the Republic of Serbia. Population: approximately 1.6 million people.
15 See chapter 3, section 3.2.

Figure 2.11: Wheat price formation from silo to consumers

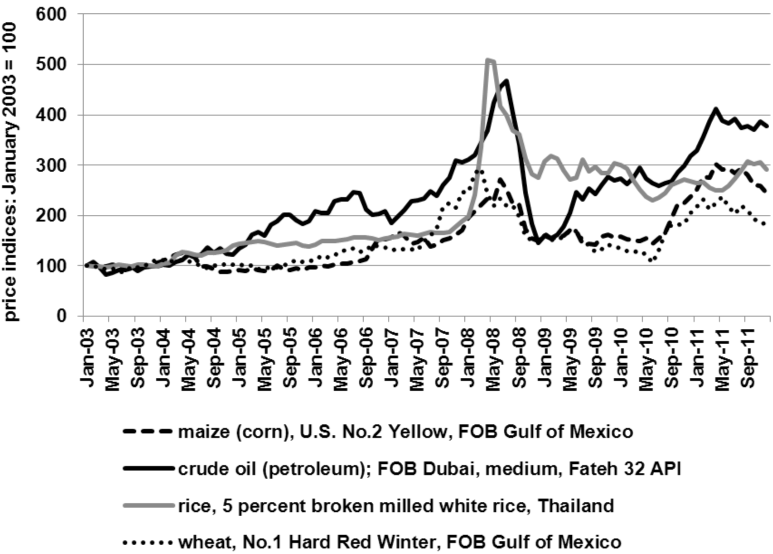


Source: own illustration.

3 Global commodity price peaks 2007/11 and Serbia's policy responds

Since the food crisis of 1972/74, commodity prices were characterized by a downward trend for decades. The first signs of an upward shift became obvious from 2003 onwards (Figure 3.1).The significant increase in oil and commodity prices started in 2007, and led to the global commodity price peak and food crisis in the first half of 2008. Nominal crude oil prices increased by 62 % in April 2008 compared to April 2007, and in the same period wheat, corn and rice prices increased by 83 %, 62 %, and 215 %, respectively; the crisis appeared in 2007 when the commodity prices started to raise significantly.

Figure 3.1: Nominal price trends of selected cereals and crude oil



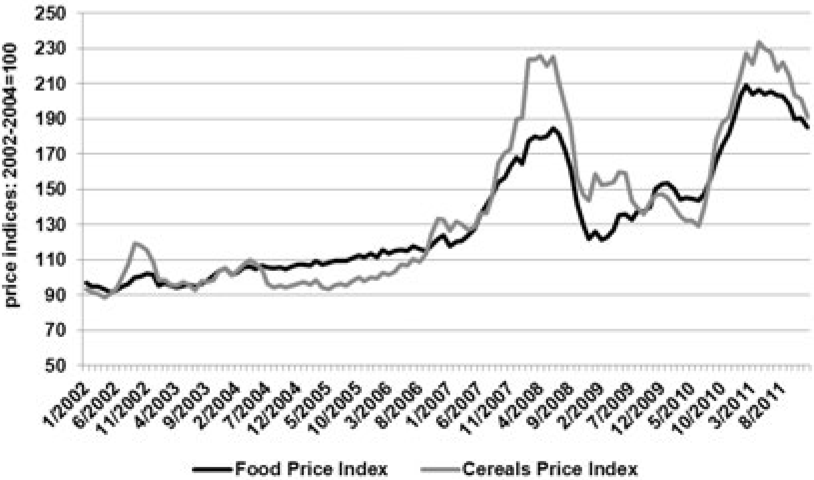
Source: own calculation based on data from the International Monetary Fund.

In 2007, the global Food Price Index[16], measured by the Food and Agriculture Organization of the United Nations (FAO), rose 20 % compared to 2006, reaching its

16 The FAO Food Price Index is a measure of the monthly change in international prices of a basket of food commodities. It consists of the average of five commodity group price indices (representing 55 quotations), weighted with the average export shares of each of the groups for 2002-2004.

highest point in 2008 when it had risen by 42 % compared to the pre-crisis period. During the same periods, the Cereals Price Index[17] increased by 31 % and 75 %, respectively (Figure 3.2).

Figure 3.2: Global Food Price Index



Source: FAO.

Note: All indices have been deflated using the World Bank Manufactures Unit Value Index rebased from 1990=100 to 2002-2004=100.

After the commodity and food price peak in 2007/08, prices fell rapidly in 2009 but were still higher than before the crisis. Nevertheless, another commodity price peak appeared in 2010, indicating a possible new crisis, which actually appeared in 2011. The highest value of the global Food Price Index in the last 20 years was reached in 2011 when it rose by 48 % compared to the pre-crisis level in 2009, or 72 % compared with the 2006 food price index value. The cereals index increased by 45 % compared to 2009 and by 94 % compared to 2006.

Although the nominal prices reached their highest peaks in 2007/08 and 2010/11, the deflated commodity prices were not higher than the prices recorded during

17 The Cereals Price Index consists of the International Grains Council (IGC) wheat price index; itself an average of 9 different wheat price quotations, and 1 maize export quotation, after expressing the maize price into its index form and converting the base of the IGC index to 2002-2004. The Rice Price Index consists of 3 components containing the average prices of 16 rice quotations: the components consist of the Indica, Japonica and Aromatic rice varieties and the weights for combining the three components are assumed to be (fixed) trade shares of the three varieties.

Source: http://www.fao.org/worldfoodsituation/wfs-home/foodpricesindex/en/.

the 1972 to 1974 price peak in real terms (Piesse and Thirtle, 2009; Timmer, 2008). Nevertheless, the recent commodity price peaks had severe consequences for poor people, especially in developing countries. However, the precise number of additional people pushed into poverty is not clear. A wide range of literature is based on different simulations that attempt to estimate this number. According to the first World Bank estimations, more than 100 million people were pushed to poverty in 2007/08 (World Bank, 2008); later, the same institution estimated this figure to be 160 million (De Hoyos and Medvedev, 2009). Other studies estimated between 63 and 170 million people, taking into consideration the food crisis in 2007/08 and the financial crisis in 2009 (Tiwari and Zaman, 2010; USDA, 2009). A study by Headey (2011) goes even further, estimating that the number of food insecure people ranges from 60 to 250 million.

The concern about high global commodity prices and their influence on domestic food prices forced governments around the world to implement various combinations of policy measures or to improve the existing ones. These governments' aim was to secure their domestic supply, buffer the impact of rising global prices, and protect the most vulnerable consumers.

Since the global commodity price peaks represent the main background of this study, it is necessary to address the most important factors that caused the crisis. Thus, in section 3.1, we provide a brief description of the main factors influencing the commodity price peaks. Additionally, section 3.2 describes the chronology of the governmental responses in Serbia to the global commodity price peaks, which is essential for further methodological and empirical explanations.

3.1 Decisive factors influencing global commodity price peaks

A wide range of research studies attempt to identify the causes of the significant commodity and food price surges in 2007/08 and 2010/11. Most of the studies hypothesize that factors such as the strong growth of demand in China and India, rising oil prices, the devaluation of the U.S. Dollar, bio-fuel production, low commodity stocks, adverse weather conditions, various trade shocks and other factors have caused the crisis. All of these factors cover both the supply and the demand side, and their impact could be categorized as short-term, medium-term or long-term.

Following Trostle (2008, p. 6) on the supply side, factors include a slowdown in agricultural production (long-term factor), rising oil prices and farm production costs (medium-term factors), and adverse weather and export policies (short-term factors). On the demand side, the strong growth of demand in China and India (long-term factor), declaiming commodity stocks, bio-fuel production, the devaluation of the U.S. Dollar (medium-term factors), speculations on the futures markets and importer policies (short-term factors) are all assumed to contribute significantly to the crisis.

Even though a large number of factors contributing to the global food crisis have been identified, there is a wide discussion about the relevance and impact of these factors. In the following pages, some of the most important factors will be presented, together with the discussion that refers to their relevance of being one of the key factors causing the crises in 2007/08 and 2010/11.

3.1.1 **Agricultural productivity decline and consumption growth**

One of the arguments concerning the causes of the food crisis is that the growth of global agricultural productivity has been slowing down and even declining over the last decade. CHAND (2008, p. 116) states that there are four main factors influencing global cereal supply and demand imbalances: a) a deterioration in terms of trade driven by the World Trade Organization (WTO) trade liberalization; b) decades of a declining cereal price trend, which led to a decrease in the total area used for cereal production; c) a sharp decline in overseas development assistance used for improving rural development infrastructure and the transfer of new technologies; d) second generation problems of the green revolution generally coincide with a productivity slowdown (production grows slower than consumption).

Concerning the supply side factors, ABBOTT et al. (2008) use data about cereal yields as a measure of the productivity slowdown. They argue that yield technology will continue to be the most important factor for increasing supply over time, and that increasing investments in agricultural research is the only proper way of improving yields. The study by LICKER et al. (2010) shows that there is an unused potential in crop yields. They estimate the so-called yield gap by comparing the actual yields to their climatic potential yields for the 18 most dominant crops. Their results show that 60 % more wheat, 50 % more maize, and 40 % more rice could be produced globally if the 95 % of croplands met their current climatic potential.

On the other side, the intensive economic growth of developing countries caused a change in diets, which transferred the demand from cereals to more protein-based products. This tremendous change in demand is mainly associated with China and India, who have experienced significant economic growth over the last decade. Some studies emphasize that this factor is one of the significant causes of the global commodity price peaks and the food crises in 2007/08 and 2010/11 (ABBOTT and BOROT DE BATTISTI, 2011; VON BRAUN, 2008). The main argument refers to the change in consumption patterns that cause significant cereal imports. However, in the studies by HEADEY and FAN (2010 and 2008), they argue that this hypothesis could be dismissed since the growth in demand would be high even if China and India were excluded from the trade data. Also, these authors argue that Asian countries might increase their fruit and meat consumption, which cannot be connected to the larger cereal bills. Further on, BAFFES and HANIOTIS (2010) argue that the demand growth for most of the grains in China and India has slowed, especially for the period between 2006 and 2008, which is directly connected to the decreasing demand for meat. On the other hand, PIESSE and THIRTLE (2009) argue that the rapid development in China and India could not cause sudden cereal price shocks, and that the influence could be only indirect through an increased demand for oil. TROSTLE (2008) came to the same conclusion, arguing that Chinese oil imports have had an annual growth rate of 21 % since 1996 until 2006.

Considering the previous discussion, it is not clear if the increased demand for food, caused by the economic growth of developing countries, is one of the most important factors causing the increase of commodity and food prices during the peaks in 2007/08 and 2010/11.

3.1.2 **Rising oil prices and biofuels**

Broad research studies indicate that some of the most important factors causing the 2007/08 commodity price peak were rising crude oil prices and increased bio-fuel production. The prices of cereals, chemicals, and farmers' operational costs are assumed to be directly influenced by the change in crude oil prices. HEADEY and FAN (2008) estimated that the rising oil prices increased the production cost of corn, wheat and soybeans by 30-40 % in the U.S. between 2001 and 2007. They also estimated that these oil-based price increases comprise about 8 %, 11 %, and 20 % of the corn, soybean and wheat price increases, respectively. MITCHELL (2008) estimated that, due to the increased crude oil prices, transport costs increased the U.S. export price for wheat and corn by about 10.2 %.

The general impact of rising crude oil prices on food prices was studied by CHAND (2008), who compared the correlation between crude oil and food prices for two separate time periods. The first period, from 1987 to 1999 was characterized by a flat trend in crude oil prices. CHAND further argues that the short and periodical crude oil price changes did not affect the food prices directly since the food prices followed an independent trend caused by other factors. In contrast, the second time period from 2000 until 2007 was characterized by a sharp, persistent increasing trend in crude oil prices, which was followed by a sharp increase in food prices. Furthermore, BAFFES (2007) used an ordinary least squares (OLS) regression of the individual commodity price on the crude oil price by accounting for inflation and technological changes. He used annual data from 1960 to 2005 and estimated that the pass-through coefficient of cereals was about 0.18. Considering this coefficient, CHAND (2008) estimated that rising energy prices (crude oil prices) contributed to the 47 % of total increase in food prices from 2003 until 2008.

Considering that oil prices were exploding during the periods of the commodity price peaks, this was a great opportunity for bio-fuel producing countries to increase their production (e.g. the U.S. for bio-ethanol and the European Union for bio-diesel). According to MITCHELL (2008), once oil prices reach the threshold price of 50-60 U.S. Dollars/barrel, bio-fuel production starts to play a role. Later, WIGGINS et al. (2010) also argue that the threshold price of about 60-70 U.S. Dollars/barrel is a starting point for profitable bio-ethanol production. HEADEY et al. (2009) argue that, concerning the 2007/08 crisis, the sharp increase in oil prices disrupted bio-fuel production, which consumed almost 30 % of U.S. corn production. They argue that the high corn prices contributed to the price increase of other substitute products. Mainly, the intensive bio-ethanol production in the U.S. had a major impact on the increased demand for corn, pushing the supply from food and feed purposes and thus causing a significant price surge. Consequently, the high corn prices forced consumers and food processors to supplement corn with other staple food crops, thereby causing another misbalance on these markets.

However, it is very difficult to identify the precise impact of bio-fuel production on food prices since each study considers different assumptions, methodologies and time frames for their simulations. Rosegrant (2008) used an International Model for Policy Analysis of Agricultural Commodities and Trade, which represents a partial-equilibrium modeling framework for analyzing different scenarios of the bio-fuel impact on food prices. The results show that the increased bio-fuel production between 2000 and 2007 accounted for 39 %, 21 %, and 22 % of the increase in real prices of corn, rice and wheat, respectively. Collins (2008) used a mathematical simulation to estimate the impact of bio-fuels on the prices of corn and soybeans. He concludes that the intensive bio-ethanol production could be a reason for about 60 % of the corn price increase from 2006 to 2008. Additionally, Collins estimated that intensive bio-diesel production contributed to the soybean price increase of 60 %. Furthermore, FAO data (2012) shows that the bio-fuel demand accounted for 60 % of the global change of wheat and coarse grain prices from 2005 to 2007. On the other hand, the record prices of corn, wheat and vegetable oils have reduced the economic feasibility of bio-fuel production in many countries, despite the high fossil fuel prices and strong governmental support (OECD, 2008).

3.1.3 **Depreciation of the U.S. Dollar and commodity stocks decline**

The steep depreciation of the U.S. Dollar and the decline of commodity stocks since 2002 have been considered two of the most important factors contributing to the increase of global commodity prices in 2007/08, and then again in 2010/11.

The decreasing value of the U.S. Dollar relative to the currency of the importing countries especially contributed to the increased demand for U.S. commodities, which led to the price peaks (Piesse and Thirtle, 2009). The bulk of attention in the literature is drawn to the impact of the U.S. Dollar depreciation on food prices because most of the commodities are traded in U.S. Dollars. Abbott et al. (2008) use the USDA Economic Research Service's agricultural trade-weighted index of real foreign currency per unit of deflated U.S. Dollar to show that the U.S. Dollar depreciated by 22 % from 2002 to 2007, where the value of agricultural exports increased by 54 %. They also argue that half of the price spike in 2007/08 can be attributed to the depreciation of the U.S. Dollar. However, Mitchell (2008) argues that about 20 % of the rise in food prices could be attributed to the U.S. Dollar's depreciation, assuming that the depreciation increases commodity prices (quoted in U.S. Dollars) with an elasticity of 0.75; he compared the real weight traded exchange rate and the index of food prices from January 2002 until June 2008. Additionally, HEADEY and FAN (2010) argue that the conversion of commodity prices from U.S. Dollar to Euro would cut off 20-30 % of the nominal increase in food prices denominated in U.S. Dollars because the inflation rates in Europe and the U.S. do not greatly deviate, and conversion to real prices would not matter much.

All in all, there is no clear consensus on the proportion of the food price increase caused by the U.S. Dollar's depreciation. Nevertheless, certain commodity price patterns can be identified: when the U.S. Dollar is weak, the commodity prices on the world market are high, and variations in commodity prices are greater than changes in exchange rates (HEADEY and FAN, 2010).

Another very important factor contributing to high food prices is the decline in commodity stocks. WIGGINS et al. (2010) argue that the cause of low stocks of major grains can be found in the policies of keeping low public stocks in the U.S., China, Europe and in developing countries, which resulted in a gradual stock decline since 2000. They also argue that, due to the policies, the world end-of-season stocks of three main grains, expressed as a ratio of use, fell from 34 % in the late 1990s to under 20 % in 2005. Additionally, WIGGINS et al. (2010) support the conventional wisdom that a stocks/use ratio for wheat under 20% leads to strong upward price moments. Results from several studies identifying the stock to utilization ratio as the key factor that caused the crisis are in line with this statement. The studies of PIESSE and THIRTLE (2009), ABBOTT et al. (2008), MITCHELL (2008), and TROSTLE (2008) showed that the stock to use ratio for grains and oilseeds has always been very low (about 15 %) during food crises, for example in 1972/74, and later in 2007/08.

3.1.4 **Low real interest rates and speculations on futuresmarkets**

Low interest rates and possible speculative activities on the futures markets were among the most discussed factors that might play an important role in causing the commodity price peaks in 2007/08 and 2010/11.

Many studies indicate that low interest rates might be the main reason why investors pulled their money from industries that traditionally secured high interest rates, and invested them in commodity futures markets, as well as other sectors (HEADEY, 2011; BAFFES and HANIOTIS, 2010; FAO, 2010). HEADEY et al. (2009, p. 10) consider interest rates to be a common cause of overshooting commodity prices, which was initially hypothesized by FRANKEL (1984, 2006). These authors argue that, "*when interest rates are low, money can flow out of interest-bearing instruments and into commodities, causing real commodity prices to rise more than other prices because other prices are 'sticky'. However, stocks of commodities would be expected to increase according to this theory, whereas the available evidence suggests that this is not the case. However, the portfolio shift toward commodity markets provides some basis for the hypothesis that speculative activity in commodity markets affected spot prices*."

Also, speculative activities on futures markets were identified as one of the possible factors contributing to the commodity price peaks (see Gutierrez, 2012; Irwin and Sanders, 2010; Irwin et al., 2009; Robles et al., 2009; and Masters, 2008). Here we have to make a clear distinction between speculations[18] on commodity markets that are always present and based on market fundamentals of supply and demand, and speculations that occur in the period of price peaks. Furthermore, Gilbert (2010) makes a clear distinction between several groups of speculators: a) traditional; b) trend following; c) hedge funds; and d) index-based and other long-term investors in commodity futures. The literature generally focuses on speculators that are not considered as traditional, and on the role of these speculators during the commodity price peaks in 2007/08 and 2010/11. Since there are different aspects of speculations, they naturally lead to different methodological approaches concerning different commodities, and thus different results.

That speculation has an impact on rising commodity prices is shown in the study of Plastina (2008), who analyzes the flow of investment funds to the cotton futures markets by dividing speculators into index and non-index traders. Plastina argues that speculations from non-index traders were the main factor influencing the rise of cotton prices during the 2007/08 price peak. Furthermore, Robles et al. (2009) used the Granger causality test to identify whether speculative activities on futures markets had an impact on agricultural commodity prices in 2007/08. These authors' results show that speculations might have some, but no clear influence, especially on the current price changes of wheat, maize, soybean and rice. Slightly different results were presented in the study by Gilbert (2010), who argues that there is weak evidence that index-based investments contributed to the rise in grain prices. However, he found that it certainly had an effect on rising oil and metal prices.

On the other hand, studies exist which could not identify the influence of speculations on futures markets. According to Mitchell (2008), the increase in futures contracts cannot be closely connected with the increase in wheat prices, which raises doubts about the impact of futures contracts on the significant wheat price increase in 2007/08. Another argument that raises doubt is the fact that the prices of some agricultural and mineral commodities rose much higher than the prices of wheat and corn, although there are no futures markets for those products, or at least one not as developed. For example, rice prices recorded the sharpest spike, despite the fact that the futures market for rice is not very well developed compared to wheat and corn. Irwin et al. (2009) used the bivariate Granger causality regression to provide the evidence if index traders, or swap dealers, had an impact

18 Here we focus on speculators on futures markets. Speculator might consider two actions: 1) he can take the so called "short position", meaning that he can sell his commodity with an expectation that it will lose its value in the future; 2) he can take "long position", meaning that he can buy certain commodity with an expectation that it will increase its value in the future (Robles et al., 2009, p. 3).

on market returns. These authors used two datasets covering the period from mid-2006 until the end of 2009. The first dataset refers to the positions held by index funds in 12 grain, livestock, and soft commodities futures markets. The second dataset refers to index-type investments, mainly positions of swap dealers, in 22 commodity futures markets including metals and energy. Their results show no evidence that the positions held by index traders or swap dealers had any impact on market returns. Furthermore, Stoll and Whaley (2009) used the Granger causality regression to investigate whether commodity index investing has an impact on the wheat futures market or commodity markets in general. These authors found that commodity index investing is not a speculation and that it has very small, if any, impact on futures prices. Also, Buyuksahin and Jeffrey (2009) used Granger causality regression to identify if speculators (e.g. hedge funds) had any role in rising oil prices from 2000 until 2008. These authors' results show that there is no evidence that speculators had any impact on rising oil prices.

Overall, it is still not clear how, and to what extent, possible futures market speculations influence the commodity price peaks.

3.1.5 **Unfavorable weather conditions and governmental interventions**

Reduced agricultural production due to adverse weather was one of the most important factors influencing the commodity price peaks in 2007/08, and especially in 2010/11. Weather conditions were a more long-term factor concerning the 2007/08 crisis since unfavorable weather conditions were present prior to the crisis, from 2005 to 2007. According to the OECD (2007), shortfalls in wheat production in major producing countries such as Australia, the U.S., EU, Canada, Russia and Ukraine, whose wheat prices have major impacts on world markets, can be assigned primarily to unfavorable weather conditions. The influence of unfavorable weather conditions was particularly important for the 2010/11 crisis. Indeed, the weather began to influence expectations of the 2010/11 global crop production as early as June 2010. The weather events were becoming more extreme compared to 2007/08, including the 2010 drought in Russia. Indeed, the heat wave caused the highest July temperatures in 130 years. This was followed by the governmental decision to ban wheat exports in order to secure domestic consumption (Welton, 2011). Several other countries followed by imposing some sort of wheat export restriction (Giordani et al., 2012; Sharma, 2011). Predictions of the influence of climate change on the yields of major crops made by Lobell et al. (2011), shows that there will be yield changes much greater than those recorded before, during and after the crises in 2007/08 and 2010/11. This will reasonably contribute to even higher price increases in the future. Thus, the issue of climate change will continue to be one of the most important factors influencing food prices.

Besides unfavorable weather conditions, the literature recognizes governmental policy interventions as another of the most important factors accelerating commodity and food prices during the global crisis. In both the crisis periods of 2007/08 and 2010/11, governments of both exporting and importing countries intervened on their commodity markets in order to mitigate the impact of rising global commodity prices (FAO, 2008). Most of the net exporting countries implemented some kind of export restrictions (e.g. export ban, export tax, or export quota) to secure a sufficient domestic supply. Additionally, some of countries implemented policy measures to protect vulnerable consumers and to increase the incentives of producers during the crisis periods (Trostle et al., 2011). Thus, governmental interventions, especially export restrictions, have drawn considerable attention from policy makers and researchers in recent years. The main research focus is on the effects of the export restrictions on international and domestic food prices, and on welfare implications for the counties enforcing them (see Abbott, 2012; von Braun and Tadesse, 2012; Sharma, 2011).

The impact of export restrictions on international commodity markets was investigated by Piermartini (2004), who examined the influence of the export taxes on global commodity prices and trade volumes, as well as the welfare distribution between international and domestic producers and consumers. His case study concerning copra (a raw material in coconut oil production) export taxes in the Philippines shows that implementing the export tax caused an amplification of the price fluctuation of copra on the domestic market instead of stabilizing them; the terms-of-trade effects were not accomplished since the Philippines are considered a small copra exporting country. Indeed, due to cross-sector spillover effects, the main consequence of the reduced copra prices was that unskilled workers experienced welfare loss. Piermartini observed similar results for an export quota on palm oil in Indonesia and an export quota on cotton and yarn markets in Pakistan. Overall, his results show that export taxes have an important impact on commodity prices: they cause the inefficient production, consumption and allocation of resources and thus contribute to the deadweight loss for the whole economy. Also, Mitra and Josling (2009) investigate the impact of export restrictions and welfare implications for countries enforcing restrictions and those who are affected by these measures. By estimating world supply and demand for different commodities, these authors were able to compare the world price and quantity traded both before and after the implementation of an export ban by several exporters (i.e. India). Their results show that export restrictions cause significant increases in domestic prices, leading to a decline in consumer welfare and a net economic welfare loss for the country imposing such restrictions. In the case of export restrictions imposed by a large commodity exporter, the international price will increase, leading to a short-run welfare gain for producers and a welfare loss for consumers. Furthermore, Dollive (2008) used quantitative analyses in order to identify the impact of export restraints on grain prices during the global commodity price peak in 2007/08. His research is focused on China, Argentina and Ukraine, and he provides country-specific case studies concerning the implementation of different types of export constraints for different commodities. The results from all three case studies confirmed that implementing export restrictions (i.e. export tax, export quota or export ban) has an impact on trade partner countries and on global markets (especially in the case of large exporting countries). Also, Dollive argues that export restrictions enforced by large exporters might influence other exporters to make the same decision due to increased demand (e.g. the case of Ukraine, Russia and Kazakhstan in 2007/08). Dawe and Slayton (2011) come to a similar conclusion by observing the impact of rice export restrictions implemented by India and Vietnam during the global commodity price peak in 2007/08. These authors argue that export restrictions created uncertainty on the rice market, mostly because the duration of restrictions was not known a priori. Jones and Kwiecinski (2010) used a consistent methodology to estimate the marginal changes in fiscal expenditure and revenue, which might be caused by intensive governmental interventions. These authors observe ten country-specific cases with the aims of identifying the short-term policy responses caused by increased international commodity prices, as well as analyzing the impact of these responses on domestic markets. Their results indicate that export restrictions imposed by particular countries did not always have the desired effect. The export restrictions of Ukraine, India and China certainly had a significant effect on exported volumes, while the export restrictions in Russia and Vietnam did not achieve their goal. They also found that the policy interventions in India, China and Indonesia were most effective in mitigating high international prices on their domestic markets. On the other hand, the export restrictions in Ukraine did not limit price transmission from the international market. Martin and Anderson (2012) examine the impact of export restrictions on rising commodity prices during the price booms in 1973/74 and 2006/08, and estimate to which extent changes in trade policy measures contribute to the price increase of wheat and rice by comparing the distortion rate between consumer and international prices. Their results indicate the significant impact of trade policy measures on raising wheat and rice prices. These authors estimated that 30 % of the observed international price of wheat and 45 % of the price of rice can be explained by governmental interventions.

More country-specific analysis has been conducted by von Cramon Taubadel and Raiser (2006), who investigate the effects of the grain export quota in Ukraine. They estimated that wheat producers lost around 350 million U.S. Dollars during the marketing year 2006/07, while wheat exporters lost around 300 million U.S. Dollars by not being able to export wheat until the end of 2006. Consumers did not benefit either, since prices of flour and bread rose significantly during the observed period. Nevertheless, these authors argue that the main beneficiary of the governmental policy are millers and feed producers who managed to increase their margins during the observed period. Later, Grueninger and von Cramon Taubadel (2008) estimated that producers lost around 1.6 billion U.S. Dollars during the 2007/08 marketing year, and at the same time wheat exporters lost about 48 million U.S. Dollars. As in the earlier case, the authors argue that consumers were confronted with rising food prices and that the main beneficiaries of the governmental interventions were millers who used the situation to increase the margin between wheat and flour prices. Also, NOGUES (2008) investigates the domestic impact of export restrictions in Argentina by simulating their socio-economic impact. He conducted micro-simulations to estimate the impact of eliminating export restrictions on the costs for the basic food basket and the basic total basket. He then used these two simulations to calculate the incidences of indigence and incidences of poverty, respectively. His results suggest that export restrictions worsen the economic and social performance of a country. NOGUES argues that eliminating export restrictions in Argentina would increase agricultural production (estimated increase in GDP between 2-4 %), employment (by 300,000 jobs), and reduce poverty in the long run (for half a million people). Additionally, he states that eliminating export restrictions should be a gradual process because domestic food prices will increase instantly and thus affect the consumers' welfare. WOLDIE and SIDDIG (2009) found that the overall estimated welfare impact of cereal export restrictions in Ethiopia was about 148 million U.S. Dollars. These authors argue that export bans cause greater welfare loss when applied on grains and cereals, which are inelastic staple goods (see also MITRA and JOSLING, 2009). Later, WELTON (2011) investigated the domestic and international short- and long-term impact of the grain export ban implemented by the Russian government in 2010/11. Concerning the domestic short-run impact, he argues that the export ban was not effective since wheat, flour and bread prices increased after the measure become fully effective, thus increasing the poverty within the country. In the long run, an export ban has a negative effect on the producers' incentive to produce grains. Concerning internationals' short-term effects, the export ban had a price-increasing effect on the world market, while in the long term Russia lost its reputation for being a reliable supplier. Recently, GÖTZ et al. (2013) investigated the domestic market effects of export restrictions imposed by Russia and Ukraine in 2007/08. Their results indicate that export restrictions reduced the degree of market integration between Ukrainian and Russian wheat markets and the world market. They also found that crisis policies in both countries contributed to increased domestic market instability, which caused negative welfare effects for wheat producers who were not able to benefit from the high world prices. Furthermore, negative market effects discouraged private investors from investing in grain production and infrastructure, which directly affects the possibility of Russia and Ukraine maximizing their grain potential.

Throughout the literature, it becomes evident that export restrictions have played a significant role during recent commodity price peaks by causing consumers' and net economic welfare loss, followed by an increased number of poor people within the country imposing the restrictions.

3.2 Chronology of the Serbian governmental policy interventions

This section provides a chronology of the policy interventions taken by the Serbian government during the commodity price peaks in 2007/08 and 2010/11. As such, it represents the essential part of the study, which will be used extensively for the empirical analysis in chapter 5 and for the general discussion in chapter 6.

Information about the policy measures was collected in interviews with key experts, traders, and politicians who were directly or indirectly involved in lobbying, creating or implementing these measures. The interviews were mainly conducted in person with the following people: Mr. Vukosav Sakovic, the leading national expert on grain markets in Serbia and the president of the Serbian Grain Fund "Zita Srbije"; Mr. Zdravko Sajatovic, the representative of the Serbian Union of millers ("Zitovojvodina"); Prof. Dr. Natalija Bogdanov, a leading agricultural policy expert; Prof. Dr. sc. agr, and Dr. ecc. Vlade Zaric, a leading agricultural trade policy expert; Mr. Dejan Soskic, the Governor of the National Bank of Serbia, and Mr. Bojan Markovic, Vice Governor of the National Bank of Serbia. These interviews were conducted between February 2009 and December 2011. Additional information was gathered from official announcements by the government and the Ministry of Agriculture, Trade, Forestry and Water Management (MATFWM) that were released during the observed period. Also, an extensive literature review has been conducted of the specialized grain trade reports provided weekly by the Serbian Grain Fund and other specialized media (including Agra Food East Europe, the United States Department of Agriculture – Global Agricultural Information Network, USDA GAIN reports, and specialized agricultural websites).

Facing soaring domestic and international wheat prices, especially in 2007/08 and 2010/11, the Serbian government (de facto MATFWM) was intervening radically on the wheat and flour markets. The government introduced numerous ad hoc policy measures to mitigate the influence of the high global commodity prices on the domestic Serbian market. The interventions on the bread[19] market were rather indirect until 2011.

All governmental interventions, both in 2007/08 and 2010/11, were caused by the rapidly increasing Serbian wheat export and very high wheat prices on the domestic, regional and world markets (Figure 3.3). The government justified its interventions by the danger of running out of emergency[20] wheat stocks, which could have forced Serbia into a wheat-importing position, and by high food prices that would affect consumers negatively. Thus, the aim of the government was to secure the domestic wheat supply and protect consumers.

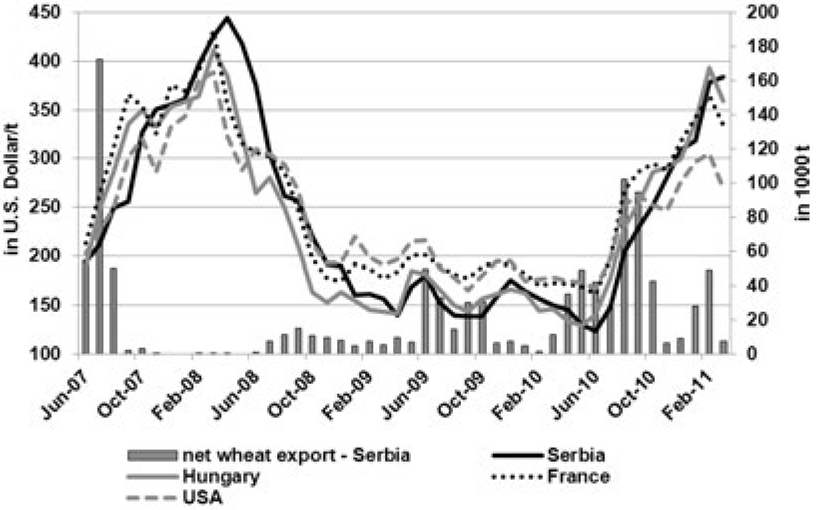
A detailed description of the implemented policy interventions on the wheat, flour

19 Concerning the "bread market", we consider prices and policy measures that refer to the so-called "social" bread. This type of bread weighs 500 g/loaf and is made from flour of the type T500. This is the cheapest and most consumed bread in Serbia.

20 Here we refer to total wheat stocks within the country that are owned by the government and other private entities (producers, mills, bakers, cooperatives, traders, etc.). According to experts, emergency stocks amount to about 350,000 t, which is almost equal to three months of domestic wheat consumption in Serbia. If the total domestic stocks go lower than this level, it is reasonable to expect that wheat imports will be necessary.

and bread markets regarding the commodity price peak in 2007/08 are described in section 3.2.1, while the measures used in 2010/11 are described in section 3.2.2.

Figure 3.3: Serbian, regional and world wheat prices, 2007 to 2011



Source: Serbian Grain Fund, own illustration.

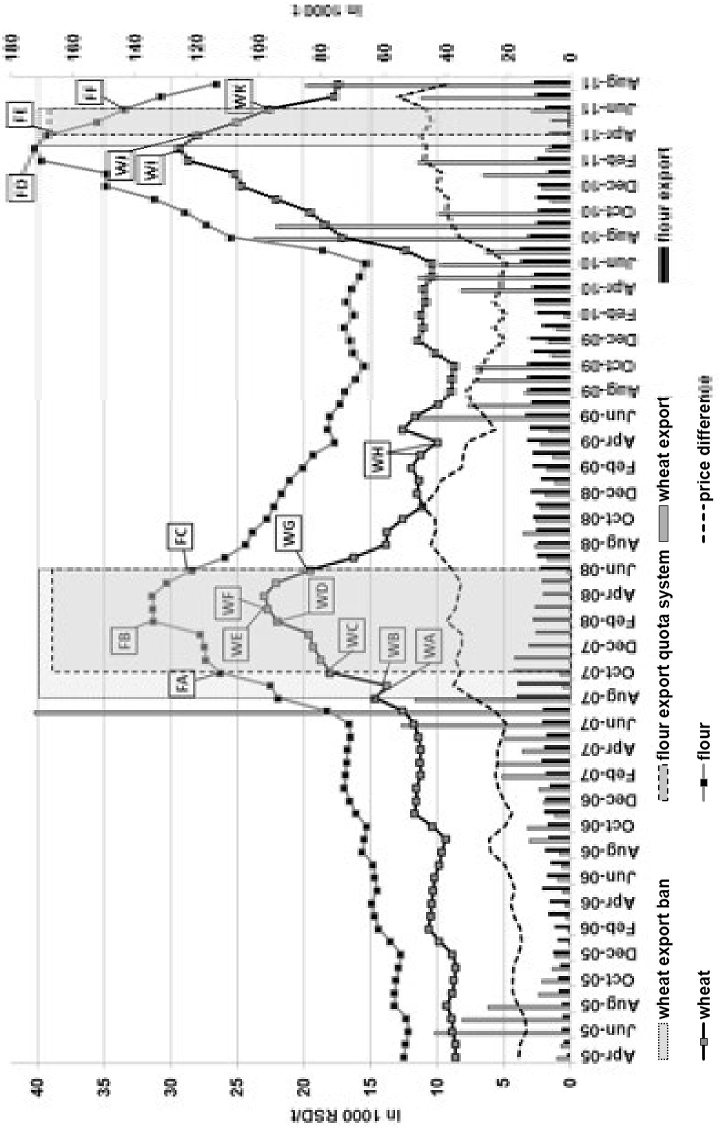
Note: Serbian wheat prices are FCA (Free Carrier Named Place) silo selling price; Hungarian prices are futures prices from the Budapest Stock Exchange Ex Works (EXW) silo prices or Free on Board (FOB) Danube port prices; French prices are futures prices from the Euronext Paris (mainly EXW silo prices); USA prices are futures prices for Soft Red Winter wheat from Chicago Mercantile Exchange (mainly EXW silo price).

3.2.1 Commodity price peak of 2007/08

The Serbian government started to intervene on the domestic wheat market due to a dramatic increase of wheat exports prior to the 2007 harvest. In particular, wheat exports[21] skyrocketed from June until the beginning of August 2007 (Figure 3.3). The significant increase in the foreign demand for Serbian wheat was induced by the relatively low price of Serbian wheat compared to the world market price. Consequently, high wheat prices led to increased flour prices. The increasing export demand for flour pushed flour prices even higher than the wheat prices, which implied a doubling of the price difference (margin) between flour and wheat prices (Figure 3.4). Therefore, the government justified the wheat market interventions by the need to secure a sufficient supply for domestic consumption, and to prevent domestic food prices from large increases.

21 The main export destinations were EU member countries such as Germany, Cyprus, Austria, Slovenia and Romania, with about 74 % of the total wheat export in the first half of 2007, and Bosnia and Herzegovina, with about 17 %.

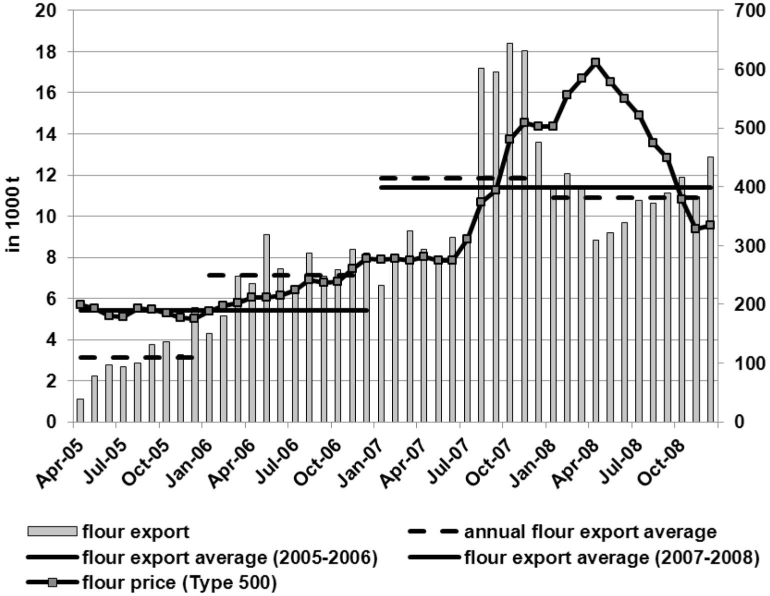
Figure 3.5: Policy interventions on wheat and flour markets in Serbia, 2005 to 2011



Source: Serbian Grain Fund and GEA Info Center, own illustration.

Note: Labels in Figure 3.5 are explained within the text.

Figure 3.4: Monthly flour prices and export quantities, 2005 to 2008



Source: GEA Info Center, GTIS, own illustration.

On August 4, 2007, the Serbian government introduced quantitative export controls[22] on wheat and other grains (Figure 3.5, WA[23]). It was first announced that the export quota would last for 3 months, or until December 2007. Although the MAFWM announced the introduction of export quotas for wheat, the export quotas were actually not issued. Thus, the wheat export was, de facto, completely banned (USDA, 2007). Consequently, the wheat export ban raised the domestic wheat supply, which resulted in a stabilization of domestic wheat prices. However, the wheat prices rose again at the end of September 2007, since the domestic wheat demand increased because of the almost doubled flour export (Figure 3.4). We argue that this period of time in 2007 was the turning point in the development of Serbian flour exports. The main reason is certainly the CEFTA[24] agreement. Since July 2007, this agreement was fully effective, and Serbian traders were able to export flour, as well as other products, without any additional tariff to other CEFTA members. Together with the implementation of the wheat export ban, this was the main reason why flour exports doubled.

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22 Serbian official Gazette, No. 73/07, 97/07 and 126/07.

23 Description of labels presented in Figure 3.5. First letter of the labels refers to the specific market prices (W refers to wheat market and F to flour market), and the second letter refers to the time sequence of the policy measure being implemented (A-first, B-second, etc.).

24 For details see appendix A.

In addition, the DCR announced the purchase of about 60,000 t of wheat from Serbian producers in September 2007 to ensure sufficient wheat stocks (Figure 3.5, WB). Consequently, because of increasing demand, the wheat prices surged by about 30 % within one month. This imposed pressure on the government to consider renewing the export restrictions.

Since wheat prices reached historically high levels in October 2007, on October 26, the Serbian government decided[25] to extend the wheat export ban for another 125 days, or until March 5, 2008 (Figure 3.5, WC). Concurrently, the government introduced a flour export quota of 80,000 t for the same period (Figure 3.5, FA). This resulted in wheat and flour prices dampening until January 2008. During the same period, the price difference between flour and wheat prices oscillated at a very high level.

The second export ban extension[26] was on February 29, 2008, when the government decided to extend the export ban until June 15, 2008 (Figure 3.5, WD). This time, the additional flour export quota of 20,000 t was issued (Figure 3.5, FB). However, the flour export quota was at no time binding, since 84,461 t was exported from a 100,000 t quota (November 2007/May 2008)[27].

At the beginning of March 2008, the DCR decided to purchase[28] about 50,000 t of wheat from the domestic market; the governmental purchase was realized at extremely high prices (Figure 3.5, WE). This pushed Serbian wheat prices to 452 U.S. Dollars/t (April 2008) and thus well beyond the wheat world market price of 369 U.S. Dollars/t. Indeed, in March and April 2008, Serbian wheat prices were about 20 % higher than world market prices. According to experts (V. Sakovic, several personal interviews, February 2009 – December 2011), the market was very thin and only small quantities of wheat were traded. Only a few wheat-processing companies who had run out of stocks bought at these high prices, whereas most companies utilized wheat from their own stocks.

Despite the extremely high domestic wheat prices, the regular wheat import tariff[29] of 30 % was not removed until the end of March 2008. Eventually the government cancelled[30] the wheat import tariff for the quota of 200,000 t (Figure 3.5, WF). Consequently, Serbian wheat prices started to fall severely although no wheat was imported, according to the Serbian official trade statistics (SORS).

On June 15, 2008, the Serbian government removed the grain export ban and flour export quota (Figure 3.5, WG and FC). At that time, the wheat market was charac-

25 Serbian official Gazette, No. 097/07.

26 Serbian official Gazette, No. 023/08.

27 From the first export quota of 80,000 t, about 55,000 t of flour was exported in the period of November 2007/February 2008.

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

29 Under normal circumstances, the wheat import tariff is 30%, and varies according to different bilateral agreements (see appendix A).

30 Serbian official Gazette, No. 026/08.

terized by increased uncertainty. The substantial wheat price decrease in the fall of 2008 was caused by the above average wheat harvest in July 2008, and the large stocks of wheat harvested in 2007 of about 350,000 t, which could not be exported due to the export ban. This led to a domestic wheat supply exceeding the annual domestic consumption by about 600,000 to 800,000 t of wheat. Concurrently, the regional demand for Serbian wheat was low due to the above average harvest in 2008 in the whole region. Another reason for Serbia's low wheat exports was the low quality of the 2008 wheat harvest, which was classified as class II (in terms of content of protein and sedimentation value) and was less suitable for milling. This reduced Serbia's competitiveness compared to other regional suppliers, e.g. Hungary and Romania. Therefore, Serbian wheat exports remained low even in 2008, which further increased the domestic stocks.

In the aftermath of the crisis, Serbia's wheat market was further destabilized by the governmental storage of 40,000 t of wheat in private silos, which were purchased in April and May 2008. This reduced wheat demand by the silos' owners and thus the domestic wheat demand during the 2008 harvest, which further decreased wheat prices in the Serbian market. Additionally, in March/April 2009, the DCR lent substantial amounts of wheat to processing companies (Figure 3.5, WH). This further decreased the market demand for wheat so that wheat prices dropped to a record low price level and further destabilized the market.

Since the price of wheat seeds and fertilizers was very high in 2008, farmers reduced their costs by decreasing the input of fertilizers. Thus, 50 % less fertilizer was used in wheat production compared to the previous year, which increased uncertainty about the size of the expected wheat harvest. This uncertainty was further increased by a severe draught in May and June 2009, one month before the harvest, which also had a price-increasing effect. Finally, the wheat harvest in 2009 was the second largest harvest ever (and immediately followed the largest harvest), which stabilized wheat prices and removed uncertainty.

In addition to the wheat and flour markets, the Serbian government also tried to intervene indirectly on the bread market in 2007/08. The main reason was the significant increase in bread prices, which bakers justified with the rapidly increasing wheat and flour prices on the domestic market. According to our data analysis, we identify three periods between 2007 and 2008 where the bread prices were changed with indirect or no influence from the government.

First, after the bread price remained constant for almost two years from 2005 until 2007, rumors about a bread price increase occurred at the beginning of July 2007. The Serbian Bakery Union (SBU)[31] recommended an increase in bread prices of

31 The Serbian Bakery Union has more than 7,000 members that employ about 70,000 workers.

35 %, from 26 RSD[32] to 35 RSD, for a loaf of bread[33] in all bakeries in Serbia. They justified this bread price increase with the price rise of raw material, particularly wheat and flour, by 41 % and 48 % (since 2005), respectively. Speculations about further bread price increases caused the MTS and the largest representatives of the baking industry, mills and retailers to meet on August 25, 2007 to discuss the future development of bread prices. The "gentlemen's agreement", i.e. no signed obligations, of all participants said that the price of bread would be set at the level of 29.5 RSD (13.4 % price increase) and would changed in the following 6 months, with the intention being to keep this price for 12 months in total (Figure 3.6, BA[34]). This agreed price was determined so that producers and traders could cover their costs and consumers could buy bread for a reasonable price. In this way, traders agreed to reduce their trade margin in order to keep the price on the agreed level. Nevertheless, this price level was not obligatory for small private bakeries because they were not invited to the meeting. Thus, they announced a price increase to the level of 32 RSD.

Second, on November 16, 2007, the large industrial bread producers increased bread prices from 29.5 to 33 RSD, which represented an increase of 12 % (Figure 3.6, BB). They justified this price increase with the record high prices of wheat and flour. This induced small private bakers to increase the bread price to 35 RSD (from 32 RSD in August 2007).

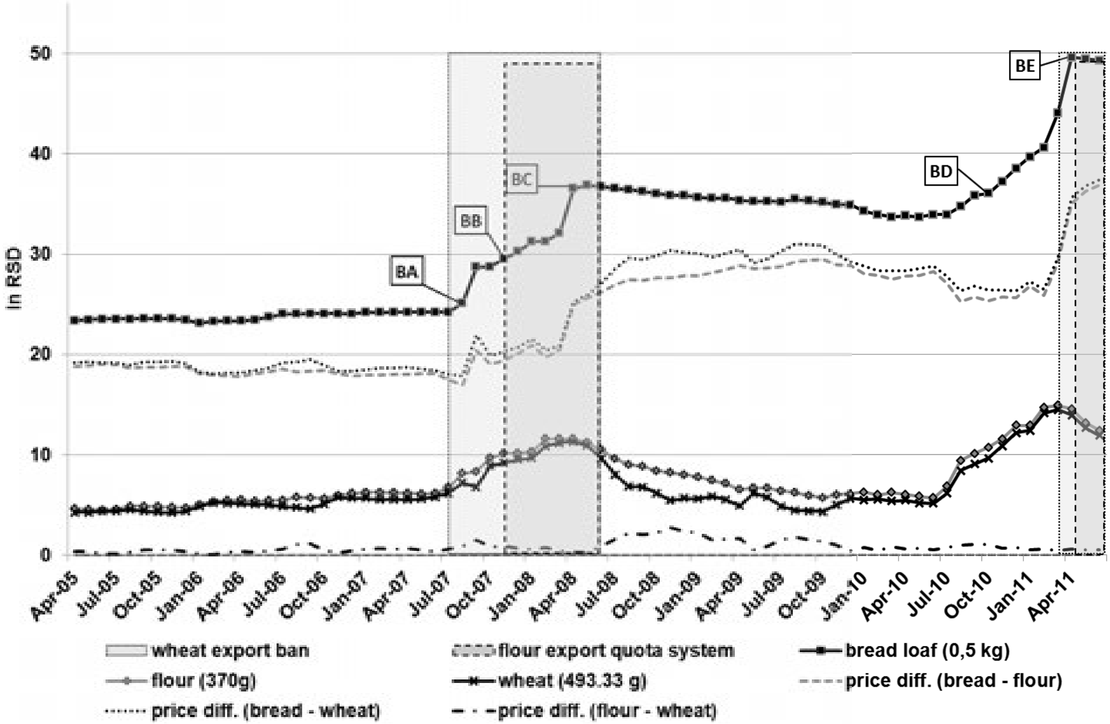
A third bread price increase was announced by the SBU in the middle of February 2008, and was justified by the argument of increased input costs. The official price change was implemented on April 1, 2008, when the price of bread was changed from 33 to 40 RSD (Figure 3.6, BC), representing a price increase of 21 %.

32 The Republic of Serbia Dinar (Serbian Dinar) is the official currency in the Republic of Serbia.

33 One loaf of bread is about 500g.

34 Label **B** refers to the price increasing events/policy measures introduced on the **bread market**. The second letter refers to the time sequence of the event/policy measure (A-first, B-second, etc.).

Figure 3.6: Price increasing events/policy measures on bread market, 2005 to 2011



Source: Serbian Grain Fund, GEA Info Center and SORS, own illustration.

Note: Labels in Figure 3.6 are explained within the text.

3.2.2 **Commodity price peak of 2010/11**

Similar to the crisis period in 2007/08, the Serbian government started to intervene on the domestic wheat market due to a dramatic increase of wheat exports in January and February 2011 (Figure 3.5). The main arguments for this intervention were that about 615,000 t of wheat had been exported (July 2010/February 2011) which was 115,000 t more than the planned 500,000 t, and that this was causing a significant imbalance on the domestic wheat market.

In light of this concern, the government introduced a wheat and flour export ban[35] in March 17, 2011 as the first policy measure implemented by the new agricultural minister, who had just come into office on March 14, 2011. It was announced that the export ban would last for 90 days. This time, the ban referred to wheat and flour, which was not the case in the 2007/08 grain export ban (Figure 3.5, WI and FD).

After only two weeks of the wheat and flour export ban, on March 31, 2011, the Serbian government announced the introduction of an export quota[36] for flour totaling 33,000 t (Figure 3.5, FE). The quota was supposed to be used in a 3 months period amounting for 11,000 t each month starting from April 1, 2011. Together with the flour export quota, the government cancelled the import tariff for 100,000 t of wheat no later than June 15, 2011 (Figure 3.5, WJ). This measure was effective from April 8, 2011. The last recorded policy intervention was actually the change of the already implemented policy measure concerning the wheat and flour export ban where, according to the new regulations from April 12, 2011, all Serbian flour traders who had signed contracts with foreign partners before March 16, 2011, were able to export flour in the amount stated in the contract. Finally, both the wheat export ban and the flour export quota system were cancelled on June 15, 2011 (Figure 3.5, WK and FF).

As opposed to the situation in 2007/08, the government directly intervened on the bread market by regulating the minimum bread production, the trade margin and the retail bread price.

On October 14, 2010, the MTS required[37] bread producers to produce at least 40 % of their bread (of their total bread production) with wheat flour type T500 (Figure 3.6, BD; Figure 3.7). Also, this measure fixed the wholesale bread trade margin at a maximum of 2 % and the retail trade margin at a maximum of 7 %. This means that the total trade margin, including bakers' and retailers' margin, rebate, and cash discounts, should not be more than 9.14 %.

To enable an easier application of this measure, the MTS prepared 75,000 t of flour (about 100,000 t of wheat) for the purpose of lending it to the bakeries. In return, those bakeries borrowing flour from the MTS were to return it after one year and not change the price of bread for at least 6 months. According to experts (V.

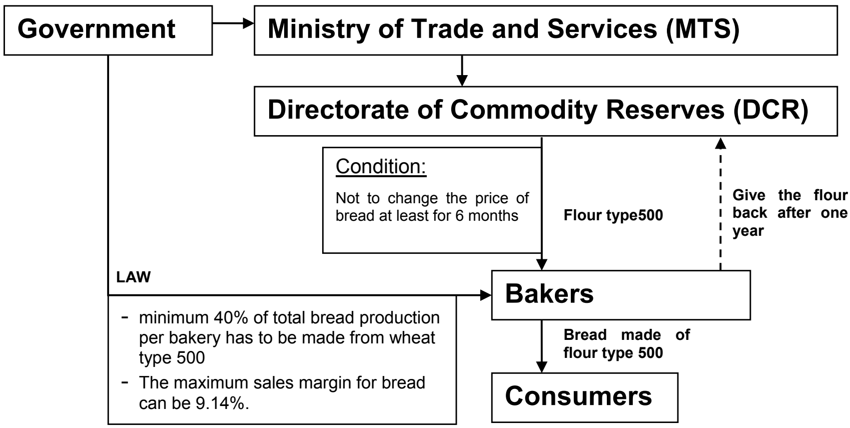
35 Serbian official Gazette, No. 18/11.
36 Serbian official Gazette, No. 23/11.
37 Serbian official Gazette, No. 75/10.

Sakovic and Z. Sajatovic, several personal interviews, February 2009 – December 2011), this measure had a very small effect because only 19,500 t of flour (about 26,000 t of wheat) were borrowed from the MTS.

Finally, on April 1, 2011 the MATFWM introduced a policy measure[38] concerning the production of bread made of flour type T500 (Figure 3.6, BE). According to this policy measure, all bakeries were obliged to produce at least 40 % of their daily bread production of flour type T500. The maximum retail trade margin was set to 7 %, while the maximum trade margin could not be more than 9.14 % of the bread producer price. This time, compared to the policy measure from 2010, the maximum bread producer price was set to 46 RSD/loaf of bread and the maximum retail price of bread was fixed at 54.22 RSD/loaf of bread.

To summarize, the combination of the various governmental policy measures implemented in an ad-hoc manner (without predictions about the possible outcome) during the commodity price peaks in 2007/08 and 2010/11 have contributed to the significant wheat, flour and bread price changes during the examined period.

Figure 3.7: Influence of the Serbian government on the bread price, 2010/11



Source: own illustration.

38 Serbian official Gazette, No. 23/11.

4 Theoretical concepts and estimation approaches

In this chapter we aim to provide a general overview of the theoretical framework and the estimation approaches that represent the foundation of further empirical analysis.

This chapter is structured as follows: Section 4.1 provides a general overview of the fundamental theoretical concepts underlying horizontal and vertical price transmission analysis. Section 4.2 provides a brief overview of the econometric models used for modeling nonlinearities in price transmission with a focus on regime-dependent models (i.e. Threshold and Markov-switching models). In section 4.3, the estimation procedures concerning the selected econometrical models and simulations at the different levels of the wheat-to-bread supply chain are described in detail. The data sets used for the analysis are presented in section 4.4.

4.1 Fundamental price transmission concepts

The transmission of price shocks through horizontally and vertically related markets drew considerable attention over the last decade, especially because of the global commodity price peaks and their effects on the global and domestic agricultural markets. There are two general price transmission concepts: a "horizontal" price transmission, which focuses on examining the spatial[39] price relationships between prices on different locations (e.g. the transmission of world wheat prices to domestic wheat prices and vice versa), and a "vertical" price transmission, which focuses on evaluating the price links between different stages (levels) of the supply chain (e.g. the transmission of wheat prices to flour and bread prices).

The fundamental theory of spatial price transmission relies on the concept of a spatial arbitrage condition. This condition implies that the price difference between the same products on two spatially separated markets will never exceed the transaction costs[40]. If the price difference is higher than the transaction costs and

39 As discussed in the study by Listorty and Esposti (2012, p. 82), in addition to the general notion of horizontal price transmission (i.e. spatial price transmission), one can also refer to horizontal price transmission when observing the price linkages between different commodities (e.g. between wheat and corn prices), from non-agricultural markets to agricultural markets (e.g. bio-fuel markets to corn markets), or from different contracting levels for the same commodity (e.g. from wheat futures market to the spot market). In this study, we concentrate on the spatial price transmission notion of horizontal price transmission because in the first empirical model, we investigate the price linkages between Serbian and world wheat market prices.

40 Transaction costs include all necessary costs that occur during the transfer of products from one market to another (e.g. transport costs).

if markets are functioning well, market participants (arbitrageurs) will exploit the opportunity to earn profits and thus they will buy a product on a market where the price is lower and sell it on a market where the price of the same product is higher. Consequently, due to the increased demand on the first market, the price of the product will increase. On the contrary, due to the increased supply on the second market, the price of the product will be reduced. Thus, the spatial arbitrage condition is an equilibrium concept. Following FACKLER and GOODWIN (2001, p. 977), the general interpretation of the spatial arbitrage condition can be presented by the following formula:

$$p_j - p_i \leq r_{ij} \tag{1}$$

where p refers to prices of the products, *i* and *j* indicate two spatially separated markets, and r indicates transaction costs from moving a certain product from market *i* to market *j*.

The spatial arbitrage condition represents the foundation for the Law of One Price (LOP). Theoretically, there is a difference between the "weak" and "strong" LOP. The spatial arbitrage condition is a "weak" form of the LOP, which states that markets which are linked by trade and arbitrage will have a common price for homogeneous products when expressed in the same currency, net of transaction costs. According to MARSHALL (1890, p. 189): "*the more nearly perfect a market is, the stronger is the tendency for the same price to be paid for the same thing at the same time in all parts of the market.*"On the other hand, the "strong" LOP states that the price difference should be equal to the transaction costs (assuming that trade between the markets is continuous):

$$p_j - p_i = r_{ij} \tag{2}$$

FACKLER and GOODWIN (2001, p. 978) argue that "*violations of the strong form of the LOP may indicate a lack of a stable trading relationship or a disequilibrium situation (or both).*"

The LOP is a static concept which implies that prices are always in equilibrium. Nevertheless, the LOP is very unlikely[41] to hold in practice (LISTORTI, 2009; CONFORTI, 2004; MILJKOVIC, 1999). There are several factors that affect the LOP. Some of the most important factors indicated in the literature are transaction costs, border and domestic policies, market power and exchange rates.

Under the notion of transaction costs, one usually considers transport costs, which are particularly important for the trade of agricultural products. These costs usually refer to the freight or per unit transportation costs. As stated by LISTORTI (2009, p. 18), besides transport costs, transaction costs also refer to the variable transport costs (i.e. fright rates), exogenous costs (e.g. testing charges), unit average du-

41 Some studies provide evidence in favor of the LOP (See GOODWIN et al., 2013; MICHAEL et al. 1994; BESSLER and FULLER, 1993).

ties, and immeasurable transaction costs, which CONFORTY (2004) classifies into three major groups: information, negotiation, and monitoring and enforcement costs. According to FACKLER and GOODWIN (2001), even if the LOP is satisfied, prices will not move together due to high transaction costs. Besides transaction costs, border and domestic policies directly affect both spatial and vertical price transmission (THOMPSON et al., 2002; MUNDLAK and LARSON, 1992). Spatial price transmission is directly affected by trade policies (e.g. export ban, export quota, import tariff, etc.) since they keep the price signals from being fully transferred from the world market to domestic markets. Nevertheless, these trade policies can also affect domestic markets and thus vertical price transmission. Market power is another important factor influencing price transmission (MCCORRISON et al., 2001; GOODWIN and HOLT, 1999). Depending on the concentration of a certain industry, it may be that a price increase on the producer level is completely and fully transmitted to consumers, but not in the case of a reduced price. Thus, the agents holding market power will mainly pass through only positive input changes (GHOSHRAY, 2002). Concerning the effects of the exchange rate, DORNBUSH (1997) and KNETTER (1993) argue that the influence of the exchange rate on output prices within the country mainly depends on the ability of firms to adjust their costs according to the exchange rate fluctuations. Besides the domestic effects, MILJKOVIC (1999) argues that the exchange rate risk also has an important impact on export prices.

Besides the spatial arbitrage condition and the LOP, the concepts of spatial market efficiency and market integration play an important role within the theoretical framework of price transmission.

The concept of market efficiency implies that the arbitrage ensures that price differences reflect all marketing costs on the related competitive markets characterized by perfect information. Thus, inefficient markets are considered those on which arbitrage opportunities arise (LISTORTI, 2009). BARRETT and LI (2002) consider this concept as a price-based indicator of tradability. On the other hand, they refer to the concept of market integration as a quantity-based indicator of tradability. These authors also argue that market integration reflects the tradability of products between spatially separated markets, irrelevant of the presence of market efficiency.

According to FACKLER and GOODWIN (2001, p. 978), market integration can be interpreted as a measure of the expectation of the following price transmission ratio:

$$R_{AB} = \frac{\partial p_B / \partial \varepsilon_A}{\partial p_A / \partial \varepsilon_A} \tag{3}$$

where ∂p_B refers to the change in price in region B, ∂p_A is change in price in region A, and ε_A is a hypothetical price shock that shifts the demand for goods in market A, but not in market B. If the expected price transmission ratio (R_{AB})

is equal to 1, then markets A and B are assumed to be perfectly integrated. This ratio is not symmetric, which means that one region can be more integrated with another region than vice versa ($R_{AB} \neq R_{BA}$).

The concept of market integration is not the same as the LOP. According to FACKLER and GOODWIN (2001, p. 979), the LOP can hold even if the price transmission ratio is lower than 1. On the other hand, a price transmission ratio equal to 1 implies a "strong" form of LOP, which leads to the following "rule":

Perfect market integration ⇒ "strong" LOP ⇒ "weak" LOP.

Markets for which there is no transmission of price shocks are said to be non-integrated.

In contrast to horizontal price transmission, vertical price transmission focuses on four fundamental aspects. The first aspect refers to the magnitude, i.e. to the size of the response of prices at each level of the supply chain triggered by a certain shock. This is one of the most examined aspects of vertical price transmission.

Besides the size of the response, the second aspect 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 (VAVRA and GOODWIN, 2005). 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 constraints are present, the transmission of shocks may take place only with a certain time delay or, in an extreme case, they can be completely prohibited.

The third aspect of vertical price transmission refers to the direction of the adjustment, and considers if the price adjustments to a certain shock are transmitted upwards or downwards along the supply chain.

Finally, the fourth aspect refers to the nature of the price transmission, i.e. to whether the price adjustment follows positive or negative shocks, or in other words, if there is a symmetrical or an asymmetrical price adjustment. An asymmetrical price adjustment can occur in any of the previously described vertical price transmission aspects (magnitude, speed and direction). According to PELTZMAN (2000), asymmetric price transmission is the rule rather than the exception. Further, MEYER and VON CRAMON-TAUBADEL (2004) indicate the importance of asymmetric price transmission for welfare and policy implications, arguing that asymmetric price adjustments can cause consumers to not benefit from the reduced prices on the producers' level of the supply chain, or cause producers to perhaps not benefit from the price increase on the retailers' level of the supply chain. These authors conclude that the distribution of the welfare effect across different levels of the supply chain will be altered relative to the case of the asymmetric price transmission.

The asymmetrical price adjustment in both spatial and vertical price transmission can be classified according to speed and magnitude, and according to whether the adjustment is positive or negative. Following Meyer and von Cramon-Taubadel (2004, p. 583), the first criterion for identifying asymmetry in price transmission is to identify whether the speed or the magnitude of transmission is asymmetric. In the case of asymmetry in the speed of adjustment, it can lead to temporary transfers of price shocks, both spatially or vertically. Concerning the presence of asymmetry in the magnitude of price transmission, it may lead to permanent transfers of price shocks. Thus, if asymmetry is present in both speed and magnitude, it can lead to the combination of temporary and permanent transfers of price shocks.

The second classification of asymmetry in price transmission is done by identifying if asymmetry is positive or negative. If the prices at the higher stage of the supply chain react more fully and faster to price increases on the lower stage of the supply chain compared to the case when prices on the lower stage are declining, then asymmetry is classified as positive. In contrast, if prices at the higher level of the supply chain react more fully and faster to price decreases on the lower level of the supply chain, asymmetry is classified as negative.

Finally, the third classification refers to whether asymmetry affects spatial or vertical price transmission. The influence on spatial price transmission can be seen in the example of small wheat exporting countries that are more likely to adjust their prices more fully and faster to the wheat price increase on the world market (set by big exporters) than in the case of a price decrease on the world market. The influence on vertical price transmission can be seen with the example of a price increase on the producer level being fully, and almost instantaneously, transmitted to the higher levels of the supply chain (processors, wholesalers or retailers) than in the opposite case when prices are declining.

4.2 Econometric framework for analyzing price transmission

Before building a proper framework for the price transmission analysis it is crucial to identify the price series properties. Considering that we observe the wheat market in Serbia, our data mainly consist of commodity prices (see section 4.4.). According to Myers (1994), the main characteristics of the commodity prices are that they are characterized by the stochastic trend and that they tend to move together over time. To identify the properties of our data, we conduct the standard unit root and cointegration tests.

The price series are tested for stationarity[42] in order to avoid the case of spurious[43]or nonsense regression. Following Vavra and Goodwin (2005, p. 30) the concept of stationarity and nonstationarity can be presented by the following model:

42 The term “stationarity” refers to the “covariance-stationarity”, meaning that a mean of the process does not depend on time (Hamilton, 1994).

43 If two non-stationary variables are regressed on one another, the coefficient obtained from the regression can be highly statistically significant, although the R^2 value is very low. This result could wrongly lead to the conclusion that there is a significant statistical relation-

$$y_t = \beta y_{t-1} + \varepsilon_t \quad (4)$$

Where β represents the estimated coefficient and ε_t is an error term. If β equals 1, then the model has a unit root, meaning that the data series is nonstationary. Thus, β has to have a value between -1 and 1 in order for the model to stationary.

In this study we use the augmented Dickey-Fuller (ADF) test[44] (DICKEY and FULLER, 1979), and the alternative KPPS test (KWIATKOWSKI et al, 1992) to identify the order of integration of the data series. Thus, by making the first difference of equation 4, we will obtain the following:

$$y_t - y_{t-1} = \beta y_{t-1} - y_{t-1} + \varepsilon_t \quad (5)$$

$$\Delta y_t = (\beta - 1) y_{t-1} + \varepsilon_t \quad (6)$$

$$\Delta y_t = \delta y_{t-1} + \varepsilon_t \quad (7)$$

Where Δ is a first difference operator, and $\delta = (\beta - 1)$. The standard Dickey-Fuller test (DICKEY and FULLER, 1979) tests the null hypothesis that the $\delta = 0$, meaning that the data series contain a unit root against the alternative that $\delta = 1$. The standard Dickey-Fuller test can be extended to the augmented Dickey-Fuller (ADF) test, which found broad application in the price transmission analysis. Thus, equation 7 could by modified as:

$$\Delta y_t = \alpha + \delta y_{t-1} + \sum_{i=2}^{k} \lambda_j \Delta y_{t-i+1} + \varepsilon_t \quad (8)$$

The hypothesis of a unit root is the same as in the standard DF test. In order to check the results from the ADF test, one of the alternatives is to use the KPPS test. As opposed to the ADF test, the null hypothesis is that the data series is stationary against the alternative of a unit root.

Once the properties of the data are identified, the preconditions for the price transmission analysis are fulfilled. Because most of the agricultural prices are nonstationary (STIGLER, 2011), the usage of cointegration techniques for analyzing price transmission became one of the most used techniques. Basically, cointegration models allow one to analyze the stationary long-run relationship obtained from the nonstationary variables even if they diverge from this relationship in the short run. Thus, cointegration models are suitable for analyzing both short-run and long-run price dynamics.

The empirical specification of the cointegration models can be presented through the vector error-correction model (VECM). The underlying idea of VECM is based on the equilibrium relationship between the observed variables, where the equilibrium is characterized by the forces that push the economy back towards the equilibrium whenever it moves away (ENGLE and GRANGER, 1987). Temporary

ship between the variables. The spurious regression phenomenon was firstly discovered by YULE (1926).

44 See LISTORTI and ESPOSTY (2012) for a review of the different unit root tests.

deviations from the equilibrium are called equilibrium errors, and the forces correcting these equilibrium errors are said to have an error-correcting behavior. The vector included in the model allows for more than one equation with at least two endogenous variables, and for complex interdependencies among them. Thus, the idea is that the part of the disequilibrium from one period is corrected in the next period. The VECM can be formulated in the following way:

$$\Delta p_t = \alpha\beta' p_{t-1} + \sum_{i=1}^{k-1} \Gamma_i \Delta p_{t-i} + \varepsilon_t \quad (9)$$

Where p_t represents a vector of prices of homogenous products in spatially-separated markets (in the context of spatial price transmission), or a vector of prices of products at the different level of the supply chain (in the context of vertical price transmission), and 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 denotes the cointegration 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, and α denotes 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 represents the speed of adjustment. The matrices Γ_i contain the short-run reactions of the price differences on past differences, and ε_t denotes an error term.

Estimating the VECM consists of several separate estimations. First, the cointegration matrix β is estimated by using the Johansen's maximum likelihood estimation (JOHANSEN, 1988) based on the reduced rank regression, which GONZALO(1994) finds is the best among other estimators (such as Engle and Granger two step ordinary least squares (OLS) regression, nonlinear least squares, principal components and canonical correlation). Second, the loading matrix α (speed of adjustment) is estimated by the OLS. At the end, the short-run dynamics Γ_i, conditional on the estimated matrix Π are estimated by the equation wise OLS (IHLE, 2009).

The presence of cointegration can be identified through a rank Π= $\alpha\beta'$. If the rank (Π) is between 0 and the number of price series (n), and is equal to the number of cointegrating relations (r), i.e. 0 < rank(Π) = r < n, the variables are considered to be cointegrated, which confirms that that the markets under study are integrated.

Despite the extensive use[45]of VECM models and their extensions[46], in price transmission analysis there are still some limitations present that do not allow for the adequate modeling of complex price movements. The underlying assumption of the VECM is that all of the model parameters (α, β, Γ_i, equation 9) are assumed to be constant, which means that this model is characterized by the unique long-run

45 Among others, RAPSOMANIKIS et al. (2003) and FACKLER and GOODWIN (2001).

46 Threshold cointegration models (BALKE and FOMBY, 1997), and asymmetric cointegration models (MEYER and VON CRAMON-TAUBADEL, 2004 and GHOSHRAY, 2002).

equilibrium where the adjustment towards the equilibrium are symmetric (Ihle, 2009; Escribano, 2004).

As stated by Listorti and Esposti (2012, pp. 90-91), one of the recent extensions of the price transmission modeling approaches concentrates on the nonlinearity[47] of the relations among price series. One of the major empirical strategies for including nonlinearity within the conventional VECM is to use the regime-dependent models. The underlying assumption of regime-dependent VECM models is that at least a subset of the model parameters is allowed to change in different regimes, meaning that they can take different but constant values in each of the regimes (Listorty and Esposti, 2012). The main characteristic of these models is that given a certain underlying switching mechanism, time series switch back and forth between the certain numbers of different regimes (Ihle, 2009). Because of their flexibility, regime-dependent VECM models found broad application in price transmission analysis.

Following the interpretation of Listorti and Esposti (2012, p. 92), the general case of the nonlinear VECM is a smooth-transition VECM developed by Teräsvitra (1994):

$$\Delta p_t = \left(\alpha^1 \beta' p_{t-1} + \sum_{i=1}^{k-1} \Gamma_i^1 p_{t-i}\right)\left(1 - G(S_t, \gamma, c)\right) + \left(\alpha^2 \beta' p_{t-1} + \sum_{i=1}^{k-1} \Gamma_i^2 p_{t-i}\right) G(S_t, \gamma, c) + \varepsilon_t \quad (10)$$

where Δp_t is a vector of two prices, α is the speed of adjustment, β represents the long-run relationship between the prices, and the matrix Γ_i refers to the short-run dynamics of the model. The variable $G(S_t)$ represents the transition function with a possible range of the values being between 0 and 1. The variable S_t is the transition variable (usually lagged residuals from the error-correction relationship), parameter γ is the speed of transition between regimes, and parameter c represents the threshold between the regimes. Superscripts 1 and 2 represent two regimes in which observed prices can appear. According to equation 10, the parameters expressing the adjustment and short-run dynamics differ across the regimes, while the long-run relationship (β) remains the same.

Smooth transition models with different specifications of the transition function $G(S_t)$ have found broad application in the price transmission literature. For example, application[48] in spatial price transmission analysis can be found in the study by Ubilava and Holt (2009). These authors use an exponential STVECM to analyze a system of vegetable oil prices and its asymmetric nature by accounting for El Nino effects. Their results from the STVECM suggest a smooth transition between the estimated regimes where the overall model fit to the data is much better than that obtained by the linear models (i.e. VECM). Recently, Serra et al. (2011)

47 The term "nonlinearity" refers to the non-stable parameters of the price transmission model.

48 Among others, additional applications of smooth transition models can be found in the study of Goodwin et al. (2012), Serra (2011), Ghoshray (2010), and Holt and Craig (2006).

use a smooth transition VECM to analyze price relationships within the US ethanol industry. Their model allows for a long-run relationship among the prices, as well as for their nonlinear adjustment towards the long-run equilibrium. For the transition variable, the authors use a lagged residual from an error-correction term. The exponential specification of their model allows them to model a smooth transition between the regimes by using the inverted normal density function. Their results suggest strong energy and food price links because they identified the existence of a long-run relationship among the prices. A recent application of smooth transition models in vertical price transmission analysis can be found in the study by Hassouneh et al. (2012), who use a bivariate STVECM to investigate the effects of avian influenza on price transmission in the Egyptian poultry market. These authors developed an avian influenza food scare information index that was used as a transition variable in the model. Their results suggest that the price adjustments to the market equilibrium mainly depend on the magnitude of the avian influenza crisis. Also, their results indicate that retailers use their market power to increase marketing margins during a period of crisis, while the wholesale margins decline.

There are many different forms of the model presented in the equation 10. Nevertheless, two[49] forms of this model prevail in the price transmission literature, and differ in the underling regime-switching mechanism.

The first form refers to the threshold models, which are considered a well-established methodology for analyzing nonlinearities in price transmission. The main characteristic of these models is that time series might behave differently depending on the threshold variable, which has to be known and quantified. A model can identify different regimes whenever the threshold variable crosses the estimated threshold. At the regime switch, some or all parameters change their value compared to the previous regime. Thus, price transmission parameters are constant within the regimes, but they may differ across the regimes.

Balke and Fomby (1997) provided some of the first descriptions of the threshold cointegration framework which found extensive application in price transmission analysis, both horizontal and vertical. Some[50] of the applications in spatial price transmission include the study of Goodwin and Piggott (2001), who use a threshold autoregression model and cointegration model to account for the transaction costs within the spatial market integration between four different corn and soybean markets in the US. These authors' results indicate that price adjustments towards the shock are much faster if they account for the threshold behavior than in the case of ignoring it. Serra et al. (2006) compared the non-parametric techniques

49 We want to acknowledge the most recent Copula-based model introduced by Goodwin et al. (2013), which can be used for analyzing nonlinearity in price transmission.

50 Among others, additional applications of the threshold models within the spatial price transmission could be found in the studies of Brosig et al. (2011), Greb et al. (2011), Amikuzuno (2010), Sephton (2003), and Ghoshray (2002).

to the non-linear threshold model in order to analyze the spatial price transmission within the EU pork market. Their results indicate that both techniques provide evidence of asymmetric price transmission between the pork markets, where lower transmission is identified when using threshold models. In contrast to the conventional threshold models that assume only one underlying long-run equilibrium between prices, MYERS and JAYNE (2012) develop a framework allowing for multiple equilibria and speeds of adjustments with the regime separation, depending on the magnitude of trade between different maize-producing regions in South Africa and Zambia. Their results indicate that during periods of intensive governmental interventions (i.e. wheat imports), price transmission does not take place.

A recent application of threshold models[51] in vertical price transmission analysis can be seen in the study of BEN-KAABIA and GIL (2007), who use a three-regime threshold autoregressive model to investigate vertical price transmission within the Spanish lamb sector. These authors found that market power might be the main cause of asymmetry in price transmission in the short run. Also, they argue that when the marketing margins are generally low, negative supply shocks would squeeze the margin even more. Also, SHADMEHRI and AHMADI (2010) use a threshold error-correction model to investigate vertical price transmission within the Iranian lamb sector. These authors' results indicate that there is a symmetrical transmission of prices from producers to consumers. On the other side, asymmetry is present in the transmission of prices from consumers to producers, meaning that the lamb prices are set at the retail level of the marketing chain, and are then proposed to producers. Furthermore, HASSOUNEH et al. (2010) apply a regime-switching vector error-correction model (RSVECM) to the analysis of the impact of Bovine Spongiform Encephalopathy (BSE) on price relations in the Spanish bovine sector. These authors extended the threshold error-correction framework proposed by BALKE and FOMBY (1997) by including the regime-switching autoregressive process. Thus, their model represents the multivariate version of the regime-switching autoregressive model (RSAR), and their results indicate that BSE scares have a different impact on beef consumers and producers because consumers are found not to react to BSE scares, while the producer prices adjust to the magnitude of the crisis. Recently, REZITIS and STOVROPOULOS (2011) have used a threshold error-correction autoregressive model to investigate the non-linear adjustment and price volatility within the Greek broiler sector. These authors identify three different regimes where the broiler pricing system increases either the consumer price level and volatility, or the producer price level or volatility depending on the direction of the regime change. They argue that the main sources of the asymmetric price and volatility adjustments come from market power, the product's perishability and inventory management strategies.

51 Among others, the additional application of threshold models within the vertical price transmission analysis can be found in the studies by REZITIS and STAVROPOULOS (2011), SERRA and GOODWIN (2003), and GOODWIN and PIGGOTT (2001).

Besides threshold models, the second form of equation 10 refer to Markov-switching models. The main difference compared to the threshold models is that the state variable, which governs the regime switches, is unobserved. Thus, the actual regime of the model depends on the probabilistic process governed by the Markov-chain (see section 4.3.1 for a detailed description of the model and the underlying regime generating process).

Relatively few studies apply the Markov-switching model to spatial price transmission analysis. Ihle et al. (2009) use MSVECM to illustrate the advantages of using this type of model in price transmission analysis. Their example refers to maize price transmission between Tanzania and Kenya, and their results show that Markov-switching models present a suitable tool, especially for identifying different price transmission regimes during policy interventions such as the maize export ban in Tanzania. Recently, Götz et al. (2013) applied MSVECM to analyze the domestic effects of Russian and Ukrainian export restrictions during the global food crisis in 2007/08. Their empirical results indicate that three price transmission regimes occurred during the observed period, where the “crisis” regime coincided with the period of governmental interventions in both Russia and Ukraine. Also, these authors found that wheat export restrictions in Russia and Ukraine temporarily reduced the integration of these markets with the world market, which increased instability on the domestic markets.

Brümmer et al. (2009) were among the first to introduce the Markov-switching model framework to the analysis of vertical price transmission in agricultural markets. These authors use MSVECM to investigate the impact of policy measures on vertical price transmission between weekly wheat and flour prices in Ukraine. Their results indicate that intensive policy interventions in Ukraine contributed to domestic wheat and flour price instability. Besides the previously mentioned study, few papers apply MSVECM to vertical price transmission analysis. Rezitis et al. (2009) use MSVECM for identifying the impact of the Common Agricultural Policy (CAP) reforms on the lamb sector in Greece. Their results show the instability of prices during the transition period after the implementation of the CAP reforms, indicating that the Greek lamb sector had difficulties adjusting to the new regulations. Recently, Busse et al. (2012) used MSVECM to investigate vertical price transmission along the biodiesel supply chain in Germany. These authors observed price transmissions between diesel and biodiesel, and between rapeseed oil, soy oil, and biodiesel. They argue that different governmental policies (mainly support for bio diesel production) contributed to uncertainty and instability in the German biodiesel supply chain.

As described previously, both TVECM and MSVECM are suitable for modeling the regime-dependent behavior of the time series, and allow for a nonlinear adjustment of deviations from the long-run equilibrium. In both models, the parameters are constant within one regime but are permitted to change between the regimes. Nevertheless, the underlying regime-switching process differs significantly due to the different estimation approaches. In the TVECM, the error-correction term ect_t is the variable that causes the regime switch. Thus, the regime-switching mechanism is endogenous and is completely determined by the price series. Also, the regime-switching variable must be specified before estimating the regimes. In contrast to the TVECM, the main advantage of the MSVECM model is that it can distinguish different price transmission regimes even if the state variable, which governs the regime switches, cannot be completely observed (Brümmer et al., 2009). Usually, the interpretation of the variable causing the regime-dependent behavior is done after estimating the regimes, and relies on the researcher's knowledge of the specific market conditions.

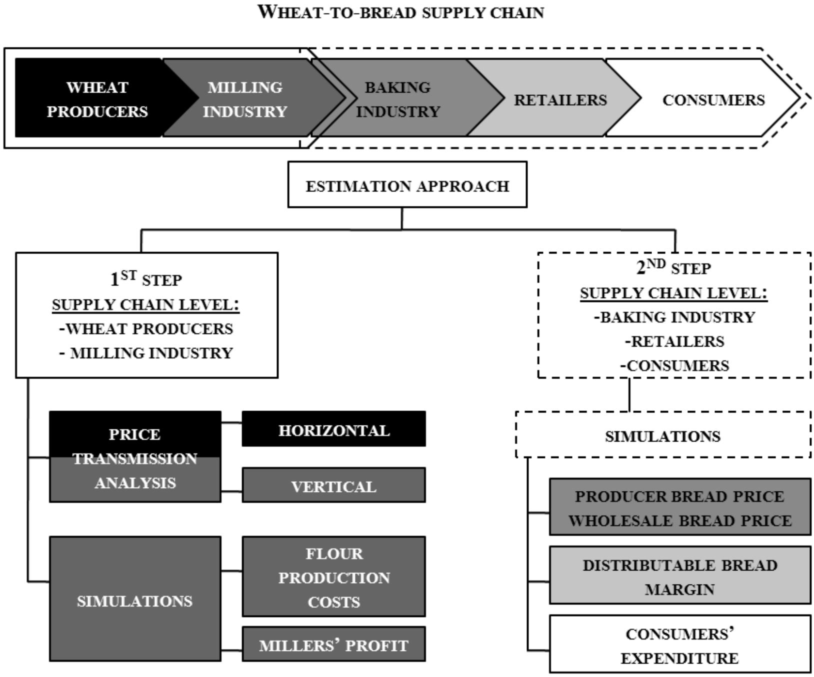
Overall, according to Ihle (2009, p. 184), the TVECM is the more appropriate model for analyzing the time series within a stable economic and political environment in the absence of events that might influence trade. On the other side, the MSVECM is more suitable for analyzing time series within the context of an unstable political environment, where it is unlikely to expect that determining the regimes depends solely on equilibrium errors. This characteristic of the MSVECM is crucial for our study because it is very difficult to clearly identify the reactions of market participants within the unstable political and economic environment in Serbia during the observed period of global commodity price peaks (chapter 3). Even though the exact dates of the implementation of some policy measures are known, e.g. the grain export ban, one cannot say with certainty when the market participants will react. Market participants can change their behavior according to their expectations before the new policy measure is introduced or abolished, or they can react with a certain delay. Thus, specifying the regime-switching variable a priori might be very difficult since the Serbian government simultaneously introduced several policy interventions (section 3.2, chapter 3). Finally, considering the characteristics and the advantages of the presented models, we argue that the Markov-switching model is a suitable framework for our price transmission analysis.

4.3 Estimation approach

To identify the impact of policy measures on the individual wheat-to-bread supply chain members, we divided our estimation approach into two steps (Figure 4.1).

The first step in Figure 4.1 refers to the analysis concerning wheat producers and the milling industry. We further divide this step into two parts. In the first part, we conduct the price transmission analysis to identify the transmission of price signals from the world wheat market to the domestic Serbian wheat market (spatial price transmission), and from the domestic wheat market to the domestic flour market (vertical price transmission). In the second part, we estimate the flour production costs and the millers' profits in the entire observed period. To identify if the millers benefited or lost from the governmental interventions, we compare the previously-obtained results to the laissez-faire policy case.

Figure 4.1: Estimation approach



Source: own illustration.

The second step in Figure 4.1 refers to the analysis concerning the baking industry, retailers and end consumers. This step consists of three parts. The first part refers to estimating the bread producers' price and the wholesale bread price depending on the different wheat price development scenarios. The second part refers to the simulation of the distributable bread margin, which also depends on different wheat price developments. Finally, in the third part of the figure, we analyze how the consumers' expenditure was affected by governmental interventions.

4.3.1 **Estimation approaches for the wheat producers and milling industry**

The initial part of the first step in our estimation approach refers to the price transmission analysis, both spatial (between the Serbian and world wheat markets) and vertical (between domestic wheat and flour markets). Thus, we use two regime-dependent econometrical models.

As previously mentioned, even though the exact dates of implementing some policy measures, e.g. the grain export ban are known, one cannot say with certainty when market participants will react. Market participants can change their behavior according to their expectations before the new policy measure is introduced or abolished, or they can react with a certain delay. This is the main reason why we selected the Markov-switching model framework for our price transmission analysis.

The Markov-switching model can be traced back to HAMILTON (1989), who extended the approach by GOLDFELD and QUANDT (1973) regarding the switching regression model. KROLZIG (1997) developed the MSVECM as a special case of the more general Markov-switching vector autoregression model. The MSVECM is widely used for analyzing business cycles and financial research. A mentioned above, BRÜMMER et al. (2009) introduced this model in price transmission analysis.

We choose the unrestricted[52] Markov-switching (vector) error-correction model as a model framework for our price transmission analysis. We use the MSECM model for spatial price transmission, and the MSVECM for vertical price transmission. The main difference is that the first model is univariate, meaning that we allow for the changes of the world wheat market prices to be transmitted to the domestic Serbian wheat prices, but not vice versa because Serbia is a small wheat exporter and thus has no influence on wheat's world market price.

In general, our model is presented by the following formula:

$$\Delta p_t = \upsilon(S_t) + \alpha(S_t)p_{t-1} + \delta(S_t)p_{t-1} + \sum_{i=1}^{k} A_i(S_t)\Delta p_{t-i} + u_t \quad (11)$$

where Δ is the first difference operator; p_t represents the vector of the prices; υ gives the vector of intercept terms; α is the vector of the speed of adjustment coefficients; δ is the vector of the short run price impacts; A_i are the matrices containing the short run parameters of the system, and u_t is the error term. 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 $\nu(S_t)$, $\alpha(S_t)$, $\delta(S_t)$ and $A_i(S_t)$ show the dependence of these parameters on the state variable S_t. (e.g. intercept υ, equation 12):

$$\upsilon(S_t) = \begin{cases} \upsilon_1 \ if \ S_t = 1 \\ \vdots \\ \upsilon_M \ if \ S_t = M \end{cases} \quad (12)$$

The model assumes a piecewise linearity, meaning that its parameters are allowed to take on different constant values in each regime. Since we are using unrestricted models, the intercept of the long-run equilibrium (β_0) and the long-run price

52 In the restricted specification of the MSVECM the long-run co-integration vector β is assumed to be constant and is not allowed to switch between the regimes.

transmission parameter (β_1) have to be estimated[53] indirectly for each (V)ECM regime in both MS(V)ECM models.

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 from one regime to another is only conditioned by the regime of the previous period (independent of the regime's history):

$$\Pr(S_t \mid S_{t-i}, \Delta p_{t-1}, \beta' p_{t-1}) = \Pr(S_t \mid S_{t-1}, \Pi) \tag{13}$$

The square matrix Π contains the (row-wise) probabilities $[\pi_{ij}]$ for the transition from regime i in time t, to regime j in time t+1, conditioned by the regime of the previous period:

$$\Pi = \begin{bmatrix} \pi_{11}\pi_{21}\cdots\pi_{M1} \\ \pi_{12}\pi_{22}\cdots\pi_{M2} \\ \vdots \quad \vdots \quad \cdots \quad \vdots \\ \pi_{1M}\pi_{2M}\cdots\pi_{MM} \end{bmatrix} \tag{14}$$

The row i, column j element of Π is the transition probability π_{ij}. It should be noted that:

$$\pi_{i1} + \pi_{i2} + \cdots + \pi_{iM} = 1 \tag{15}$$

The Markov Chain is assumed to be ergodic, which ensures a stationary distribution of the regimes, and also irreducible, implying that any regime can be reached from any other regime.

Estimating a MSVECM is based on maximizing the likelihood function with the Expectation-Maximization algorithm developed by DEMPSTER et al. (1977). Subsequently, 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[54] is divided into 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 significantly differ.

After conducting the price transmission analysis, the second part of the first step of our estimation approach refers to estimating the flour production cost and the millers' profits.

53 See appendix B for a detailed calculation.

54 The estimation procedure is available in the MSVAR package (KROLZIG, 2006) for the matrix programming language Ox (DOORNIK, 2002).

The flour production costs and the millers' profits strongly depend on the flour extraction technology, i.e. which type of flour is used, and what percentage can be extracted from one kilogram of wheat. According to PRPA (2004), more than 30 different flour production technologies are used in Serbia, and they differ in the extracted type of flour and in the generated by-products. The primary flour types are T500 and T400, which are mainly used for the production of bread and confectionary products, respectively. Therefore, our calculations are based on the flour extraction technology that extracts 53 % of flour type T500, 15 % of flour type T400, 10 % of flour type T850, 20 % of fodder flour, and 2 % by-products.

To estimate the profit, we first calculate the millers' revenue (R_t) at each point of time (t) as a sum of five different extracted flour types (F) valued by their respective weekly spot market prices (p_t^f):

$$R_t = \sum_{M=1}^{k} \sigma(F) p_t^f \tag{16}$$

$$\sigma(F) = \begin{cases} \sigma_1 \; if \; F = 1 \\ \vdots \\ \sigma_n \; if \; F = k \end{cases} \tag{17}$$

where$M \in \{1, \ldots, k\}$ and $\sigma \in \{1, \ldots, n\}$ depend on the selected flour extraction technology. Thus, in our case σ_1 =0.53, σ_2=0.15, σ_3=0.1, σ_4=0.2, and σ_5=0.02. Also, in this case F=1 corresponds to flour type T500, F=2 to flour type T400, F=3 to flour type T850, F=4 to fodder flour, and F=5 for other by-products.

By deducting the respective costs from the miller's revenue, we are able to calculate the potential millers' profit (π_t), which is presented in the following equation:

$$\pi_t = R_t - p_t^w - C_t \tag{18}$$

Where p_t^w stands for the wheat prices and C_t stands for other costs (in our case we account for packaging costs, which we assume to be fixed at the level of 0.5 RSD/kg).

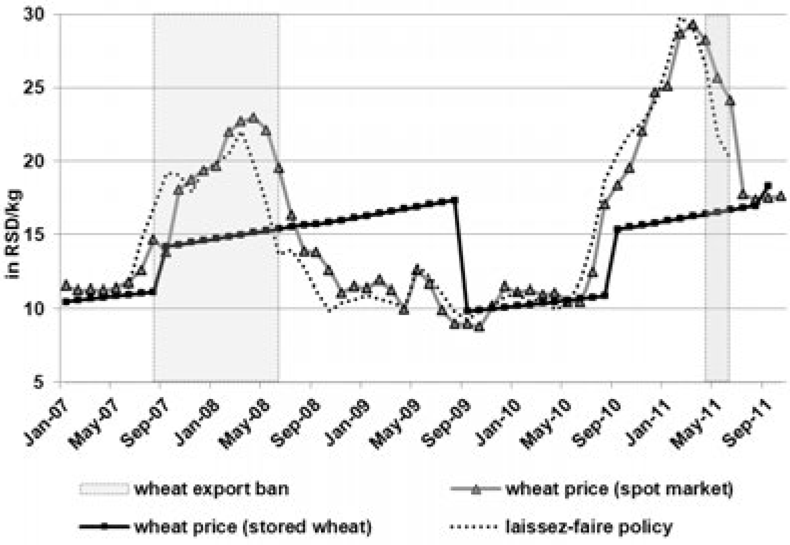
For calculating the millers' profit we use three scenarios based on different wheat price calculations (Figure 4.2). Scenario 1 refers to the mills that do not have access to large silos and continuously buy wheat on the spot market. Thus, the flour production costs and millers' profits are simulated based on the wheat spot market price. This scenario is relevant for the numerous small mills that are dominant in rural areas.

Scenario 2 is based on the wheat spot market price that prevails during the previous harvest (July/August) and the relevant wheat storage costs. This scenario refers to large industrial mills in urban areas, particularly near Belgrade. The wheat price that accounts for certain storage costs is calculated by the following formula:

$$p^w_{S_{t+i}} = [(\overline{p^w_t p^w_{t+1}})\gamma]\,\omega_i \tag{19}$$

Where $p^w_{S_{t+i}}$ represents the price of the wheat stored until *I* period of time (in the calculations presented, wheat can be stored for a maximum of 12 months starting from September). Variable p^w_t is the wheat spot market price during the first month of the harvest (the wheat harvest in Serbia usually starts in July), p^w_{t+1} is the spot market price in the second month of the harvest (the harvest can rarely be extended to the first days of August), γ stands for the silo handling costs that include quality control costs and the costs for the physical transfer of the wheat into the silo (these costs are usually about 3 % of the wheat purchase price). The parameter ω_i represents the monthly storage costs (1 % per month).

Figure 4.2: Monthly wheat spot and storage prices in Serbia, 2007 to 2011



Source: SERBIAN GRAIN FUND.

Scenario 3 is a hypothetical reference case scenario used to illustrate a situation on the wheat spot market in which the Serbian government does not intervene (laissez-faire policy case). In order to create this scenario, we needed to select the wheat prices from some other country which has very similar price development, and where the government did not intervene during the period of the global commodity price peaks. For this scenario, we selected the Hungarian wheat prices considering that Hungary is Serbia's largest wheat export competitor, and as observed in Figure 3.3. (Chapter 3), wheat prices are moving closely together with the Serbian wheat prices. In addition, the Hungarian government did not intervene during the observed period. Thus, the Hungarian wheat prices reflect the most possible prediction of the wheat price development on the Serbian market in the laissez-faire policy case. To estimate the millers' profits in the laissez-faire policy case, we need to estimate the domestic (Serbian) flour spot prices supposing that the Hungarian wheat price level would have prevailed on the Serbian market (Figure 4.3). Thus, we used the results from the price transmission analysis that were taken from the following formula:

$$ln\, p_i^f = \beta_0 + \beta_1 ln\, p_i^H \quad (20)$$

where $ln\, p_i^f$ refers to the estimated flour prices (in logarithm) depending on the respective Hungarian wheat spot market price $ln\, p_i^H$. The coefficients β_0 (constant) and β_1 (long-run price transmission parameter) are retrieved from the MSVECM.

After estimating the spot market prices for flour type T500, we estimated the price of other flour types by multiplying the obtained price with the percentage of the price difference between Serbian flour T500 and other flour types that are used in previous scenarios. By estimating the spot market prices for all types of flour in the laissez-faire policy case, we are able to estimate the millers' profits by deducting the Hungarian wheat prices from the estimated millers' revenue, as explained above.

Figure 4.3: Estimated flour prices (laissez-faire policy case)

Source: own illustration.

4.3.2 Estimation approaches for the baking industry, retailers and end consumers

The second step in our empirical approach consists of three parts that refer to the estimations for the baking industry, retailers, and end consumers.

The first two parts (estimations for the baking industry and retailers) contain the estimations of the bread producer price, the wholesale bread price and the distributable bread margin. These estimations are based on the structure of the average bread loaf production costs presented in Table 4.1. This cost structure refers to the average costs of the large industrial bread producers in Serbia. Thus, they do not present the exact costs of bread production for one specific large industrial bread producer. This cost structure would significantly differ if it were observed for the small artisanal bakeries.

Table 4.1: Bread production cost structure

No.	A) bread producer price (production costs)	No.	B) bread wholesale price (A+)	No.	C) end consumer bread price (B+)
1	flour (370 g)	6	transport	10	retailers margin
2	gross wages	7	cost of bread return	11	VAT
3	energy	8	other costs		
4	general costs	9	wholesale margin		
5	amortization				

Source: Zitovojvodina, own illustration.

Concerning the bread production costs estimations, certain assumptions have been made. Thus, cots of flour are allowed to vary according to the change in the monthly price of wheat. The costs of gross wages are allowed to change according to the annual percentage change in gross wages within the food processing sector. Energy costs (mainly electricity) were adjusted according to the known annual price increase. Transport costs (mainly fuel prices) were allowed to change according to the percentage change in monthly diesel prices.

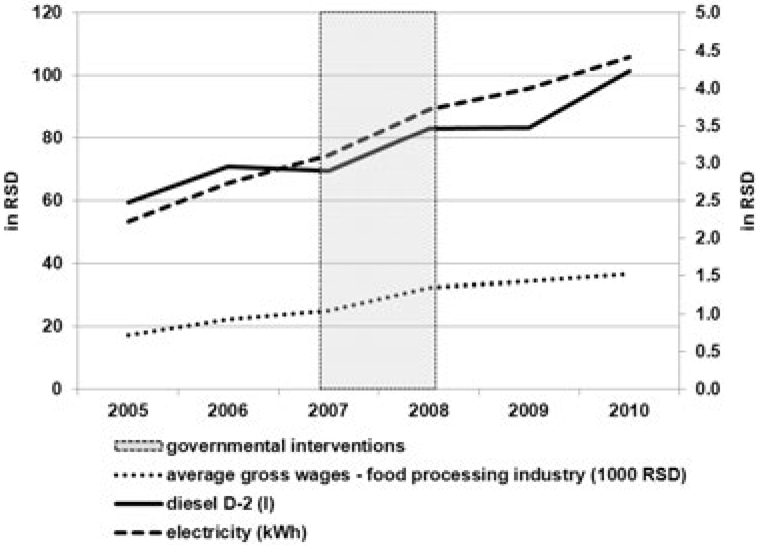
Figure 4.4 shows the price development of electricity and fuel and the development of gross wages within the food processing industry during the observed period. The general costs, amortization, costs of bread return and other costs were assumed to be constant during the simulation period[55].

The estimated bread producer price is the first result of the simulation, and is calculated by summing up the costs of flour (370 g), gross wages, energy and other common costs (general costs and amortization). The second result is the estimated wholesale bread price, which is calculated by adding the transport costs, other costs and the bakers' margin to the producer's bread price. For the purpose of this simulation, the bakers' margin[56] is set to a constant value of about 1 RSD/bread loaf, which is about 4 % of the wholesale bread price, on average.

55 Because of the lack of data, simulations only refer to 2007/08.

56 According to experts, bakers' margin is usually less than 6 % of the wholesale bread price.

Figure 4.4: Electricity and diesel prices and gross wages, 2005 to 2010



Source: AERS and SORS , own illustration.

The second part of the second step in our empirical approach refers to the simulations of the distributable bread margin. In order to explain the notion of the distributable bread margin, we start with an estimation of the maximum achievable retailers' margin, which is calculated as the difference between the retail bread price (reduced by the value added tax) and the previously estimated wholesale bread price. However, according to experts (Z. Sajatovic, several personal interviews, 2009 to 2011), the minimum retailers' margin is about 10 % of the retail bread price. Thus, if the estimated maximum retailers' margin is below 10 %, the large industrial bread producers have to cover the difference, meaning that they are incurring losses.

Furthermore, if the difference between the simulated maximum achievable retailers' margin and the minimum retailers' margin is a positive value, we have a distributable bread margin. Thus, the distributable bread margin refers to the additional profit that the large industrial bread producers and retailers are able to gain given the retail bread prices and the estimated wholesale bread prices. According to experts (Z. Sajatovic, several personal interviews, 2009 to 2011), the distributable bread margin is distributed between the large industrial bread producers and retailers. However, the bakers' margin is usually not higher than 6 % of the retail bread price. Thus, the biggest part of the simulated distributable bread margin is gained by retailers.

All bread production costs and the distributable bread margin simulations are conducted for three possible scenarios, differing in the underlying wheat price.

Scenario 1 depicts the most realistic situation because it refers to large industrial bread producers that buy wheat during the harvest, have access to silos and produce flour that 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, the additional monthly wheat storage costs (September 2007 until August 2008) are added to the wheat spot market price prevailing during the harvest of a particular marketing year, respectively. We argue that this scenario presents the "actual" bread production cost structure.

Scenario 2 is a hypothetical scenario where we assume that flour is produced from the wheat bought for the actual 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 citing increases in the wheat spot market price. Thus, we argue that this scenario presents the "pretended" bread production costs structure.

Scenario 3 is a hypothetical scenario for the average bread production costs that is based on the Hungarian wheat market price. This scenario serves as our reference case representing bread production costs in the laissez-faire policy case, that is, without any policy interventions on wheat and flour markets.

The third part of the second step in our empirical approach contains the estimations concerning consumers' expenditures for food, especially bread and cereals. Here we concentrate on a very poor part of the population, which is the most vulnerable concerning significant food price changes.

4.4 Data

The data used in this study is secondary data provided by various institutions, including the Serbian Grain Fund, the cereals and oilseeds division of the Agriculture and Horticulture Development Board of the United Kingdome (HGCA), the GEA Info Center and the Statistical Office of the Republic of Serbia (SORS). We use several time series datasets for different products, which mainly cover the period from 2005 until 2011. This time frame includes the period of the two global commodity price peaks in 2007/08 and 2010/11, which are our main focus.

The first data set is used for conducting the price transmission analysis between the world wheat prices and the Serbian wheat prices to identify whether the market stability and the integration of the Serbian wheat market was changed by the intensive policy interventions (first part of the first step in our empirical approach). For this analysis, we use a unique dataset of the average weekly spot market wheat (milling quality) grower prices of Serbia (p_t^S), measured as a free carrier[57] (FCA) silo selling price.

57 FCA –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).

For the selection of the proper world wheat price we considered several facts. The ports of the Black Sea are the closest trade places of the world market for Serbia. Thus, free on board (FOB)[58] wheat prices of Russia or Ukraine would ideally serve as the world market price in our analysis. However, Russia and Ukraine restricted their wheat exports temporarily during the observed period (GÖTZ et al., 2013; WELTON, 2011). This explains why a continuous weekly FOB wheat price series does not exist for any of the Black Sea ports. Also geographically close to Serbia is the Budapest Commodity Exchange in Hungary, though Hungarian prices are mainly of regional significance (FAO, 2011). Finally, the EU FOB price usually serves as the relevant world market price for the European wheat exporters (European Commission, 2014; IGC, 2014). Considering that the France is the major grain exporter of the EU, and that the grain is exported to the world market primarily through the port of Rouen, we choose the port, free on board (FOB), prices of wheat (French soft wheat, class 1) of Rouen in France (p_t^R) as a measure for the world market price (Figure 4.5).

Our dataset covers 255 observations from January 2005 until November 2009. All prices are converted into U.S. Dollars using weekly exchange rates (National Bank of Serbia). For the analysis, we use both price pairs in natural logarithms. The missing values are imputed based on the Amelia program (HONAKER et al., 2009) in ***R***. The descriptive statistics of the price time series are presented in Table 4.2.

Figure 4.5: Weekly Serbian and world wheat prices, 2005 to 2009

Source: SERBIAN GRAIN FUND and HGCA, own illustration.

58 FOB–The seller has to deliver goods on board a vessel designated by the buyer (INCOTERMS, 2010).

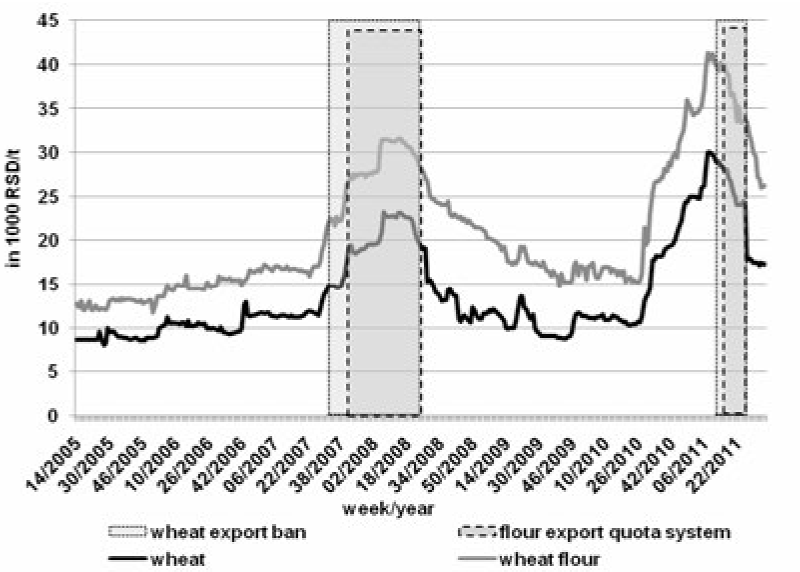
Table 4.2: Descriptive statistics of the price time series – Weekly Serbian and world wheat prices (in U.S. Dollars/t)

Variable	No. of observations	Mean	Standard deviation	Min.	Max.
Time frame (January 2, 2005-November 17, 2009)					
p_t^S	255	200.72	88.85	99.93	446.61
p_t^R	255	215.85	85.07	122.77	449.26

Source: SERBIAN GRAIN FUND and HGCA, own calculation.

The second data set is used for conducting the vertical price transmission analysis between the domestic Serbian wheat and flour prices (the initial part of the first step in our empirical approach). For this analysis, we used average weekly spot market wheat (milling quality) grower prices (p_t^w) measured as a silo selling price (FCA), and average weekly FCA spot market wheat flour[59] (p_t^f) mill selling prices as a measure for the flour wholesale price. The prices are presented in RSD/t because we are observing vertical price transmission on the Serbian domestic market; we use both price pairs in natural logarithms. Our dataset covers 335 observations from April 2005 until August 2011 (Figure 4.6). The descriptive statistics of the price time series are presented in Table 4.3.

Figure 4.6: Weekly wheat and flour prices, 2005 to 2011



Source: SERBIAN GRAIN FUND and GEA INFO CENTER, own illustration.

59 Wheat flour type T500 is mainly used for bread production.

Table 4.3: Descriptive statistics of the price time series – Serbian wheat and flour prices (in RSD/t)

Variable	No. of observations	Mean	Standard deviation	Min.	Max.
Time frame (April 4, 2005 – August 29, 2011)					
p_t^f	335	21,041	7,528	11,675	41,350
p_t^w	335	14,024	5,570	8,000	30,000

Source: Serbian Grain Fund and GEA Info Center, own calculation.

In addition to the first two data sets that are used for conducting the price transmission analysis (spatial and vertical), we used two more datasets to conduct the simulations of the bread producer price, the wholesale bread price and the distributable bread margin. Thus, we use the average monthly spot market FCA prices for flour types T450, T850, fodder flour, bran and "other" (non-classified) flour (Figure 4.7). This dataset covers 58 observations from January 2007 until October 2011. All prices are expressed in RSD/t.

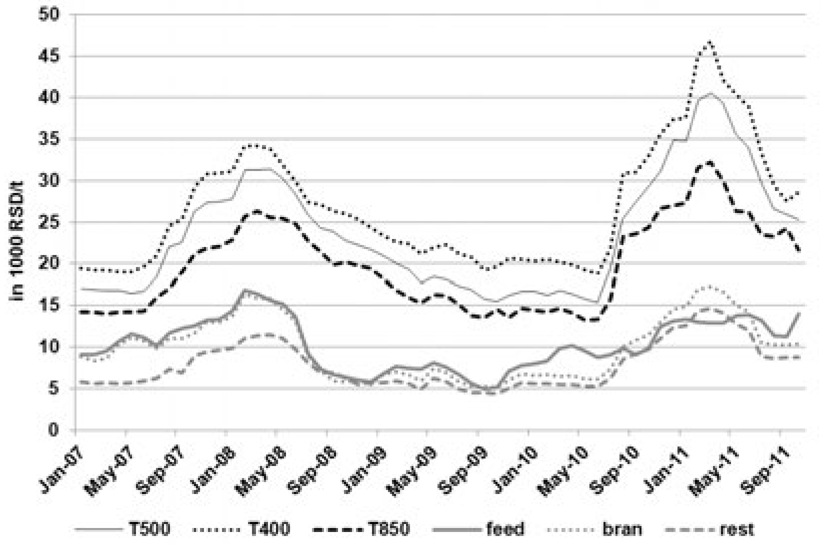
Also, we use the average monthly retail (end consumer) bread prices from April 2005 to July 2011 covering 75 observations. The bread prices are expressed in RSD/bread loaf[60] (Figure 4.8).

To simulate the hypothetical laissez-faire policy case, we use the Hungarian average weekly wheat EXW[61] silo selling prices. The data covers a period from June 2007 until December 2011. All prices are recalculated to RSD/kg, and the exchange rate is obtained from the National Bank of Serbia.

60 One bread loaf weighs 500 g.

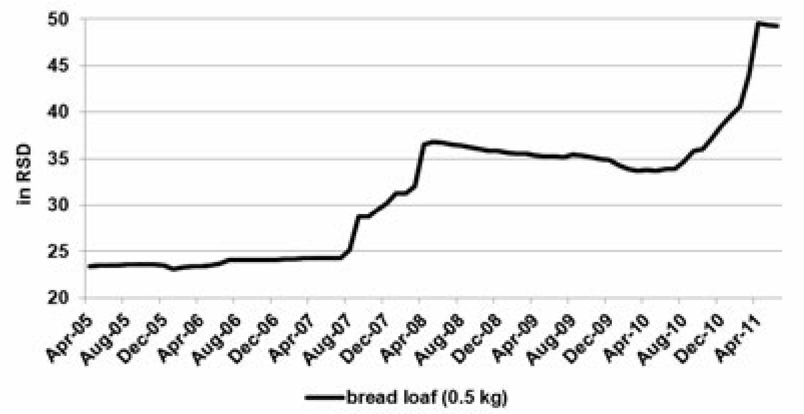
61 EXW – ex works (named place of delivery) – The seller makes the goods available at its premises (INCOTERMS, 2010).

Figure 4.7: Monthly wholesale flour prices, 2007 to 2011



Source: GEA INFO CENTER, own illustration.

Figure 4.8: Monthly retail bread prices, 2005 to 2011



Source: SORS, own illustration.

5 Empirical results

This chapter presents the empirical results from our two-step estimation approach (chapter 4, section 4.3). Section 5.1 provides the empirical results of two price transmission models, flour production costs, and millers' profit simulations. Section 5.2 provides the results of the estimations of bread producer prices and wholesale bread prices, and simulations of the distributable bread margin. Additionally, section 5.2 provides the empirical analysis concerning consumers.

5.1 Empirical results for wheat producers and the milling industry

The empirical results presented in this section refer to the price transmission analysis, both spatial and vertical. The detailed results of two price transmission models are presented in appendix B. Besides the price transmission analysis, we also present results of the estimations of flour production costs, as well as the millers' profits.

5.1.1 Empirical results for the wheat producers

Our first empirical results refer to the spatial price transmission estimations. We observe the transmission of price signals from the world wheat market to the Serbian domestic market to identify how intensive policy interventions influenced market integration and stability during the observed period. The main focus in this part of the analysis lies on the first commodity price peak in 2007/08.

Prior to the cointegration analysis and the model estimation, we conducted the ADF and KPSS test to identify the price series' order of integration. For selecting the proper lag length of the autoregressive process, we use the Akaike Information Criterion (AIC). Results from both tests indicate the presence of a unit root in Serbian wheat prices ($\ln p_t^S$) and world wheat prices ($\ln p_t^R$) in levels because we could neither reject the null hypothesis of a unit root (ADF-test) nor 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 5.1). Hence, both series are found to be integrated at order 1.

Table 5.1: Unit root tests (1st model)

Series	Augmented Dickey-Fuller test			KPSS test		
	Test statistic	Specification	5 % critical value	Test statistic	Specification	5 % critical value
$\ln p_t^S$	-1.6234	1 lag, constant	-2.86	0.8152	10 lags	0.463
$\ln p_t^R$	-1.1854	1 lag, constant		1.1932	10 lags	
$\Delta \ln p_t^S$	-12.3740	0 lag	-1.94	0.2599	10 lags	0.463
$\Delta \ln p_t^R$	-13.7565	0 lag		0.2343	10 lags	

Note: The 5 % critical value in the KPSS test is the same for levels and first differences.
Source: own calculation.

Further, we estimated the time series for cointegration. The results presented in Table 5.2 suggest that the Serbian and world wheat prices are cointegrated. This can be interpreted economically in the sense that a long-run equilibrium between the Serbian and world wheat prices exists, and that the Serbian and world markets are integrated. Thus, the preconditions for utilizing a vector error-correction model (VECM) are given.

Table 5.2: Cointegration test results (1st model)

Johansen's cointegration test					
Number of cointegrating vectors H_0	H_1	Specification	Rank test	p-value	5 % critical value
0	1	2 lags, constant	23.35	0.0164	20.16
1	2		1.63	0.8402	9.14

Source: own calculation.
Note: number of lag length is selected according to the AIC.

The results of the VECM estimation are given in Table 5.3. We conducted the diagnostic tests for the linear VECM by performing the Lagrange-multiplier (LM) test for residual autocorrelation and the Jarque-Bera test for the normal distribution of disturbances. The presence of serial correlation was identified as $\chi^2(1)=74.1$ ($\rho=0.01$), as well as the non-normality of disturbances ($\rho=0.00$). Thus, we checked the system for stability by using a Chow breakpoint test (Chow, 1960). The bootstrapped procedure[62] was used in order to calculate the empirical ρ-values for different breakpoints[63]. The fact that some of the ρ-values of the breakpoints lie below 0.05 indicate that there might be several structural breaks in the linear VECM. In addition to the Chow test, we conducted the τ-Test; the results suggest that the long-run equilibrium relationship is not stable throughout the whole time period underlying our analysis because some values of the τ statistics are above the 5 % critical level (appendix B).

62 We account for 1,000 bootstrap replications. The results are presented in appendix B.
63 We used every week as a possible breakpoint.

Table 5.3: Estimated coefficients of the long-run equilibrium regression – vector error-correction model (1st model)

coefficient	estimated value	t-value	p-value	standard deviation
intercept				
β_0	-0.081	-0.190	0.850	0.426
loading coefficients				
α_{p^S}	-0.097	-4.718	0.000	0.020
α_{p^R}	0.002	0.137	0.891	0.017
estimated cointegration relation				
β_1	-0.972	-12.143	0.000	0.080
lagged endogenous terms				
Δp_{t-1}^S	0.266	4.487	0.000	0.059
Δp_{t-1}^R	-0.114	-1.466	0.143	0.078

Source: own calculation.

Since all previously described tests indicate that the linear VECM is not an appropriate representation for our data, we decided to use a regime-switching model framework (see chapter 4, section 4.2).

Since Serbia is a small wheat exporter and has no influence on the world wheat market price, we estimated a univariate unrestricted MSECM model. Besides that, our model allows for contemporaneous price transmission.

The MSECM is estimated for different specifications with regard to the number of regimes, autoregressive parameters and lagged short-run price transmission parameters. Also, the intercept, short-run price transmission, autoregressive parameters and variances may differ between the regimes. The final specification of the model is selected according to the Schwarz Criteria (SC) and the Hannan and Quinn (HQ) model selection criteria. Both criteria suggest a model with 2 regimes and 1 autoregressive parameter (MS(2)ECM(1)). The optimal model is the MSIAH type, which allows the intercept (I), the short-run price transmission, the autoregressive parameters (A), and the variances/heterogeneity (H) to switch between regimes. The model diagnostics indicate that no autocorrelation is present, and that homoscedasticity and normality of the residuals are given.

Figure 5.1 shows the regime classification of our model, and provides the smoothed regime probabilities for each observation. Thus, the figure indicates the probability of the regime to which one observation is most likely attributed. Each observation corresponds to a particular week.

It is evident from Figure 5.1 that the domestic wheat market in Serbia is characterized by frequent switches between the two price transmission regimes. We call the dominant regime during the time period of our analysis the "normal" regime, which contains 164 observations and has an average duration of less than

9 weeks. The normal regime is supplemented by a second regime that we call the “adjustment” regime, which comprises 89 observations and has an average duration of less than 5 weeks.

The state of the market changed from normal to adjustment several times before, during and after the export ban (August 2007- June 2008). Regime changes are observed in times of the wheat harvest prior to the food crisis, when significant amounts of Serbian wheat were exported (e.g. June, July and August 2005, September and October 2006, June, July and August 2007), or in periods of bad weather (e.g. June 2005 or April 2006), which is decisive for the size and quality of the forthcoming wheat harvest.

During the wheat export ban, the market primarily remained in the normal regime and changed to the adjustment regime in October 2007 and February 2008, when the extension of the export ban was officially announced. The adjustment regime also prevailed in September 2007 and March 2008, when the government purchased wheat from the market (Figure 5.1). These results indicate that the governmental market interventions caused substantial temporary instability on the domestic wheat market.

Directly after the cancellation of the export ban in June 2008, the adjustment regime became the dominant regime for 26 weeks, indicating a high market and price instability. It again prevailed for 13 weeks during the harvest 2009.

The estimated transition probabilities show the highest degree of persistence for the normal regime (0.885). Nevertheless, the adjustment regime also has a high probability to persist (0.788). However, the probability of switching from the adjustment regime to the normal regime is higher than vice versa.

Table 5.4 presents selected parameter estimates of the MSECM, which we interpret as indicators for the degree of market integration, the state of market equilibrium, and market stability.

Concerning market integration, we find that the long-run price transmission elasticity improved in the adjustment regime compared to the normal regime because the difference from the perfect price transmission (when β=1) was reduced.

The market equilibrium is characterized by the size of the deviation of the equilibrium, which is given by the error-correction term (ect_t)[64], and the speed of adjustment. The regime-specific ect_t increased enormously, and the speed of the adjustment rose by 969 % in the adjustment regime compared to the normal regime. This suggests that the domestic Serbian wheat market was temporarily disturbed,

64 The equilibrium between the Serbian and the world wheat market is characterized by the size of the deviation from the long-run price equilibrium (error-correction term – ect_t). The market is said to be in its equilibrium if the ect_t=0. If the ect_t>0, the domestic prices are above the equilibrium, whereas ect_t<0 means that the domestic prices are below the equilibrium.

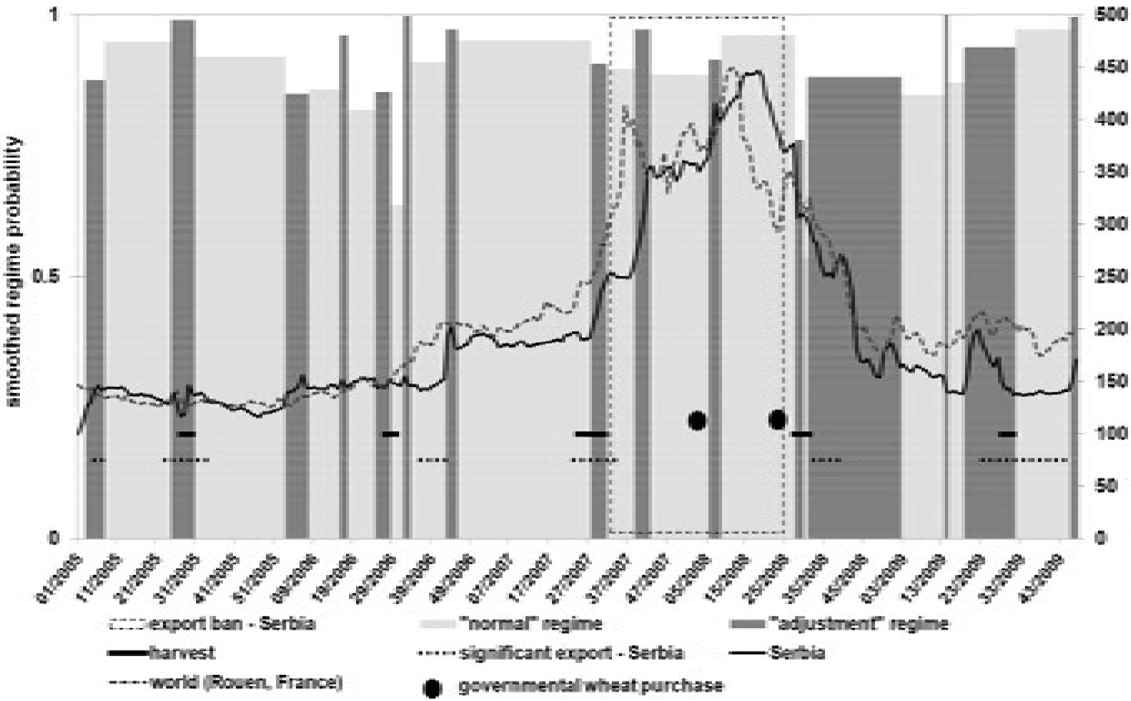
especially after the cancellation of the export ban. The price of wheat on the Serbian market fell substantially below its equilibrium level; the main reasons for this were the above-average harvest, large transfer stocks and low wheat quality. This implies that the situation of the Serbian wheat growers worsened. Whenever the Serbian wheat market is disturbed and driven away from its equilibrium, arbitrage activities intensify and accelerate the speed with which deviations from the long-run equilibrium are corrected.

Table 5.4: Selected parameter estimates MS(2)-ECM(1) – (1st model)

market characteristic	indicator	normal regime	adjustment regime
integration	long-run price transmission elasticity	1.174* (0.174) [a]	0.870** (0.130) [a]
	constant	-0.997	0.606
equilibrium			
deviation from equilibrium	regime specific average ect_t	-0.0002	-0.009
adjustment dynamics	speed of adjustment[b]	-0.029**	-0.284** (+969%) [c]
stability			
price fluctuation	residual standard error [b]	0.016	0.066 (+313%) [a]

a difference from the perfect price transmission (β=1), in absolute values.
b he most probable price transmission regime prevailing in this time period.
c compared to the normal regime.
* indicates statistical significance at 5 %; ** indicates statistical significance at 1 % level.
Source: own illustration.
Note: detailed results are presented in appendix B.

Figure 5.1: Regime classification for MS(2)-ECM(1) – (1st model)



Source: own illustration based on the model specification.

Another parameter that might be associated with the stability of the market is the regime-specific standard error. The estimated standard error for the adjustment regime is substantially higher (+313 %) than in the normal regime, indicating that the instability of the market increased significantly during the adjustment regime, and thus especially directly in the aftermath of cancelling the export ban.

Summarizing the empirical results of the first model, we can say that implementing the wheat export ban did not influence the wheat market integration and price transmission directly during the period of the export ban, but it did have rather strong effects on market integration, equilibrium and stability in the aftermath of the export ban.

5.1.2 **Empirical results for the milling industry**

The empirical results presented in this section refer to the vertical price transmission analysis. Thus, we observe the transmission of price signals from wheat producers to the milling industry (from the domestic wheat prices to the flour prices).

As we did in the first model, we conducted the ADF and KPSS tests first, with an aim to identify the order of integration for the price series. The proper lag length of the autoregressive process was identified by the AIC and SC criterions. Both tests indicate the presence of a unit root in wheat ($\ln p_t^w$) and flour ($\ln p_t^f$) prices in levels. Thus, using the first differences of the price series, both tests provide us with strong evidence of stationarity (Table 5.5). Hence, both series are found to be integrated in order 1.

Further on, we test the time series for cointegration. We use a reduced rank regression of the vector autoregressive representation with two lags included. Our results suggest that the wheat and flour price series are cointegrated (Table 5.6). Thus, wheat and flour markets are integrated.

Table 5.5: Unit root tests (2nd model)

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	

Source: own calculation.

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

Table 5.6: Cointegration test results (2nd model)

Johansen's cointegration test					
number of cointegrating vectors H_0	H_1	specification	rank test	p-value	5 % critical value
0	1	2 lags, constant	28.83	0.0020	20.16
1	2		2.85	0.6160	9.14

Source: own calculation.

The results of the VECM estimation are given in Table 5.7. The conducted diagnostic tests, LM and Jarque-Bera, indicate both the presence of serial correlation ($\chi^2(2)$=12.62; ρ=0.01) and the non-normality of disturbances (ρ=0.00), respectively. Additionally, we conducted the Chow breakpoint test and the τ-test. The bootstrapped procedure used for calculating empirical ρ-values for different breakpoints was the same as in the first model (1,000 bootstrapped replications, where every week was used as a possible breakpoint – appendix B). The results of the τ-test suggest that the long-run equilibrium relationship is at the border of stability (see appendix B).

Table 5.7: Estimated coefficients of the long-run equilibrium regression vector error-correction model (2ndmodel)

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 cointegration relation				
β_1	-0.974	-16.698	0.000	0.058
lagged endogenous terms				
Δp^f_{t-1}	-0.119	-2.145	0.032	0.055
Δp^w_{t-1}	0.166	3.666	0.000	0.045
Δp^f_{t-2}	-0.062	-1.121	0.262	0.055
Δp^w_{t-2}	0.082	1.836	0.066	0.045

Source: own calculation.

Since the results indicate that the linear VECM is not an appropriate representation for our data, we decided to use a regime-switching model framework as was the case in the first model.

We selected the final specification of the MSVECM according to the AIC, SC and 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 MSIAH type, allowing all model parameters to switch between the regimes. The model diagnostics indicate that no autocorrelation or heteroscedasticity are present. Nevertheless, the non-normality of the residuals prevails.

Our model results are illustrated in Figure 5.2, and identify 2 regimes. We call one regime the “normal” regime, and the second regime the “low adjustment” regime. Our model falls 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 low adjustment 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 period of 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 5.8).

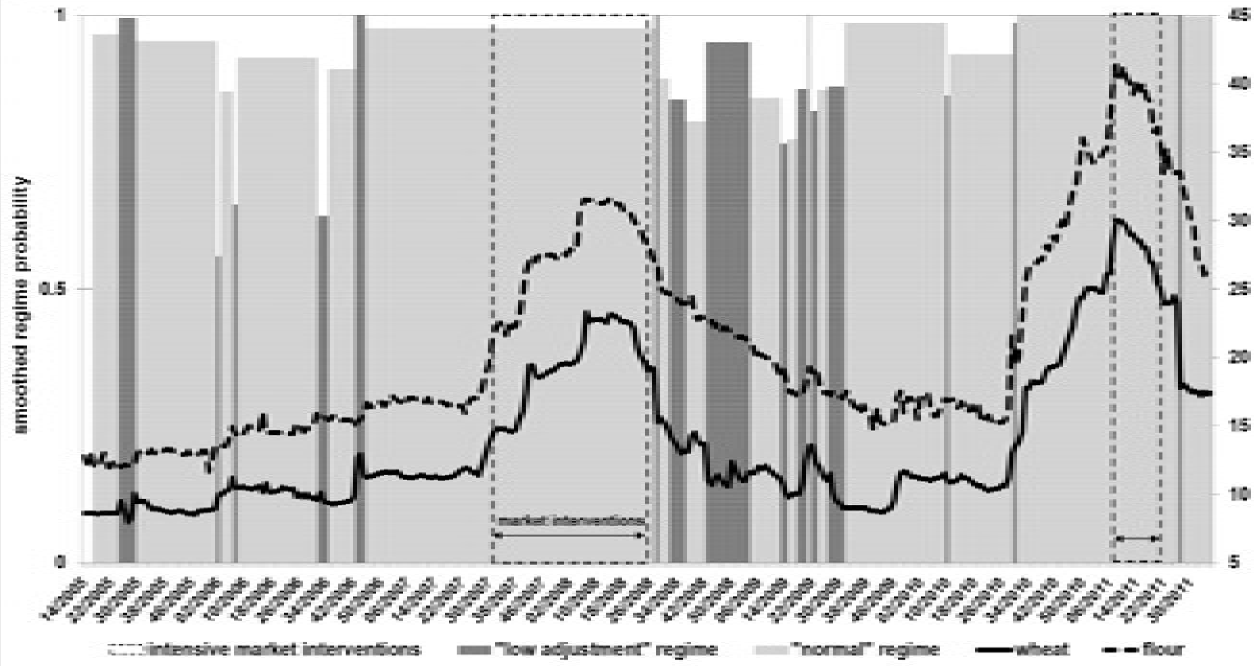
Also, the speed of adjustment in the normal regime is statistically significant and has the correct negative sign. This suggests that the wheat and flour market are integrated, and that the equilibrium errors are adjusted in the expected direction.

Figure 5.2 shows that the normal regime prevails during the intensive governmental interventions in 2007/08 and 2011. Thus, our results indicate that the governmental market interventions did not affect the price transmission between the wheat and flour markets.

The estimated long-run price transmission parameter in the low adjustment regime is smaller than in the normal regime, with a long-run price transmission parameter of about 0.6 (Table 5.8).

The speed of adjustment in this regime is not statistically significant, indicating that the integration between the wheat and flour market was disrupted. The low adjustment regime mainly prevails in the aftermath of the commodity price peaks in 2007/08, as well as in 2010/11, when wheat prices were moving back to their pre-crisis levels. However, the downward trend of the wheat prices is obviously not transmitted to the flour prices in this regime. We suspect that the millers used the situation of previously high wheat prices to argue that they are still using expensive wheat for flour production, and thus do not decrease the flour prices to the same extent as wheat prices on the spot market.

Figure 5.2: Regime classification for MS(2)-VECM(2) – (2nd model)



Source: own illustration based on the model specification.

Table 5.8: Selected parameter estimates MS(2)-VECM(2) – (2nd model)

market	indicator	"normal" regime	"low adjustment" regime
long-run price transmission	elasticity (β_1)	0.908* (0.092) [a]	0.598 (0.402) [a]
	constant (β_0)	1.293	4.142
equilibrium			
deviation from equilibrium	regime specific average ect_t	-0.0179	0.1136
adjustment dynamics	speed of adjustment [b]	-0.1126**	-0.0181
stability			
price fluctuation	residual standard error [b]	0.0354	0.0115

[a] difference from the perfect price transmission (β=1), in absolute values.
[b] the most probable price transmission regime prevailing in this time period.
* indicates statistical significance at the 5 % level;** indicates statistical significance at the 1 % level.
Source: own illustration.
Note: detailed results are presented in appendix B.

Since the price transmission results suggest that the millers might have increased their profits in the context of the price peaks in 2007/08 and 2010/11, we further investigate how the millers' profits developed during the observed time period.

Figure 5.3 shows the simulated millers' profit for scenarios[65] 1 and 2. It becomes evident that the profit in scenario 2 is substantially higher than in scenario 1 in times of governmental market interventions. Large industrial mills in particular were able to obtain more than 2 times higher profits in 2007/08, and up to 4 times higher profits in 2010/11 compared to small mills. Nevertheless, large industrial mills also experienced some losses from March to August 2009 according to scenario 2, which is relevant for the majority of large industrial mills in Serbia.

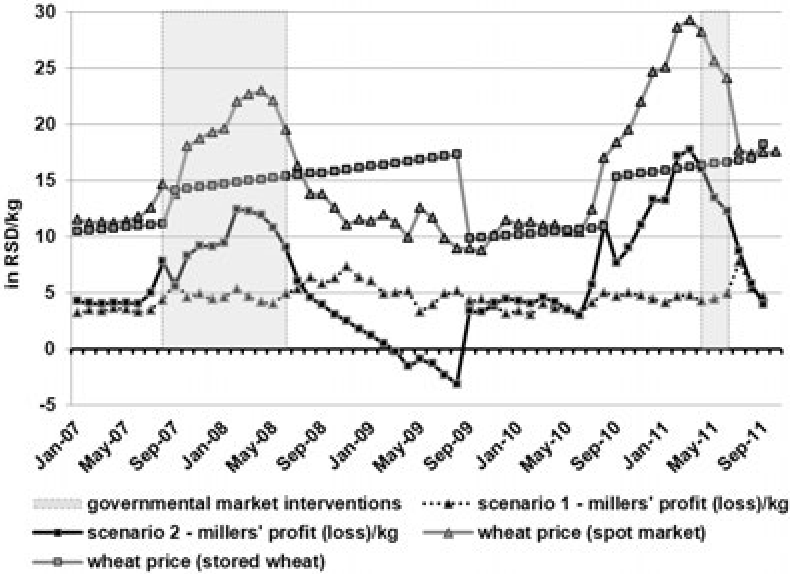
To determine if millers really benefited from the governmental market interventions, we compared the estimated millers' profits from scenarios 1 and 2 to the estimations of millers' profits from scenario 3 (laissez-faire policy case).

Figure 5.4 shows the comparison between the estimated millers' profit in scenario 1 and scenario 3. We can observe that even when the Serbian government did not intervene on the market (Scenario 3), the profits of small mills were almost at the same level as in scenario 1. Nevertheless, it is clear that small mills in scenario 1 had an opportunity to earn extra profits after the cancellation of the governmental measures because the flour prices in scenario 1 were much slower than in scenario 3, which is shown in the price transmission analysis.

Concerning the comparison between scenario 2 and scenario 3 (Figure 5.5), it is clear that the large industrial mills in scenario 2 benefited from the governmental market interventions, especially in the period before the cancellation of the policy measures.

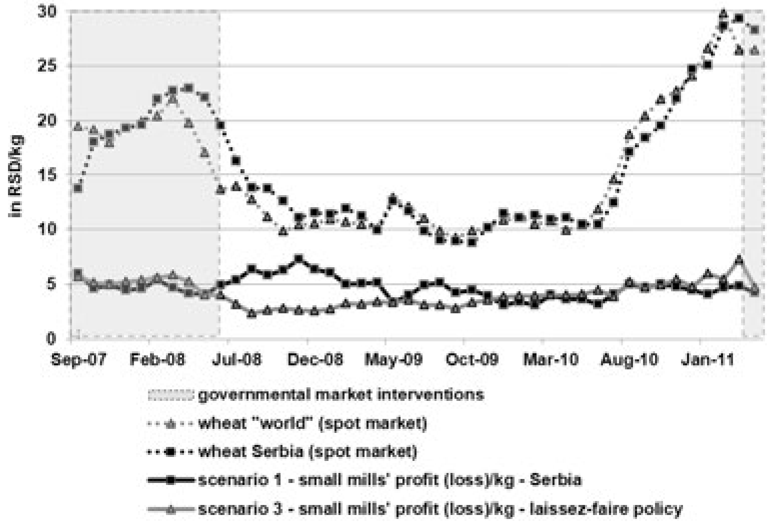
65 See chapter 4, section 4.3.1 for the scenario description.

Figure 5.3: Estimated millers' profit/loss, scenarios 1 and 2



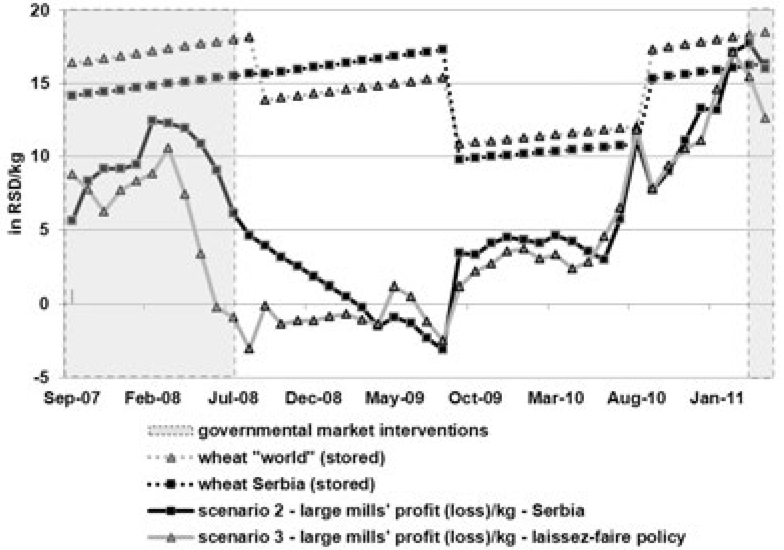
Source: GEA Info Center and Serbian Grain Fund, own illustration.

Figure 5.4: Estimated small mills' profit/loss (scenarios 1 and 3)



Source: GEA Info Center and Serbian Grain Fund, own illustration.

Figure 5.5: Estimated large mills' profit/loss (scenarios 2 and 3)



Source: GEA Info Center and Serbian Grain Fund, own illustration.

However, our simulations suggest that both small and large industrial mills profited overall from the governmental crisis policy.

Finally, most of the mills in Serbia used the strategy presented in scenario 2. The unfavorable wheat market situation in 2010 had a significant impact on the milling industry, together with the financial crisis present since 2008. The actual number of mills that were able to use the opportunity of earning extra profits presented in scenarios 1 and 2 is unknown because our estimations are based on the specific milling strategy and the given spot market wheat and flour prices. It should be noted that milling is a low-margin business, meaning that only those mills that have sufficient financial assets could overcome the crisis periods (e.g. 2010).

5.2 Empirical results for the baking industry, retailers and end consumers

5.2.1 **Empirical results for the baking industry (bread production)**

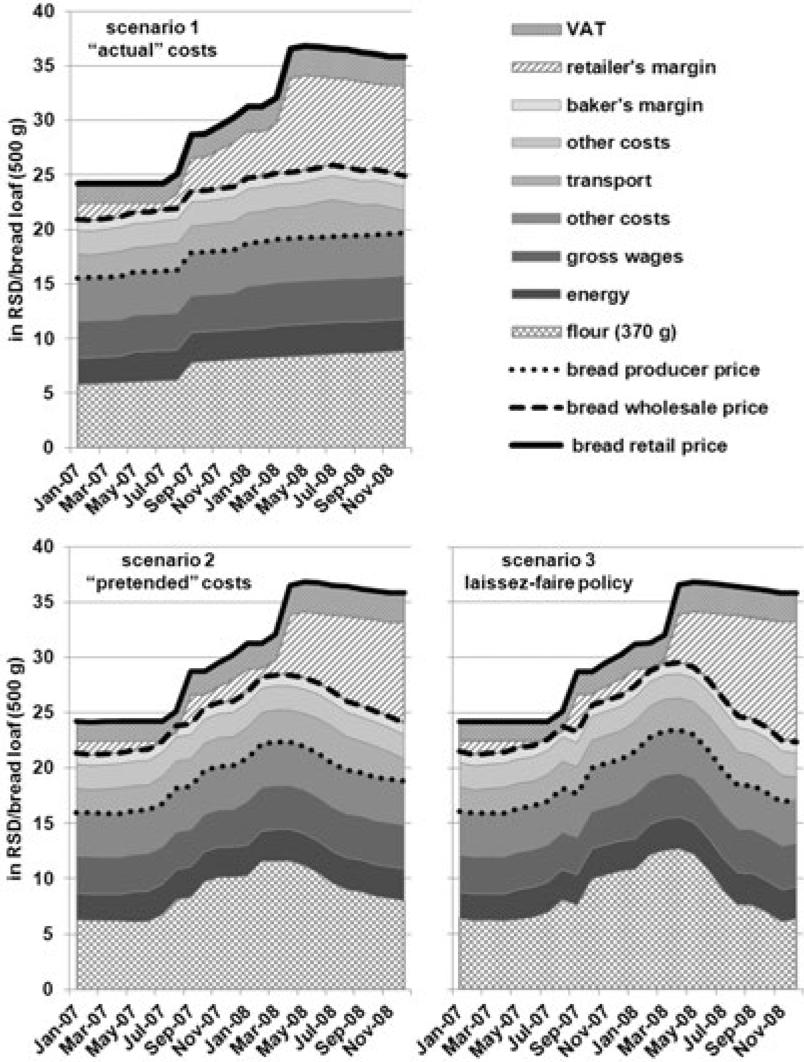
The bread producer price and the wholesale bread price are the main results of our estimations at the level of bread producers.

Figure 5.6 shows the estimation results for three scenarios that differ in the underlying calculation of wheat prices. Figure 5.7 shows the simplified version of

Figure 5.6, where we present only the bread producer price for all three scenarios, compared to the retail bread price. Our results indicate that the bread producer price in scenario 1, which accounts for the actual production costs, is significantly lower than the bread producer price in scenario 2, which accounts for the "pretended" production costs. Furthermore, the results indicate that large industrial bread producers were affected by the high wheat and flour prices on the spot market only during the harvest in July and August 2007. Thus, the significant wheat and flour price increase on the spot market did not affect the bread production cost structure during the observed period of governmental interventions. Nevertheless, the bread producers (together with the retailers) successfully increased the end consumer price of bread, even if it was wrongfully justified by the increases of the wheat and flour spot market prices.

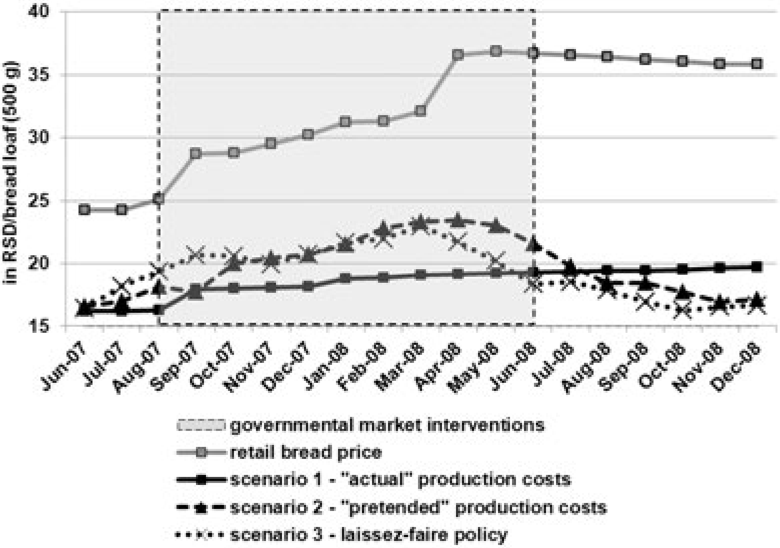
Without the governmental market interventions and thus with the Hungarian market prices prevailing on the Serbian spot market (scenario 3 – laissez-faire policy case), the large industrial bread producers (and retailers) would not have been able to realize the second dramatic bread price increase in April 2008 because the Hungarian wheat market prices were recording a strong downward trend.

Figure 5.6: Simulated bread production costs, 2007/08



Source: own illustration.

Figure 5.7: Simulated bread production costs, 2007/08



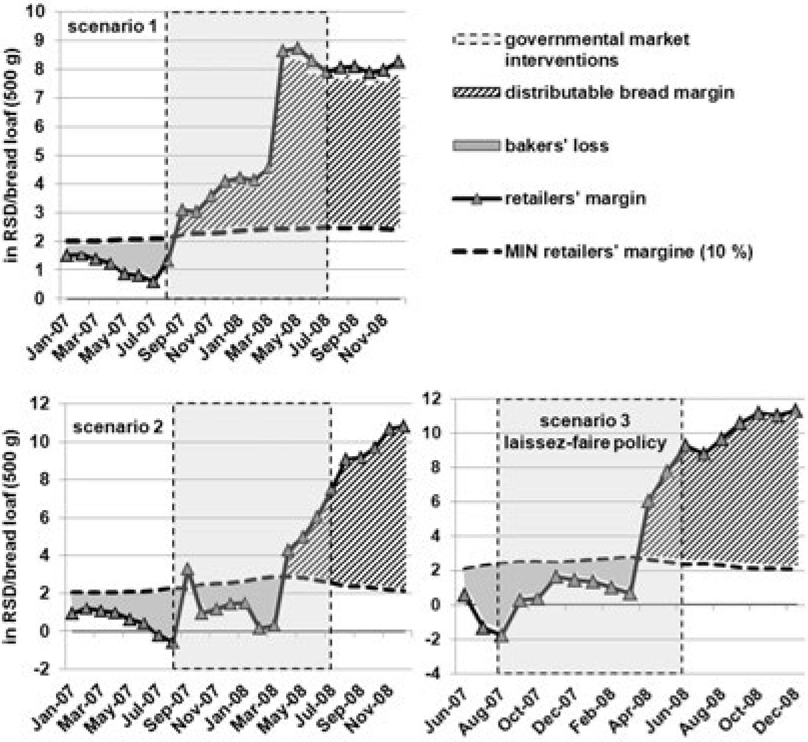
Source: own calculations, ZITOVOJVODINA and SERBIAN GRAIN FUND, own illustration.

5.2.2 Empirical results for the baking industry and retailers

In addition to the bread producer price and the wholesale bread price estimations, we simulate the distributable bread margin of large industrial bread producers and retailers. The simulation results in Figure 5.8 (scenario 1) show that large industrial bread producers were making losses, on average, before the observed period of the governmental interventions (August 2007/June 2008). According to experts, by producing the so-called "social" bread, large industrial bread producers were always at the edge of profitability. However, the potential losses with this type of bread were covered by profits from other bakery products. After the governmental interventions on the wheat and flour markets and two significant bread price increases (August and November 2007), large industrial bread producers and retailers improved their situation by being able to achieve significant increases of their profits.

If we consider scenario 1 where we account for stored wheat as the main input cost in bread production, large industrial bread producers and retailers were already able to increase their margins right after the governmental interventions on the wheat and flour markets in September 2007. Additionally, they were able to achieve a margin up to four times higher due to the negotiated bread price increase in April 2008. Even if we consider the distributable bread margin in scenario 2, where we account for high spot wheat market prices as an important input cost in bread production, it becomes evident that large industrial bread producers and especially retailers improved their situation after the second bread price increase in April 2008. Thus, our second[66] argument is that the bread price increase in 2007/08 was not adequately justified. This is also confirmed in scenario 3, the laissez-fare policy case, where we can draw the same conclusion.

Figure 5.8: Simulated distributable bread margin, 2007/08



Source: own calculations, ZITOVOJVODINA and SERBIAN GRAIN FUND, own illustration.

To summarize, the large industrial bread producers, together with retailers, benefited from the governmental interventions on the wheat and flour markets because they managed to increase the retail bread price by claiming high input costs. Additionally, they made substantial profits after the cancellation of the governmental interventions by not reducing the retail bread price according to the decrease in wheat and flour prices, arguing that the other input costs had increased severely.

66 For the first argument see section 5.2.1, page 82.

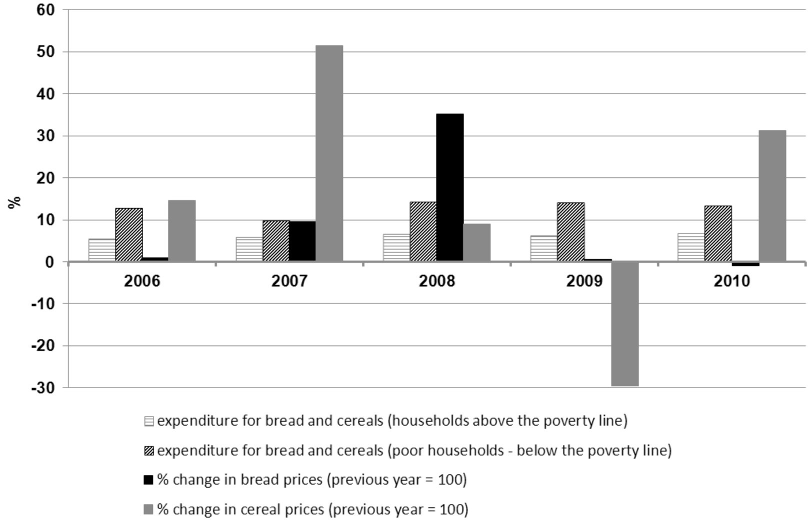
5.2.3 **Empirical results for the consumers**

Regarding consumers, the Serbian government faced significant pressure through the media and the public to protect consumers from increasing world and domestic food prices beginning in 2007. This was one of the main reasons why the government intervened on the domestic wheat and flour markets. Nevertheless, the prices for wheat continued to rise sharply even after the export ban was implemented. This implies that the prices for flour, bread and other processed wheat products also increased significantly. According to the Statistical Office of the Republic of Serbia, the retail prices for the flour type 500 (1kg) and "social" bread (0.5 kg) rose by 75 % and 52 %, respectively, from July 2007 until July 2008. During the same period, the prices for goods in the average consumer basket increased by 18 %.

According to the Study of Living Standard in Serbia from 2002 to 2007 (SORS, 2008), about 490,000 people were identified as poor in 2007, or about 6.6 % of the total population. Identifying poor people was done by setting the poverty line, which was about 8,883 RSD/month in 2007 for one-member households, or about 20,875 RSD/month for households with three family members. Thus, 6.6 % of the Serbian population had expenditures below the poverty line. Nevertheless, the number of extremely poor people whose expenditure was less than 4,138 RSD/month was close to zero.

If we compare the monthly available expenditure of a poor household family (20,875 RSD/month) with the average monthly expenditure for bread and cereals (about 2,027 RSD/month for a three member household), we can see that the expenditure for bread and cereals is about 10 % (i.e. 9.71 %) of their total expenditure in 2007. For households that are not considered poor, i.e. positioned above the poverty line, expenditure for bread and cereals is about 6 % (i.e. 5.72 %) of their total expenditure (35,414 RSD/month). If we compare these results with average household expenditure for 2008 (2,653 RSD/month), we can observe that the expenditure of poor households increased to 14.22 %, while for the non-poor households it increased to 6.62 % (Figure 5.9). Thus, the significant wheat, flour and bread price increase in 2007/08 hit the poorest of the population the most.

Figure 5.9: Household expenditure for bread and cereals, 2007/08 (%)



Note: expenditure for bread and cereals is presented as the % share of the total expenditure of the households.

Source: SORS.

Besides the high flour and bread prices, the calculations presented in Table 5.9 suggest that consumers also experienced welfare losses from the governmental crisis policy. Consumers who also pay taxes to the Serbian government had to cover the costs of the governmental wheat purchases during the crisis period, first in September 2007 (about 60,000 t) and then again in March 2008 (40,000 t). By purchasing wheat from the domestic market, the Serbian government certainly incurred budgetary expenses. The approximated total costs were about 33 million U.S. Dollars, which represents about 6 % of the average agricultural budget from 2007/08. Considering that wheat prices even increased after the governmental interventions, it is clear that this governmental policy measure had a negative impact on consumers.

Table 5.9: Governmental expenditures for policy measures in 2007/08

data		2007	2008
total Agricultural Budget (U.S. Dollars)		456,311,974	613,157,892
average exchange rate (RSD for 1 U.S. Dollar)		57.19 (September)	53.65 (March)
policy measure: buying-out wheat from domestic market			
A	**quantity (t)**	60,000	40,000
B	**average wheat price (U.S. Dollars/t)**	256.40 (September)	438.03*
A x B	**total cost per policy measure (U.S. Dollars)**	15,384,000	17,521,200
TOTAL COST	**2007/2008 (U.S. Dollars)**	**32,905,200**	

Note: * represents the agreed purchasing price.

Source: Ministry of Finance, Serbian Grain Fund, National Bank, own calculation.

Overall, our results suggest that consumers experienced welfare losses from the governmental interventions in 2007/08, although the interventions were imposed with the primary aim of protecting consumers against dramatically increasing food prices.

6 Discussion

This chapter contributes to the overall analysis by discussing the impact that the governmental market interventions in 2007/08 and 2011 had on different market participants within the wheat-to-bread supply chain in Serbia. We aim to identify who benefited and who lost from these interventions (section 6.1). Additionally, we aim to identify what alternative policy measures the Serbian government could consider applying in potentially reoccurring crisis situations (section 6.2).

6.1 Who benefited and who lost from the governmental market interventions?

The discussion in this section refers to the analyses that have been conducted at each level of the wheat-to-bread supply chain, and heavily relies on the empirical results presented in the previous chapter.

6.1.1 Wheat producers

To identify the effects of the governmental interventions on Serbian wheat producers, we distinguish between small (not specialized) and large (specialized) wheat producers.

The first group of wheat producers consists of farmers who produce wheat and other crops, and are not specialized in wheat production. These farmers mainly realize low yields and a lower wheat quality that is mainly used for feeding; this group represents the largest number of individual wheat producers who are mainly situated in Central and South Serbia. This group can be further divided in two subgroups, those who have sufficient financial resources to store their wheat in a local silo, and those who have to sell their wheat during harvest or immediately following the harvest.

The first subgroup was able to benefit during the domestic wheat price peaks in 2007/08 and 2010/11, especially during the governmental interventions on the wheat market. Wheat stored in silos had a significantly lower price than the achievable price on the spot market (Figure 4.2, section 4.3.1). The highest price difference was first achieved in April 2008, during the period of governmental interventions, when the wheat market prices were 52 % higher than the price of wheat stored after the harvest (July/August 2008). The second-highest price difference was achieved in March 2011, just before the governmental interventions, when the wheat market prices were 81 % higher than the price of wheat stored after the harvest (July/August 2010). Thus, the significant price difference allowed producers to gain significantly higher profits. This subgroup of small wheat producers was able to sell their stored wheat to small artisanal mills that do not have sufficient storage facilities and are thus obliged to continuously purchase wheat during the year in order to produce flour. Compared to the laissez-faire policy case, it becomes obvious that selling stored wheat during the governmental interventions was beneficial for this group of producers because they could sell their wheat for much higher spot prices compared to the price they would have been able to achieve if the government had not intervened on the market, especially from January 2008. Nevertheless, this subgroup comprises a very small number of wheat producers in Serbia.

The second subgroup, the group that represents most of the wheat producers in Serbia, did not benefit from the high wheat prices. The main reason is the lack of financial resources to finance wheat storage. Since wheat is the first crop harvested in the year, these farmers are obliged to sell their wheat even "on green" or during the harvest. If we consider that the significant wheat price increase was from September 2007, one month after the harvest, it is clear that these wheat producers did not benefit at all from the high prices. The situation in 2010 was a bit better because the prices of wheat were increasing during the harvest period, especially accelerating from August 2010.

The second group of wheat producers consists of specialized, large-scale, crop producers, and achieves higher average yields and a better wheat quality. These producers are usually contractually integrated with large industrial mills and large industrial bread producers that are mainly situated in North Serbia, in the province of Vojvodina, and near the capital (Belgrade). These producers store their complete production during the harvest period. Concerning the period under study, this group of producers was able to realize extra profits during the intensive governmental interventions by selling their wheat to small artisanal mills or to flour export-oriented mills, especially during the first three months of the wheat export ban. Additionally, they were able to make significant profits during the period of the governmental purchase of wheat in both September 2007 and March 2008. As was the case with the previous group of small wheat producers who have the possibility to store their wheat after harvest, it becomes obvious that selling stored wheat during the governmental interventions was beneficial for large-scale producers as well, compared with the laissez-faire policy case.

One could argue that high domestic and world prices can be beneficial for farmers who could invest more in their production. However, that was not the case in Serbia, where both groups of producers had difficulties to obtain sufficient financial resources for the new sowing period, especially in October 2007, because the prices of inputs had increased compared to the previous year. The prices of fertilizers, such as Ammonium Nitrate, Calcium Ammonium Nitrate, Nitrogen Phosphorus Potassium and UREA increased by about 20 % compared to the previous year, and fuel prices were up 10 % from the beginning of the year. Further, it was not suitable for wheat producers to obtain loans from the banks because credit lines for agriculture had very high interest rates. Thus, the total sown area in 2007 was about 200,000 ha less than in previous years, despite the high wheat prices on the market.

Besides the possible benefits for wheat producers with storage capacities during the periods of the governmental interventions, both groups of wheat producers experienced losses after the cancellation of the policy measures, especially in 2008. This fact is supported by the obtained results from the price transmission analysis, which indicate that the market was unstable for about one year (see section 5.1.1). According to experts (V. Sakovic, several personal interviews, 2009 to 2011), the direct consequence of the wheat export ban in 2007/08 was that about 350,000 t of wheat remained on the market, which, in addition to the new harvest in 2008, pushed domestic wheat prices down. Thus, all wheat producers who did not sell their stored wheat during the governmental interventions later experienced significant losses.

To summarize, most of the wheat producers in Serbia did not benefit from the governmental market interventions and high wheat prices because they had insufficient financial resources to store their wheat or to invest more in production. A very small number of wheat producers managed to earn significantly high profits during the governmental interventions because they were able to store the wheat after the harvest and sell it later for very high domestic spot prices, which were even above world market prices. Nevertheless, the situation for both large-scale and small wheat producers worsened after the cancellation of the governmental interventions because the wheat prices dropped significantly; this was caused by an increased supply from the wheat export ban.

6.1.2 **Wheat traders**

According to experts (V. Sakovic, several personal interviews, 2009 to 2011), the first governmental decision to impose the wheat export ban in 2007 was made in the late afternoon of August 3, and entered into force on August 4, 2007. This fact caused a great loss to traders (wheat exporters) who already had about 50,000 t of wheat loaded on trucks, barges or trains and had invested in packing, quality control and transport. Some shipments were already at the border waiting to be checked, while other shipments had been paid in advance, which meant that they were not owned by Serbian traders anymore. Considering that Serbian wheat prices were approximately 248 U.S. Dollars/t at the moment the export ban was implemented, we can calculate that traders lost about 12.4 Million U.S. Dollars worth of wheat export in the short-run. Besides the financial losses from investments in packing, quality control and transport to the harbors, the Serbian traders also lost some reputation in international trade because they were not able to fulfill their obligations.

The traders also experienced losses during the export ban because they were not able to sell their wheat on foreign markets for several months (August 2007/June 2008). As we said previously, about 350,000 t of wheat remained on the market because of the export ban in 2008. If we consider the average world wheat price in the laissez-faire policy case of 342 U.S. Dollars/t during the export ban, we can estimate the value of the possible wheat export of about 120 million U.S. Dollars. Nevertheless, we have to acknowledge that some of the wheat traders might have engaged in flour trade during the wheat export ban, and thus indirectly exported a certain amount of wheat.

When the export ban was lifted in June 2008, Serbian wheat was no longer competitive on international markets due to high storage costs, which amounted to about 15 % of the storage value. Considering that the Serbian wheat prices were very low after harvest in 2008, one could argue that it should have been beneficial for Serbian wheat traders because the price was lower than the world market price. Nevertheless, no significant exports were recorded in this period. The main reasons are the poor quality of the wheat and a very good regional harvest. In this situation, the price did not play a large role. The wheat quality becomes the most important factor and thus the Serbian wheat was set aside in regional trade due to its low quality.

A similar situation was observed in 2011 during the governmental interventions. The estimated worth of the possible wheat export reached 9.3 million U.S. Dollars. This estimation takes into account the average wheat export three months before the export ban (28,417 t), as well as the average world wheat market price (327 U.S. Dollars/t) taken from the laissez-faire policy case.

To summarize, the wheat traders did not benefit from the governmental interventions. Their total estimated loss was about 130 million U.S. Dollars worth of wheat export during the governmental interventions (2007/08 and 2011). Additionally, they had difficulties to restore their export activities after the cancellation of the governmental interventions.

6.1.3 **Milling industry and flour traders**

The results obtained from the vertical price transmission analysis show that the millers increased their margin in the aftermath of the governmental interventions in 2008, as well as in 2011 (see section 5.1.2). This period was characterized by increased market instability because the rapidly decreasing wheat prices were not fully transmitted to the flour prices. Estimations of the millers' profits show that large industrial mills with their own wheat storage capacities increased their profits even during the crisis when the wheat export ban and the flour export quota system were in effect. In contrast, the large number of small mills was not able to substantially profit from this situation due to high wheat prices and insufficient financial resources. The first reason was influential because small mills do not have sufficient storage facilities, and thus are obliged to buy wheat from the spot market. In addition to the high prices of wheat, which is the main raw material, the global and domestic financial crisis, especially during 2008/09, pushed many small mills out of business; the total number of registered mills declined by about 200 from 2007 to 2010 (see section 2.2.2.).

Compared to the laissez-faire policy case, both small and large industrial mills benefited from the governmental market interventions, especially in 2007/08. Namely, the large industrial mills were able to gain significantly higher profits compared to the laissez-faire policy case during the governmental interventions (Figure 5.5, section 5.1.2). Additionally, the slower reduction of the Serbian spot market flour prices compared to the estimated world market prices was beneficial for Serbian millers because they managed to gain profits until March/April 2009. In the case of the laissez-faire policy, the large industrial mills were still able to make significantly higher profits during the wheat price peak. However, the strong decrease in world wheat prices, followed by the decrease in estimated flour prices, pushed large industrial mills into an unfavorable position already from May/June 2008.

Concerning the small mills, the governmental interventions did not bring about a significant change in the millers' profits compared to the laissez-faire policy case (Figure 5.4, section 5.1.2). However, small mills manage to earn higher profits after the governmental market interventions compared to the laissez-faire policy case. Thus, in the laissez-faire policy case, the small mills would not be able to gain significantly higher profits after the cancellation of the governmental interventions in 2008, but they would not be much worse off, either.

Flour traders were rather in a better position than the wheat traders during the governmental interventions in 2007/08 and 2011. As mentioned previously, the government first intervened on the wheat market in 2007 and then, after three months, also intervened on the flour market. In 2011, the government intervened on both markets at the same time.

After implementation of the wheat export ban in 2007, flour exports doubled (Figure 3.4, section 3.2.1). Between August and November 2007, flour exports reached 70,652 t, which is about 50 % of total 2007 exports. Considering that the average monthly export in the first half of 2007 was about 8,300 t, this means that an additional 37,562 t of flour was milled and exported, which corresponds to 50,000[67] t of wheat. Thus, the flour traders gained an additional 18.4 million U.S. Dollars worth of exports. After implementation of the flour export quota in October 2007, exports were stabilized at 12,000 t a month. During the entire period of the wheat export ban, August 2007 to June 2008, flour exports comprised 137,063 t (about 183,000 t of wheat), which is about 60 million U.S. Dollars in terms of value. This was the record high flour export since 2000. Besides the wheat export ban, one of the main reasons why Serbian flour exports more than doubled was certainly the CEFTA agreement[68]. This agreement has been fully effective since July 2007, and Serbian traders were able to export flour, in addition to other products, to other CEFTA members without additional tariffs.

67 This amount of wheat corresponds to the amount that was not exported due to the implementation of the export ban.

68 For details see appendix A.

To summarize, mills used the wheat export ban to increase flour exports. Domestically, the large industrial mills benefited during the governmental interventions by achieving significantly higher profits compared to both small mills and the laissez-faire policy case. However, the large mills suffered significant losses after the cancellation of the governmental interventions. On the other hand, the small artisanal mills did not substantially benefit during the governmental interventions, but rather after their cancelation. Overall, flour traders benefited only in the short run, especially during the first three months of the wheat export ban in 2007, until the government introduced the flour export quota system. In 2011, the immediate implementation of the flour export quota system, together with the wheat export ban, was not beneficial for flour traders.

6.1.4 **Baking industry and retailers**

Our results from the estimations of the bread producer price and the wholesale bread price indicate that large industrial bread producers were not affected by the significant increase in wheat and flour spot market prices during the period of governmental interventions in 2007/08. We argue that the large bread producers used the governmental interventions and global commodity price peaks to argue for the necessity of increasing the retail bread price due to high input costs. Considering that the retail bread price increased substantially during the period of governmental interventions, and that the bread production cost structure did not change significantly, we argue that the large industrial bread producers benefited from the governmental interventions. Additionally, the large industrial bread producers benefited substantially after the cancellation of the governmental interventions when wheat and flour prices started to record a significant downward trend, which was not followed by a decrease in bread prices. The main arguments put forth by the baking industry switched from wheat and flour costs to other production costs such as electricity, fuel, wages, etc.

The significant bread price increase was not only beneficial for large industrial bread producers, but even more for retailers. By simulating the distributable bread margin, we obtained results indicating that the retailers were able to increase their margin by up to 4 times compared to the period before the governmental interventions in 2007/08.

Without the governmental market interventions, and thus with world wheat market prices prevailing on the Serbian spot market (laissez-faire policy case), large industrial bread producers and retailers would not have been able to realize the second dramatic bread price increase in April 2008 because the world wheat market prices were recording a strong downward trend. Thus, this result indicates that large industrial bread producers and retailers benefited substantially during the observed period.

6.1.5 **Consumers**

Considering the obtained results from all the previous simulations (i.e. millers', bakers' and retailers' profits, and consumers' expenditures), we argue that the consumers did not benefit from the governmental interventions. However, the Serbian government managed to dampen the wheat price increase for a very short time by implementing the wheat export ban in August 2008. Compared to the laissez-faire policy case, it becomes evident that if the government had not reacted, the wheat prices, and consequently the flour and bread prices, would have increased significantly on the domestic market. On the other hand, this short-run benefit for consumers was supplemented by a significant welfare loss in the long run (one year), mainly due to the wrong sequencing of the policy measures that caused the domestic wheat prices to increase even beyond the world market prices. Consequently, the high wheat prices on the domestic market were used as an excuse by other members within the wheat-to-bread supply chain for increasing their prices (e.g. flour and bread prices), which directly affected the consumers. Overall, the consumers did not benefit from the governmental market interventions in either 2007/08 or 2011.

6.1.6 **Summary of discussion**

To summarize the discussion, the governmental market interventions during the 2007/08 and 2010/11 commodity price peaks were only beneficial, to a certain extent, to some of the large industrial mills (mainly export-oriented), as well as large industrial bread producers and retailers (Table 6.1). On the other hand, the governmental interventions were not beneficial to the majority of the market participants (i.e. wheat producers, wheat exporters, small industrial mills and consumers).

The results of the discussion indicate that the governmental interventions, especially in 2007/08, were effective only in the short run. Comparing the domestic spot wheat prices to price developments on the world market (the reference case scenario), it becomes evident that if the Serbian government had not reacted on the market, the wheat prices would have increased much faster and at a much higher percentage. Thus, the direct consequence would have been a more drastic increase in flour and bread prices compared to the actual situation. Overall, the consumers would have borne the largest part of the food price increase.

On the other hand, the governmental market interventions led to significant market distortions in the long run. The long-lasting wheat and flour export restrictions, the combination of additional policy interventions and the overall closed state of the market (no export and high import tariffs) contributed to substantial wheat, flour and bread price increases on the domestic market, which caused large welfare losses for the Serbian economy.

Table 6.1: Who won and who lost from the governmental interventions

market participants			during the governmental interventions		after the governmental interventions	
			gain/ loss*	description	gain/ loss	description
1	wheat producers	small	-	wheat was sold before the price peak (July 2007)	-	no change since they didn't have wheat in stocks
		large	+	managed to store their wheat (high profit)	-	they suffered losses if they kept their wheat in stocks
2	mills	small	+/-	no storage capacity (high input costs)	+	cheaper inputs (reduced wheat prices)
		large	++	with storage capacity (high profit)	-	reduced flour prices (expensive stored wheat)
3	exporters	wheat	-	export ban	+	wheat export renewed
		flour	+/-	significant increase in export	+	high export continued
4	bread producers/ retailers	industrial/ big chains	+	improved their situation (bread producers)	++	made significant profit (retailers)
5	consumers	flour	--	high prices	-/+	still high prices of flour even though wheat prices were reduced (flour prices were declining)
		bread	--	high prices	--	high prices
		gov. policy measures	--	high costs for buying-out wheat	/	

Note: * (+) gain/benefit, (++) significant benefit, (-) loss, (--) significant loss.
Source: own illustration.

6.2 Alternative policy measures

As was already stressed, the main reason for the governmental interventions on the domestic wheat and flour markets was to secure a sufficient amount of wheat for domestic consumption in order to protect the consumers from high food prices (e.g. bread prices) during the crisis periods in 2007/08 and 2010/11. Considering the policy measures implemented by the Serbian government (chapter 3, section. 3.2.) and their impact on different members of the wheat-to-bread supply chain (chapter 6, section 6.1.), we aim to discuss alternative measures in the case of a possible reoccurring crisis. In the following discussion, we concentrate on trade- and consumer-oriented policy alternatives.

6.2.1 **Alternative trade-oriented policy measures**

Trade-oriented policy measures have been the most common reaction to soaring world commodity prices (Sharma, 2011; FAO, 2008). One of the main arguments for implementation such measures is that they can help to secure a sufficient amount of commodities for domestic consumption to protect the most vulnerable consumers from high food prices. These measures refer to the implementation of export restrictions (e.g. export bans, export taxes or export quotas) and to the liberalization of imports by reducing or cancelling import barriers (e.g. import taxes).

In order to evaluate the short-run welfare effects of different trade-oriented policy measures (i.e. export restrictions), we provide a simple theoretical framework. Here we refer to a small wheat-exporting country[69] to depict the situation on the Serbian wheat market.

We begin our theoretical considerations by presenting the reference case, where we assume that there are no constraints affecting the wheat exports from a small exporting country to the world market (Figure 6.1, initial case a). Furthermore, we assume that the world wheat market price is determined according to the equilibrium between the world market supply (S_w) and the world market demand for wheat (D_w). Also, we assume that the domestic wheat supply ($S_{d + export}$) is completely inelastic in the short run, and that OB represents the quantity of wheat produced domestically. For reasons of simplicity, we do not account for the possible stock-keeping by producers and traders. Since there is no barrier to trade, the world market wheat price will be transmitted completely to the domestic market at the level of A. According to this price level, the quantity of wheat demanded domestically is equal to OC, and CB is the amount of wheat that will be exported.

Now we assume the situation when the world wheat supply is reduced. This shock on the world market would cause the world supply curve (S_w) to shift to the left (S'_w). From this point on, we observe 4 different cases:

In the first case (case a, Figure 6.1), we assume that the government decides not to intervene on the domestic wheat market (laissez-faire policy). Given perfectly competitive and efficient markets, the price increase on the world market would

69 If observed as a unique case, unlike large countries, a small exporting country has no influence on the net wheat supply on the world market, and thus has no influence on the world wheat market price. Nevertheless, if a sufficient number of small exporting countries react in the same way, the effects of the so-called collective action would have the same price-increasing effect on the world market as if the large exporters imposed an export restriction (Martin and Anderson 2011). In addition, export restrictions implemented by several large exporting countries would have a “multiplier effect” on the initial price increase (shock) on the world market (Giordani et al., 2011).

be transmitted completely to the domestic wheat market and thus the domestic wheat price (A) would increase to the world market price level (A'). The domestic price increase would negatively affect the domestic demand for wheat (decrease from OC to OC'), whereas the producers would increase their exports (increase from CB to C'B). Concerning the short-run welfare effects, consumers would experience a welfare loss since their surplus (A'ADD') would be reduced compared to the reference case. On the other side, the producers' surplus would increase (A'AE_0E_1) and thus they would experience welfare benefits. Overall, the economy as a whole would gain welfare benefits since the producers' surplus gained by this measure is higher than the lost consumers' surplus compared to the reference case. The presented welfare effects would be the same for a large exporting country.

In the second case, we assume that due to the increased world market price, the government of a small wheat-exporting country decides to impose an export ban (case b, Figure 6.1). In this case, the amount of wheat previously exported to the world market (C'B) would be shifted to the domestic market. Thus, the domestic wheat price would be reduced. Consequently, the quantity of wheat demanded domestically would increase from OC' to OB. Finally, the new equilibrium between domestic supply and domestic demand is reached in E_2. Concerning the welfare effects, the increased demand and the reduced prices on the domestic market would lead to an increased consumers' surplus (A'FE_2D') in the short run compared to the reference case. Thus, the consumers would experience a welfare gain. On the other hand, since the domestic wheat price is reduced (from A' to F), the producers need to sell their wheat on the domestic market at a lower price. Due to the domestic price decrease and foregone exports to the world market at a price exceeding the domestic market price, the producers lose from this policy measure in the short run. Thus, the producers experience a welfare loss because their surplus (A'FE_2E_1) is reduced compared to the reference case. Overall, the whole economy would experience a net welfare loss (D'E_2E_1) since the decrease in the producers' surplus would be higher than the surplus gained by the consumers compared to the reference case. In the case of a large exporting country, domestic welfare would be the same as previously described. The main difference is that the export ban imposed by a large exporting country would cause the increase of the world wheat market price and thus cause negative welfare effects for the importing countries.

In the third case, we assume that the government imposes an export tax (case c, Figure 6.1). In the case of an export tax, a duty (or tax) is levied on the export of certain products for protective or revenue purposes. All types of export taxes[70],

70 We need to acknowledge the existence of the tax-rate quota scheme (TxRQ), which represents the mixture of a quota and two different tax systems, in-quota tax and over-quota tax. For example, the government might impose a certain export quota for wheat based on past exports. As long as the export quota is not reached, wheat exporters have to pay a certain in-quota tax, which is usually less than 40 %. If the wheat export exceeds the quota, wheat exporters have to pay higher taxes (over-quota tax, which can be as high as 70-100 %). For more details, see the study by SHARMA (2011).

including specific (fixed amount per unit), ad valorem (percentage tax based on the value of the product), progressive (high tax rate when the price of the product is high and vice versa) or differential (e.g. a higher tax for raw materials and a lower tax for processed products) are defined as export restrictions because their implementation leads to a reduction in exports. Export taxes are also called export duties, export fees, export charges, export tariffs, custom duties on exportation, or export levies (Kazeki, 2006).

Implementing an export tax would reduce the amount of exports because a tax decreases the competitiveness of the domestic exporters on the world market, and thus reduces their profit. Consequently, the domestic supply would increase, thereby reducing the domestic wheat price (from A' to F). Since we observe a small country case, the domestic wheat price decrease would be equal to the size of the tax[71] (Krugman and Ostfeld, 2003). For the new domestic wheat price level, domestic demand will increase from OC' to OG. Concerning the welfare effects, the decreased wheat price would be beneficial to consumers, whose surplus (A'FHD') would increase compared to the reference case. Consequently, the producers' surplus (A'FE_2E_1) would be reduced, causing them to experience a welfare loss. In general, this situation would lead to a net welfare loss (D'HI) compared to the reference case. Finally, IHE_2E_1 represents the public revenue because the government taxes the amount of wheat exported. On the other side, if the export taxes become prohibitive, the domestic exporters would not be able to export because they would no longer be competitive on the world market. In this case, the welfare effects would be the same as in the case of an export ban (case b, Figure 6.1).

In a case of a large wheat-exporting country, the size of the net welfare effects caused by the export tax would depend on the degree of the world market price increase and the degree of the increase in domestic demand. The higher the world market price increase, the higher the exporters' benefit. As already mentioned, the implementation of an export tax by a large wheat-exporting country would cause the increase of the world wheat market price. Consequently, the importing countries would experience welfare losses.

Finally, in the fourth case, we assume that the government imposes an export quota (case d, Figure 6.1). If the quota were binding, the quantity of the exported commodity (C'B) would be reduced to the level of the quota (GB), which would increase the amount available on the domestic market from OC' to OG. The increased supply would lead to the reduction of the price on the domestic market to F. This would directly lead to a change in the consumers' surplus of A'FE_2D'

71 In the case of a large wheat-exporting country, the domestic price decrease would not necessarily be equal to the size of the tax since implementing the tax would cause the world market to increase. Thus, the size of the tax would be distributed between the domestic price decrease and the price increase on the world market.

compared to the reference case. Consequently, the producers would experience a welfare loss since their surplus (A'FE$_2$I') would be reduced compared to the reference case.

If the quota were auctioned, bidders (traders) would bid the price maximum up to the value equal to the size of the quota and the price difference between the world market and domestic market prices (I'E$_2$HE$_1$). In this case, the government would be able to gain some revenue. If the quota were allocated for free, area I'E$_2$HE$_1$ represents the potential quota rent, which is the benefit of those traders who have the quota rights and thus are able to sell the wheat on the world market at higher prices than on the domestic market. The size of the potential quota rent would be higher if we accounted for the large country case. The additional quota rent benefit comes from the fact that the implementation of the export quota by the large exporting country would cause the world wheat market price to increase and thus increase the price difference between the domestic and the world market prices. Who benefits from the quota rent, and to which extent, mainly depends on the process of the quota allocation and on the traders' rent-seeking activities (Chemnitz and Grethe, 2005). In addition, if the quota is zero, the overall welfare effects would be the same as for the export ban (case b, Figure 6.1). Compared to the export taxes, export quotas are much more difficult to administer since they are susceptible to corruption, especially in the process of a quota allocation (von Cramon-Taubadel and Raiser, 2006).

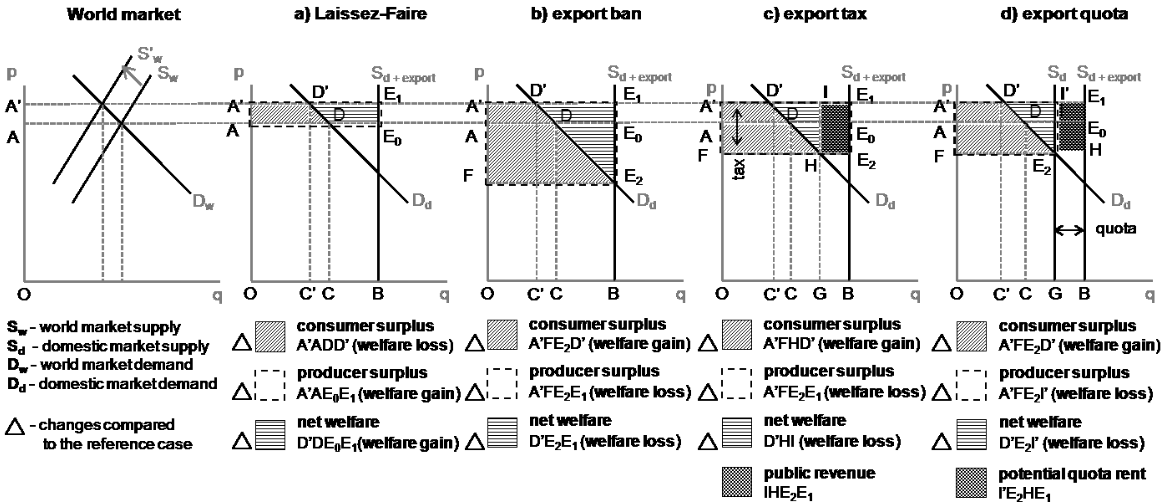
Although theoretical welfare considerations suggest that export restrictions may reduce the risk of food shortages in the short run, they all lead to a net welfare loss, not only for the country imposing them, but also on the international market. In addition, export restrictions may decrease the incentives of domestic wheat producers and private investors. Wheat producers might decide to allocate their resources to the production of some other crops, while private investors might stop or downscale investments in the wheat sector (Götz et al., 2013).

Nevertheless, if world market prices are high and the government feels forced to intervene by implementing some of the restrictions on exports (i.e. Serbia in 2007/08 and 2010/11), an implementation of an export tax would cause less market distortion than an export quota or an export ban, but only if it were not prohibitive. As already discussed, a prohibitive export tax would have the same welfare effects as an export ban. An additional argument for implementing an export tax is that an export tax system is more transparent and less susceptible to lobbying than a quota system (especially in the process of quota allocation). Also, export taxes may allow governments to gain additional budgetary incomes (the same applies to the quota system if the government decides to sell the quota rights).

Finally, implementing any kind of export restrictions should not be the first policy option during a food crisis. Thus, we argue that instead of implementing trade restriction measures, the Serbian government should immediately remove any existing trade barrier. Concerning the wheat market, the government should cancel the existing import tariff[72] of 30 %. If the import tariff were still in force during crisis periods, local traders would have no incentives to lower their prices. By cancelling the import tariff, it would be assured that the price on the domestic market is not higher than the world market price, plus the transport costs. Additionally, potential domestic wheat shortages that can be threatening for the milling and baking industries can be covered by imports.

72 Serbia has several bilateral and multilateral free trade agreements where wheat imports to Serbia are tariff-free (see appendix A). However, most of these countries are actually importers of Serbian wheat, except some EU countries and Russia. In crisis situations, like in 2007/08 and 2011, when Russia and Ukraine were restricting wheat exports, Serbia can be in a situation where they seek a supplier outside of the partner countries. In this case, there would be an import tariff of 30 %.

Figure 6.1: Short-run welfare effects – export restrictions (small country case)



Note: Labels in Figure 6.1 are explained within the text.

Source: own illustration.

6.2.2 Alternative consumer-oriented policy measures

Consumer-oriented policy measures are intended to increase food availability to socially vulnerable groups. According to FAO classification (FAO, 2008b), such measures can be classified into tax policies, market management policies, safety nets, and other measures affecting disposable income. To ensure that the most vulnerable consumers have access to food, especially during a severe food price surge, social safety nets are recognized as one of the most suitable policy instruments (Martin, 2012). Most safety net policies include food vouchers or cash transfers and food subsidies. The aim of these policies is that beneficiaries (mainly poor people) become able to purchase food on the market or in certain selected shops. In the case of food vouchers and cash transfers, the beneficiaries receive them directly, while in the case of food subsidies, financial support from the government is transferred to market participants within the food chain.

Concerning the Serbian case, we already discussed that the impact of the bread and cereals[73]price surge caused the share of average household expenditure for bread and cereals to increase to 6.62 %[74] compared to 5.72 % in 2007. As expected, the increase of the expenditure is higher for households that are below the poverty line (6.6 % of the total population in 2007, or 7.9 % in 2008). Their percentage share of the expenditure for bread and cereals increased to 14.22 % in 2008 compared to 9.71 % in 2007.

That well-targeted policy measures in Serbia already exist is indicated by several studies. According to Ivancev (2011), there are about 20 active social assistance programs[75] in Serbia grouped into two public policy instruments[76]that aim to reduce poverty, support population growth, and help the most vulnerable groups. On average, about 1.95 % (about 710 million US Dollars) of Serbian GDP was allocated to social assistance programs from 2005-2009. This percentage of GDP is smaller than in other EU countries (about 2.6 %); nevertheless, it is similar to European and Central Asia countries (ECA[77]) of comparable economic develop-

73 Due to the statistical definition of the household expenditure for bread and cereals, we considered the average price increase of all cereals (not only wheat).

74 On average, households in Serbia spend more for bread and cereals of their total expenditure than the other EU countries. Of the total expenditure, the average percentage share of expenditure for bread and cereals in the EU member countries (which accepted the Euro) was 2.5 % in 2007 and 2.6 % in 2008 (European Central Bank: http://www.ecb.int/stats/prices/hicp/html/hicp_coicop_inw_011100.4.INW.en.html).

75 The social assistance program refers to the income support benefits for poor people. A comprehensive list of existing social assistance programs can be found in World Bank (2006).

76 The first policy instrument refers to social assistance for citizens regulated through the Law on Social Welfare and Social Welfare Provision of Citizens. The second policy instrument refers to the social protection of children through the Law on Financial Assistance to families with children.

77 Europe and Central Asia - countries selected by the World Bank criterion: http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/ECAEXT/0,,contentMD-

ment (World Bank, 2009). According to the Statistical Office of the Republic of Serbia (SORS, 2008), social assistance programs primarily target poor households. About 37.2 % of the benefits were received by households living below the poverty line in 2007. Also, almost ¼ of the total expenditure of poor people is covered by benefits received through social assistance programs. Of the total benefits received by poor households, those benefits coming from the three specific policy measures cover the majority of the poor households and had the greatest contribution to the total expenditure of poor households in Serbia. These measures are: attendance and assistance allowance (received by 30.7 % of poor households, it covers about 7.2 % of the total poor household expenditure), material support for low income households (MOP[78] - received by 25.5 % of the poor households, covering 8.6 % of the total expenditure), and child allowance (received by 19.1 % of the poor households, covering 18.7 % of the total expenditure). All three measures are based on direct transfer payments for different targeted groups. According to the World Bank evaluation of the social assistance programs in Serbia (World Bank, 2009), MOP and child allowance were recognized as well-targeted measures in the sense that a high number of poor households are actually able to receive the benefits.

Overall, since well-targeted social assistance programs already exist, the Serbian government should consider scaling them up and expanding the number of households eligible to receive the benefits during crisis periods. A special focus should be placed on the MOP and child allowance programs since they are already implemented and well-targeted towards the expenditures of poor people. Still, strengthening the existing social assistance programs is problematic due to the budget constraints of the Serbian government.

To summarize, our theoretical welfare considerations show that implementing any kind of export restrictions leads to overall negative welfare effects, not only in the country imposing them, but on the international markets as well (in the case of a large exporting country). On the other hand, well-targeted consumer-oriented measures (i.e. safety nets) are more effective in protecting vulnerable consumers, and cause less negative welfare effects on the domestic and international markets compared to trade-oriented policy measures. Thus, we argue that in the case of possible repeating crises, the Serbian government should mainly focus on strengthening the existing well-targeted safety net mechanisms instead of implementing export restrictions in order to protect the most vulnerable consumers from high food prices.

K:21776903~menuPK:5026204~pagePK:146736~piPK:146830~theSitePK:258599,00.html.

78 Generally accepted abbreviation taken from the Serbian language: "Materijalno Obezbedjenje Porodice" ("Material support for low income households").

7 Conclusions

This study aims to provide a detailed analysis of the impact that Serbian governmental market interventions had on price transmission mechanisms, both between the domestic and the world wheat markets, and along the wheat-to-bread supply chain during the global commodity price peaks in 2007/08 and 2010/11. The main contribution of this study is that it recognizes the importance of governmental policy interventions on price transmission and market integration issues for a small open economy such as Serbia's. Given the global food and financial crises that have occurred since 2006, and that such price peaks are becoming more and more frequent, governmental interventions are found to be one of the most important factors contributing to the escalation of food prices. Thus, adequate policy measures that can be used in situations of high domestic, regional and global commodity and food prices have become, and will certainly continue to be, a great concern to policy makers around the world.

In this study, we use a regime-dependent model framework in order to analyze price transmissions within both horizontal and vertical concepts. The main argument underlying our decision lies in the fact that it is very difficult to ensure parameter consistency given the instability of Serbian agricultural policy. Particular difficulties arise when attempting to clearly identify the reactions of market participants towards different policy measures. We use a regime-dependent Markov-switching model to analyze the price dynamics between the Serbian wheat grower prices and the world market prices, and for the analysis of the price dynamics between the domestic wheat and flour prices. This model has recently been introduced to the field of agricultural price transmission analysis, so its usage in this study represents an additional contribution to the literature.

The empirical results from the spatial price transmission analysis indicate that the changes in world wheat market prices were not transmitted completely to the wheat producers in Serbia. The policy measures taken by the government completely banned any wheat exports, thereby not allowing wheat exporters to benefit from the high world prices. Broad additional governmental interventions during the wheat export ban caused periodical market instability. Our results further suggest that the governmental market interventions had long-lasting effects on the Serbian wheat market, especially after lifting the export ban in June 2008. In particular, the "adjustment" regime prevailed on the market for almost a year, indicating that the market agents required a long time to restore the arbitrage activities that had deteriorated during the export ban. At the same time, the instability of the Serbian wheat market increased significantly. Thus, our results indicate that most of the wheat producers did not benefit from the governmental crisis policy. The only beneficiaries were those who had the possibility to store their wheat after the harvest and then sell it during the period of the governmental interventions. However, most of the wheat producers in Serbia sell their wheat right after the harvest due to financial constraints.

The results from the vertical price transmission analysis make it evident that both small artisanal mills and large industrial mills increased their profit margins during and especially after the governmental interventions. Our analysis of the millers' profits shows that the margin increase could not be justified with an increase of flour production costs. Furthermore, large industrial mills with their own storage capacities were able to increase their profits even during the crisis when the wheat export ban and the flour export quota system were in effect. In contrast, small artisanal mills, which had to buy wheat from the spot market, could not profit substantially from this situation. However, they did made significant profits after the governmental interventions were revoked. Thus, both small artisanal and large industrial mills were able to benefit overall from the governmental market interventions both during and right after the crisis periods (2007/08 and 2010/11).

Our results from estimating the bread producer price, the wholesale bread price and the distributable bread margin show that large industrial bread producers were affected by the significant wheat and flour price increases on the spot market only during the harvest in July and August 2007. However, the export restrictions on wheat and flour were implemented in the aftermath of the harvest 2007. Nevertheless, the large industrial bread producers and retailers were successful in increasing the retail bread price, which was wrongfully justified by increases in the wheat and flour spot market prices during the crisis period of 2007/08. Compared to the laissez-faire case, large industrial bread producers, and especially retailers, benefited substantially from the governmental interventions in 2007/08.

In contrast to our expectations, consumers bore the greatest loss from the governmental interventions. Our results indicate that the loss was two pronged: First, consumers faced significant food price increases, where the most affected were poor people whose expenditure for bread and cereals increased significantly during the observed period. Second, consumers, who also pay taxes to the Serbian government, had to cover the costs of governmental purchases on the Serbian wheat market as well. Thus, our results suggest that consumers experienced welfare losses due to the governmental crisis policies.

Overall, we argue that the policy measures implemented by the Serbian government during the global commodity price peaks were not effective. Indeed, neither wheat prices nor end consumer bread prices were reduced during the governmental interventions. Instead of consumers, the main beneficiaries of the governmental interventions were the members of the wheat-to-bread supply chain at the intermediate level, especially large industrial mills, large bread producers and retailers. Furthermore, our analysis provides arguments that export restrictions are highly vulnerable to policy failure, and that their effectiveness can be easily reduced by additional political actions. Thus, we argue that implementing export restrictions as an effective measure to dampen domestic food inflation is highly questionable, especially for a product such as wheat, which represents the main raw material for end products produced within complex, highly industrialized supply chain. As an alternative, in the case of a possible recurring crisis, we argue that the Serbian government should concentrate on strengthening existing safety net mechanisms, which represent the most direct way of helping those vulnerable consumers who are most affected by high food prices.

A possibility for future research could be extending the analysis to different spatially connected regions and vertically connected agricultural and industrial sectors. Spatially, the research could be extended to the CEFTA region, which is the most important one for Serbian wheat exports. Every ad hoc policy measure addressing export restrictions provided by the Serbian government has an important impact on commodity and food price increases on the CEFTA member countries' markets, which highly depend on Serbian agricultural exports. Vertically, the research could be extended to the feeding industry, live cattle production and the meat-processing industry, for which wheat represents one of the most important inputs.

Since agriculture represents one of the strategically most important sectors in Serbia, understanding the impact of policy measures and developing alternative policy options should be a primary task for policy makers regarding the future development of the agricultural sector in Serbia. This approach would contribute to the Serbian agricultural sector becoming more resistant to possible future commodity price peaks and global food crises.

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Appendices

Appendix A

Serbian wheat and flour exports and free trade agreements

Serbian wheat and flour exports depend significantly on the amount of wheat produced, achieved wheat quality, price of wheat and flour on the domestic market (compared to the largest regional competitors, e.g. Hungary), and on several free trade agreements that are making Serbian wheat and flour more competitive on the regional markets.

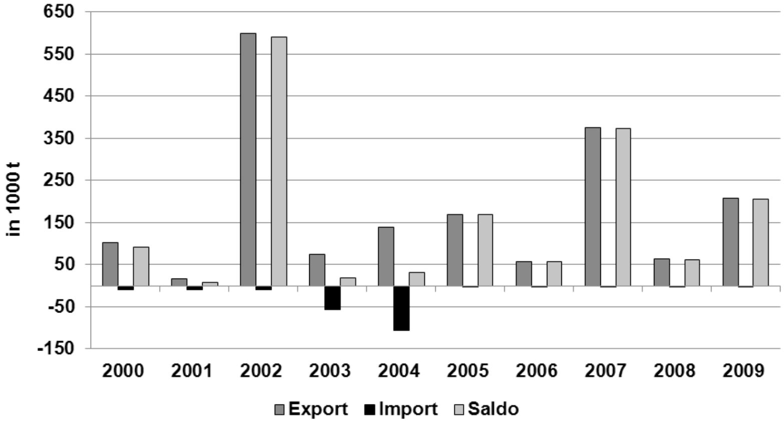
A.1 Wheat export

Traditionally, Serbia has been a net wheat exporter. However, there have been some extreme situations, caused mainly by weather conditions, when Serbia was importing significant amounts of wheat, as in 2003/04 (Figure A.1).

After the change in the political regime in October 2000, wheat exports transformed from state-owned companies to private-owned companies that appeared during the transition process (privatization). Since then, there have been numerous wheat traders who are mainly concentrated on regional markets. This happened because Serbia lost significant market shares in Europe and North Africa because Ukraine and Russia have become important world wheat exporters due to their lower prices and better quality. Besides numerous domestic companies, the largest wheat exporters are actually well-known foreign companies such as: EAST POINT HOLDING Ltd. (Cyprus), SC BUNGE Romania S.R.L. (regional office), Alfred C. Toepfer INT. Romania S.R.L. (regional office), Louis Dreyfus S.A. (The Netherlands) and GLENCORE INTERNATIONAL (Switzerland).

During the socialist political regime in the late 1980s and 1990s, wheat exports were organized only through state-owned companies. The two largest state-owned companies were Jugoimport and Progres Trade, who focused on clearly separated export markets. Jugoimport focused on the Middle East (Syria, Libya and Iraq), while Progres Trade focused on Russia and Ukraine. Most of the exported wheat was exchanged for oil or natural gas.

Figure A.1: Annual wheat export and import, 2000 to 2009



Source: GTIS, own illustration.

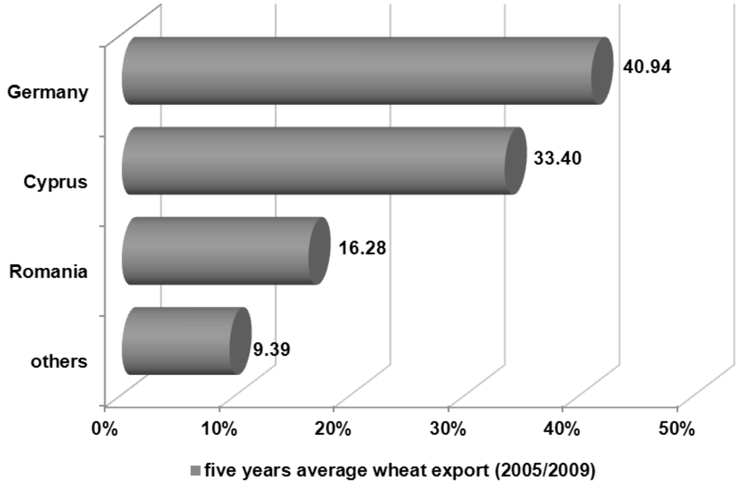
Since market liberalization in 2001, Serbian wheat export has concentrated on the EU and Balkan countries. Exports to the EU were not always determined by the price competitiveness but rather by the needs, especially in the years when the EU recorded declines in production (e.g. 2002, 2005 and 2007). Serbia's main trading partners in the EU are Germany and Cyprus, who account for 75 % of average Serbian wheat exports to the EU (Figure A.2).

The year 2007 was the main turning point for Serbian wheat exports, when Serbia signed the Central European Free Trade Agreement[79] (CEFTA). This agreement has been active since May 2007. Since then, more than 50 % of wheat (more than 80,000 t in average) is exported to the CEFTA countries (Figure A.3).

Besides Croatia, Serbia is the only CEFTA member country which achieves a surplus in wheat production. The main trading partner within the CEFTA is Bosnia and Herzegovina, to which Serbia annually exports about 40,000 t, on average (2007 to 2009). This is about 48 % of the total average Serbian wheat export to CEFTA member countries (Figure A.4).

79 The aim of the Agreement was rapid integration of participative countries to the Western European political and economic system. Since May 1, 2007 members of the CEFTA agreements have been Albania, Bosnia and Herzegovina, Croatia, Moldova, Montenegro, Serbia and The United Nations Interim Administration Mission in Kosovo.

Figure A.2: Average Serbian wheat exports to the EU, 2007 to 2009

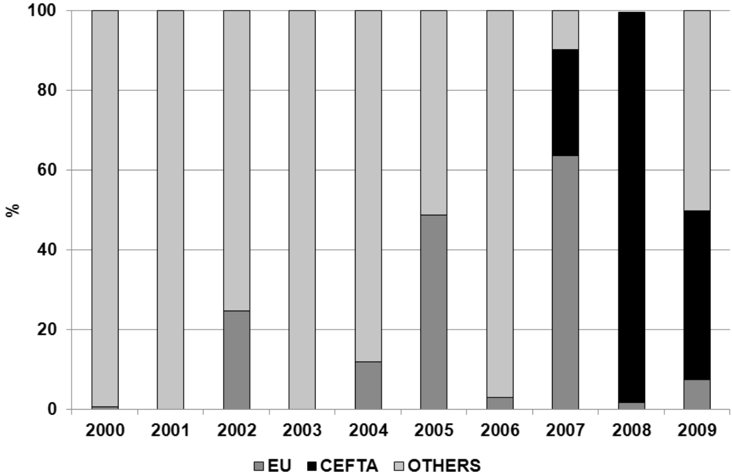


Source: GTIS, own illustration.

Wheat exports in Serbia are organized by river and rail transport. Thus, the wheat export price is calculated as FOB (river cargo terminal) or as FOR price (rail cargo terminal). The graphical interpretation of the wheat export price formation is presented in Figure A.5.

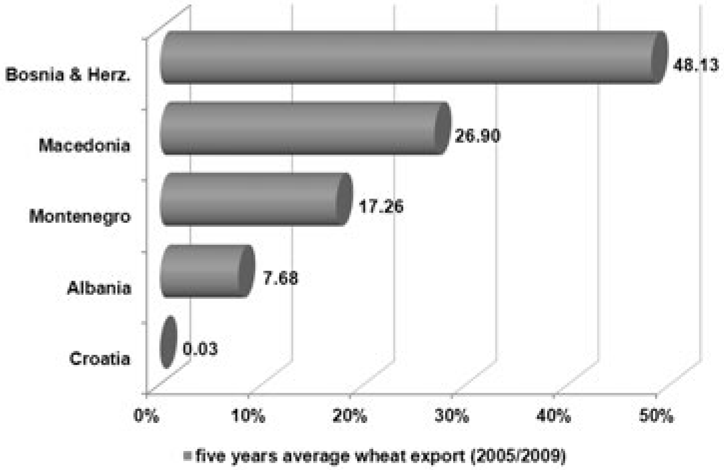
The Danube River is the transport way most used by Serbian wheat exporters who wish to reach the Black Sea ports in the East, and the European Market to the Northwest. The Danube River also presents the important European transport Corridor 7. There are several river port terminals in Serbia (such as Belgrade, Novi Sad, Bogojevo, Backa Palanka and Pancevo), which are the terminals used most frequently for wheat trade. The usual route is the export of wheat from Serbia to the Romanian port of Constance, on the Black Sea. The example of wheat export on this route is presented in (Figure A.6). On the other hand, wheat is mainly exported via the Danube from Serbia to the ports of Aschach and Pochlarn in Austria.

Figure A.3: Wheat export destinations, 2000 to 2009



Source: GTIS, own illustration.

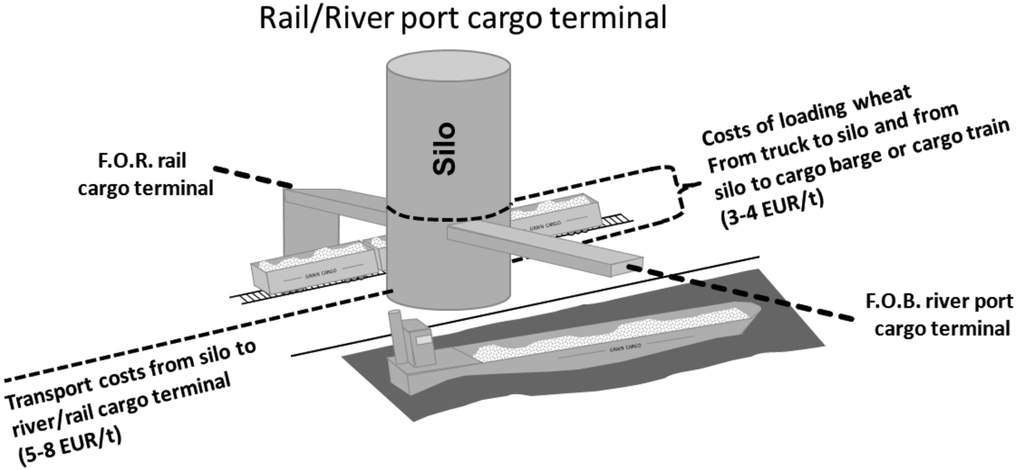
Figure A.4: Average Serbian wheat export to CEFTA members, 2007 to 2009



Source: GTIS, own illustration.

Rail transport allows Serbian wheat exporters to reach the port of Constance (Romania) on the Black Sea, the port of Bar (Montenegro) on the Adriatic Sea, and several countries in the Balkan region and the EU. Rail transport in Serbia is a part of the Pan-European rail Corridor 10.

Figure A.5: Wheat export price formation in Serbia

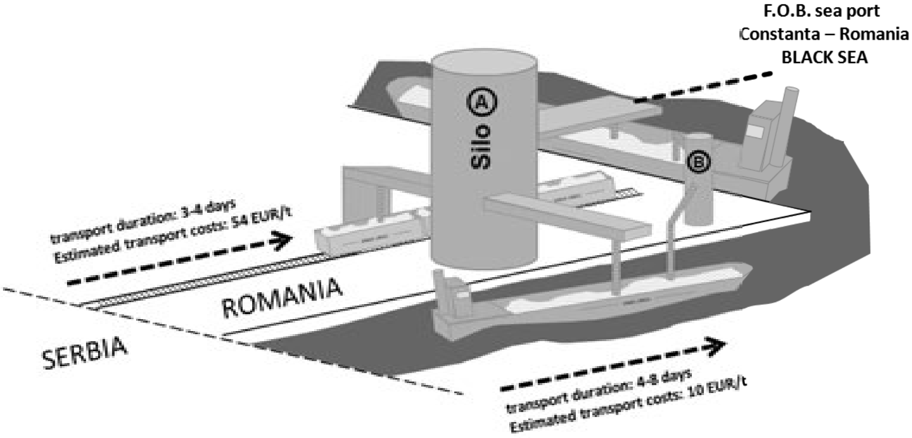


F.O.B./F.O.R.[1] wheat export price = F.C.A. silo selling price + transport costs[2] + loading costs[3]

[1] rail/river port cargo terminal
[2] from silo to rail/river port cargo terminal
[3] from truck to silo and from silo to train or barge

Source: own illustration.

Figure A.6: Wheat export from Serbia to Romania (Constance - Black Sea), 2011



Scenario A – wheat is transferred from train/barge to silo and then to the sea ship

F.O.B.[1] = F.O.B./F.O.R.[2] export price in Serbia + transport costs[3] + handling costs[4]

F.O.B.= Serbian export price + 60 EUR (rail transport)
F.O.B.= Serbian export price + 15.5 EUR (river transport)

[1] Free On Board (sea ship)
[2] F.O.B./F.O.R. rail/river port cargo terminal in Serbia (export price)
[3] by train or by barge
[4] costs for transferring wheat from train/barge to silo and than later from silo to sea ship (**estimated 5.5 EUR/t**)

Scenario B – wheat is directly transferred from train/barge to the sea ship

F.O.B.=F.O.B./F.O.R. export price in Serbia + transport costs + handling costs[1]

F.O.B.= Serbian export price + 57 EUR (rail transport)
F.O.B.= Serbian export price + 13 EUR/t (river transport)

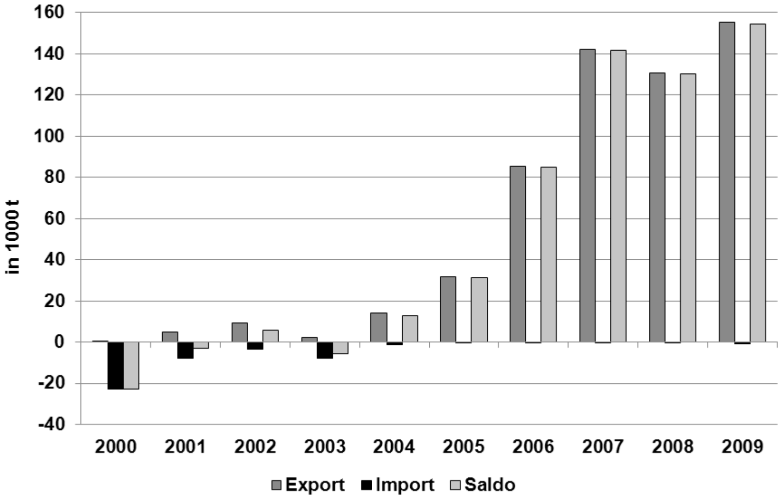
[1] cost for direct transfer of wheat from train/barge to sea ship (**estimated: 3 EUR/t**)

Source: JUGOAGENT, own illustration.

A.2 Flour export

After the collapse of the big state-owned companies in the late 1990s, it took several years for the Serbian milling industry to recover and begin intensive flour exports. Since 2004, Serbia started to be a net exporter (Figure A.7). Intensive flour exports started in 2007, together with the commencement of the CEFTA agreement.

Figure A.7: Annual flour export and import, 2000 to 2009



Source: GTIS, own illustration.

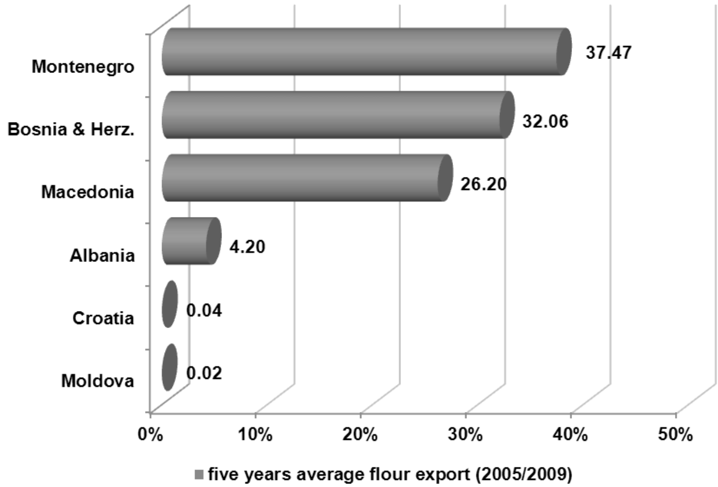
The main trading destinations for flour export are CEFTA member countries and the EU. CEFTA member countries have imported about 99 % of Serbian flour since 2007 (Table A.1). The biggest importer is Montenegro, with 37 % of total flour exported to the CEFTA region, followed by Bosnia and Herzegovina, the former Yugoslav Republic of Macedonia, Albania, Croatia and Moldova (Figure A.8).

Table A.1: Serbian flour export by main trading partners, 2005 to 2009

	Total Serbian wheat export		EU			CEFTA		
	export (t)	export (EUR)	export (t)	export (EUR)	% in total export	export (t)	export (EUR)	% in total export
2005	31,566	5,604,388	640	111,337	2.03	30,848	5,481,888	97.73
2006	85,413	14,816,600	213	35,682	0.25	85,166	14,744,914	99.71
2007	142,142	36,352,889	2,629	655,674	1.85	139,467	35,683,397	98.12
2008	130,810	42,342,558	1,052	276,441	0.80	129,731	42,056,214	99.18
2009	155,300	30,344,364	2,877	533,038	1.85	152,423	29,811,327	98.15

Source: GTIS, own illustration.

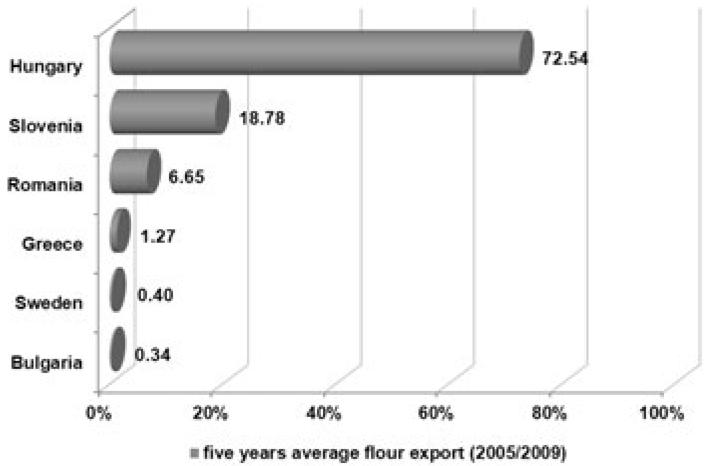
Figure A.8: Serbian flour exports to CEFTA members, 2007 to 2009



Source: GTIS, own illustration.

Concerning the EU as a trading partner, only 1.3 % of the total average flour export goes to EU member countries. The largest importer of Serbian flour is Hungary, which receives 73 % of Serbia's flour export to the EU, followed by Slovenia, Romania and Greece (Figure A.9).

Figure A.9: Serbian flour exports to the EU, 2007 to 2009



Source: GTIS, own illustration.

Flour traders in Serbia are mainly large industrial and small artisanal mills, some of which operate strictly for export purposes. Flour export is mostly organized by trucks because the largest importers are neighboring countries. This way, flour can be transported easily and very quickly to final consumers. Serbia has an advantage since the European road Corridor 10 passes through Serbia, connecting the South Balkans and Eastern Europe with Central and West Europe.

A.3 Free trade agreements

The liberalization of foreign trade began in 2001 after the political transition. The new Serbian government significantly reduced all tariff rates for all products, including agricultural products. All kinds of import and export quotas, trade permissions, and any kind of trade restrictions were cancelled. In this context, the Serbian government wanted to accelerate accession to both the WTO and the EU.

Besides significant steps toward market liberalization, Serbian agriculture is still much protected. There are three significant laws referring to the protection of the import of agricultural products to the Serbian market. First, there is a Law of Customs Tariff[80], which basically refers to the *ad valorem* tariffs for agricultural products. Second, there is the Customs Law[81], which refers to the seasonal *ad valorem* tariffs of 20 %. Finally, the third Law[82] is about additional charges of importing agricultural products to Serbia. All three laws are implemented by the principle of the Most Favored Nation (MFN)[83], and in accordance with the Harmonized Commodity Description and Coding System (fourth edition from 2007) and Amendments to the Harmonized System Nomenclature, effective from January 1, 2007.

Although Serbian agriculture has still been much protected for the last ten years, the Serbian government has signed several free trade agreements that are very important for Serbian agricultural export. Since 2006, and the first round of the negotiations with the WTO, Serbia has signed the Central European Free Trade Agreement (Active from May 2007), several bilateral free trade agreements with the Republic of Belorussia (March 2009), the Russian Federation (April 2009), Turkey (September 2010) and Kazakhstan (January 2011), and also the Interim Agreement on Trade and Trade Issues with the EU (April 2008).

According to the study by Zivkov et al. (2010), the bilateral free trade agreements with Belorussia, Russian Federation, Turkey and Kazakhstan do not have a significant impact on the Serbian wheat and flour trade. Nevertheless, the interim Agreement on Trade and Trade Issues with the EU and the negotiations with the WTO had a significant influence on import tariff reductions (Figure A.10). As

80 Serbian Official Gazette, No.: 62/05, 61/07 and 5/09.

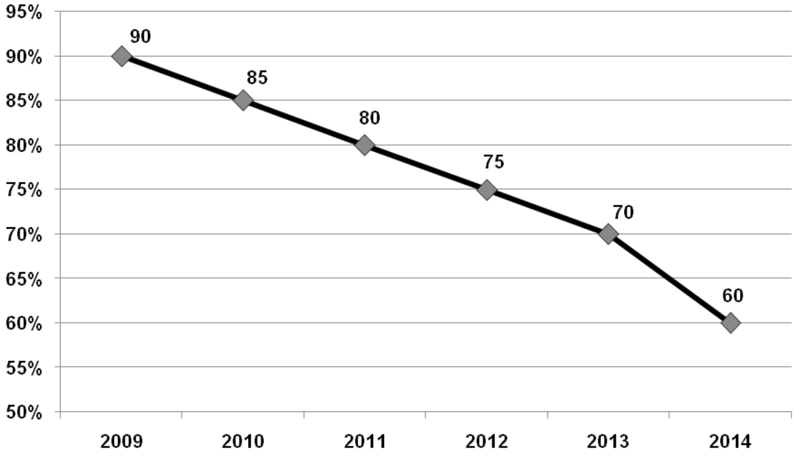
81 Serbian Official Gazette, No.: 73/03, 61/05, 85/05 and 18/10).

82 Serbian Official Gazette, No.: 90/94.

83 MFN is a status of treatment accorded by one country to another in international trade. The advantages of the MFN status are low tariffs or high import quotas.

mentioned above, the Central European Free Trade Agreement had a direct influence on wheat and flour exports because Serbia exports more than 50 % of wheat and 99% of flour to CEFTA member countries.

Figure A.10: Wheat and flour import tariff reduction, 2009 to 2014



Source: Zivkov et al. (2010), own illustration.

Note: The starting import tariff is 30 %.The wheat and flour import tariff was reduced to 90 % in the first year of the Agreement (2009) of the current value. In the last year (2014), the import tariff should be reduced to 60 % of the current value.

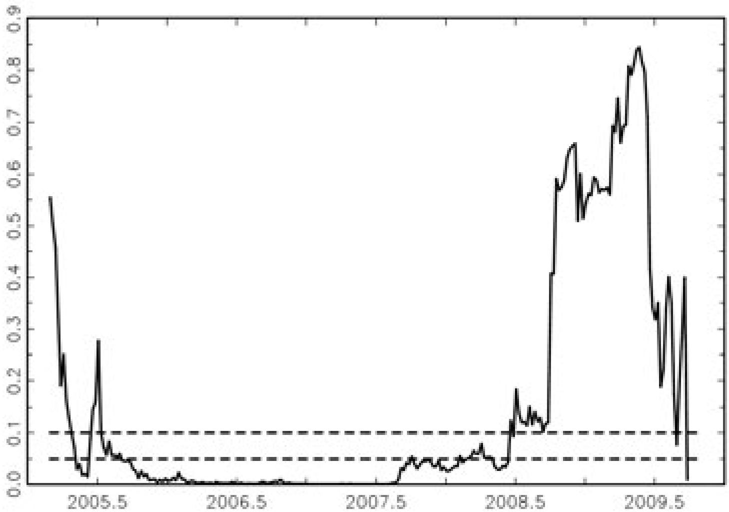
Appendix B

Empirical results (details)

B.1 Spatial price transmission (1st model)

B.1.1 Stability analysis – linear VECM (1st model)

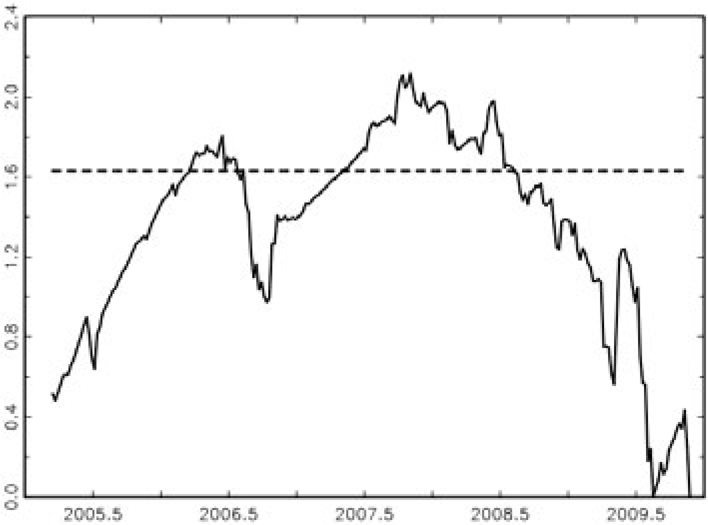
Figure B.1: Bootstrapped Chow breakpoint test *p* –values (VECM – 1st model)



Source: own calculation.

Note: A value below the lower dotted line indicates the rejection of the parameter constancy hypothesis at the 5% level of significance.

Figure B.2: Recursive τ – statistic (1st model)



Source: own calculation.

Note: A value above the dotted line indicates the rejection of the parameter constancy hypothesis at the 5% level of significance.

B.1.2 Empirical results – MS (2)-ECM(1) – (1st model)

Table B.1: Regime properties – MS(2)-ECM(1)

regime	number of observations	probability	duration
"normal"	164.3	0.6488	8.71
"adjustment"	88.7	0.3512	4.71

Source: own calculation.

Table B.2: Matrix of transition probabilities – MS(2)-ECM(1)

regime	"normal"	"adjustment"
"normal"	0.8851	0.1149
"adjustment"	0.2123	0.7877

Source: own calculation.

Table B.3: Estimated coefficients – MS(2)-ECM(1)

variable	"normal" regime	"adjustment" regime
υ	-0.0292 (0.0198)	0.1721 (0.1308)
Δp_{t-1}^{S}	0.0751 (0.0811)	**0.3229** (0.1183)
Δp_{t-1}^{R}	-0.0180 (0.0407)	-0.3246 (0.1961)
Δp_{t}^{R}	0.0026 (0.0379)	0.3754 (0.2014)
α	**-0.0293** (0.0102)	**-0.2838** (0.0694)
SE	0.015880	0.065894

Source: own calculation.

Note: Standard errors in parentheses; bold numbers indicate significance at the 5 % level; the coefficient Δp_t^R indicates contemporaneous price transmission.

B 1.3 Indirect estimation of the long-run equilibrium and the long-run price transmission parameters [84]

$$p_t^S = \beta_0 + \beta_1 p_t^R + \varepsilon_t^S \tag{21}$$

$$p_{t-1}^S = \beta_0 + \beta_1 p_{t-1}^R + \varepsilon_{t-1}^S \tag{22}$$

$$\varepsilon_{t-1}^S = p_{t-1}^S - \beta_0 - \beta_1 p_{t-1}^R \Rightarrow ECT_{t-1} \text{ (error correction term)} \tag{23}$$

Thus, the restricted ECM will have the following form:

$$\Delta p_t^S = \alpha ECT_{t-1} + \vartheta_t^S \text{ or} \tag{24}$$

$$\Delta p_t^S = \alpha\left(p_{t-1}^S - \beta_0 - \beta_1 p_{t-1}^R\right) + \vartheta_t^S \tag{25}$$

Where α is the speed of adjustment (i.e. the speed at which the deviations from the equilibrium are corrected in the following period). From the previous equation we can derive the unrestricted model:

$$\Delta p_t^S = \alpha(-\beta_0) + \alpha p_{t-1}^S + \alpha(-\beta_1) p_{t-1}^R + \vartheta_{t-1}^S \tag{26}$$

where

$\alpha(-\beta_0) = v$

$\alpha(-\beta_1) = \delta$

84 The same procedure is conducted for the indirect estimation of the parameters in the second model MS(2)-VECM(2) (vertical price transmission).

Thus, the estimation equation for the unrestricted ECM has the following form:

$$\Delta p_t^S = v + \alpha p_{t-1}^S + \delta p_{t-1}^R + \vartheta_{t-1}^S \tag{27}$$

From equation 26 we can calculate the long-run intercept and the long-run price transmission parameter:

$$v = \alpha(-\beta_0) \Rightarrow (-\beta_0) = \frac{v}{\alpha} \Rightarrow \beta_0 = -\frac{v}{\alpha} \text{ (long-run intercept)} \tag{28}$$

$$\delta = \alpha(-\beta_1) \Rightarrow (-\beta_1) = \frac{\delta}{\alpha} \Rightarrow \beta_1 = -\frac{\delta}{\alpha} \text{ (long-run price transmission parameter)} \tag{29}$$

The t-values of these parameters can be calculated by the Delta method (Patterson, 2010):

$$\widehat{Var}(\hat{\beta}) = \left(\frac{\widehat{\mu_y^2}}{\widehat{\mu_x^4}}\right)\widehat{Var}(\widehat{y_x}) + \left(\frac{1}{\widehat{y_x^2}}\right)\widehat{Var}(\widehat{y_y}) \tag{30}$$

where $\widehat{Var}(\hat{\beta})$ refers to the estimated variance of the coefficients β_0 and β_1, $\widehat{\mu_x}$ refers to the estimated speed of adjustment α (for Serbian wheat prices in the first model, and for the wheat prices in the second model), and $\widehat{\mu_y}$ refers to the estimated speed of adjustment δ (for the world wheat prices in the first model, and for the flour prices in the second model). The variable $\widehat{Var}(\hat{\mu})$ refers to the squared standard errors of the estimated speeds of adjustments (α and δ). After estimating the variance of the intercept and the price transmission parameter, we are able to calculate their standard errors and the t-values.

B.2. Vertical price transmission (2nd model)

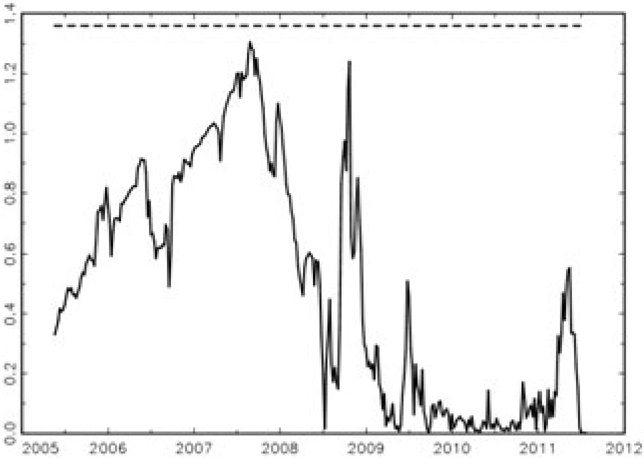
B.2.1 Stability analysis – linear VECM (2nd model)

Figure B.3: Bootstrapped Chow breakpoint test *p* –values (VECM – 2nd model)

Source: own calculation.

Note: A value below the lower dotted line indicates the rejection of the parameter constancy hypothesis at the 5% level of significance.

Figure B.4: Recursive τ – statistic (2nd model)



Source: own calculation.

Note: A value above the dotted line indicates the rejection of the parameter constancy hypothesis at the 5% level of significance.

B.2.2 Empirical results – MS(2)-VECM(2) – (2nd model)

Table B.4: Regime properties – MS(2)-VECM(2)

regime	number of observations	probability	duration
“normal”	278.1	0.8391	15.45
“low adjustment”	53.9	0.1609	2.96

Source: own calculation.

Table B.5: Matrix of transition probabilities– MS(2)-VECM(2)

regime	“normal”	“deterioration”
“normal”	0.9353	0.0647
“low adjustment”	0.3376	0.6624

Source: own calculation.

Table B.6: Estimated coefficients – MS(2)-VECM(2)

variable	"normal" regime		"low adjustment" regime	
	Δp_t^f	Δp_t^W	Δp_t^f	Δp_t^W
υ	**0.1456** (0.0656)	-0.0424 (0.0498)	0.0750 (0.0851)	**2.5582** (0.5060)
Δp_{t-1}^f	-0.0482 (0.0684)	**0.3509** (0.0535)	**-0.3890** (0.0430)	0.0342 (0.2362)
Δp_{t-2}^f	-0.08867 (0.0620)	**0.1150** (0.0479)	0.0992 (0.0736)	0.1782 (0.4088)
Δp_{t-1}^W	**0.2580** (0.0583)	0.0787 (0.0438)	0.0363 (0.0279)	**0.3821** (0.1601)
Δp_{t-2}^W	0.0961 (0.0576)	0.0590 (0.0434)	0.0567 (0.0291)	-0.1099 (0.1658)
α	**-0.1126** (0.0304)	**0.0624** (0.0240)	-0.0181 (0.0147)	0.1626 (0.0833)
SE	0.0354	0.0261	0.0115	0.0664

Source: own calculation.

Note: Standard errors in parentheses; bold numbers indicate significance at the 5 % level.

Table B.7: Contemporaneous correlation – MS(2)-VECM(2)

variable	"normal" regime		"low adjustment" regime	
	Δp_t^f	Δp_t^W	Δp_t^f	Δp_t^W
Δp_t^f	1.0000	0.4647	1.000	0.3086
Δp_t^W	0.4647	1.000	0.3086	1.000

Source: own calculation.

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