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Kerstin Marit Uhl

RUSSIAN MARKET POWER IN INTERNATIONAL WHEAT TRADE AND IMPLICATIONS FOR GLOBAL FOOD SECURITY

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SUMMARY

International wheat trade is increasingly relevant for global food security. The global trade volume rose significantly in recent years with world wheat imports soaring by more than 50% between 2000 and 2016. Growth in world wheat trade was mainly driven by soaring import demand from Asian and African countries. A smooth functioning of the world wheat market is important for food security in some wheat-importing countries. However, welfare gains from trade can be lowered if wheat exporters exert market power.

This doctoral thesis contains a description of the world wheat market. Significant changes have occurred on the world wheat market since the turn of millennium. Russia, a former net importer of wheat, emerged as a major wheat exporter and is today one of the top exporters on a global scale. Thereby, Russia increasingly contributes to global food security. Russia's main export markets are located in North Africa and West Asia. Russia predominantly exports to developing and emerging economies with traditionally wheat-based diets. The annual per capita wheat consumption in West Asia averages 147 kg, and 136 kg in Northern Africa.

The descriptive analysis of the Russian wheat export market shows that the bulk of Russian wheat in the period 2006–14 was exported by ten exporting firms. Thereby, the annual share of Russia's top exporter fluctuated between 11% and 19%. Russian wheat exports to several export markets are more concentrated. For instance, up to 60% of the annual Russian wheat exports to Armenia in 2006–14 were sold by one exporting company. And up to 23% of the annual Russian wheat exports to Egypt, Russia's top export market, were exported by one firm in the same time period. These high concentration ratios (CR) in some of Russia's export markets suggest that Russian firms might be able to exert market power.

This doctoral thesis aims to study Russian pricing behavior in international wheat trade and to measure Russian market power against the background of oligopolistic market structures in international wheat

trade, Russia's new position as a major wheat exporter, high CR in Russia's wheat export industry, and soaring grain prices since 2006/07. Previous empirical studies on Russian pricing behavior are, to my knowledge, all based on aggregated data. The empirical studies presented in this doctoral thesis are based on annual firm-level data for the period 2002–11, and daily firm-level data for the years 2006–11.

The theoretical background of my empirical studies is the pricing-to-market (PTM) method as well as the residual demand elasticity (RDE) approach, which goes back to Baker and Bresnahan (1988). The PTM approach identifies third-degree price discrimination, and thereby the violation of the law of one price (LOP) after an exchange rate shock between the currency of the exporter and the currency of an importer. In contrast, the RDE method directly measures market power by estimating the exporter's inverse residual demand elasticity.

I estimate Russian pricing behavior in international wheat markets by means of two PTM studies. The first PTM study relies on annual firm-level data for the period 2002–11. Large price fluctuations might result in parameter instability. Therefore, I estimate Russia's pricing behavior for the entire period as well as separately for the period of high world wheat market prices from 2006. The estimation results for the years 2002–11 indicate Russian price discrimination in 25 out of 61 export markets. For the period 2006–11, the estimation results provide evidence for Russian price-discriminatory behavior in 14 out of 49 export destinations. The estimation results suggest that Russia amplifies the effect of the exchange rate shock in times of high prices, and thereby contributes to price volatility.

The second PTM study is based on daily data for the years 2006–14. In contrast to the first PTM study I estimate Russian pricing behavior for different firm groups separately. Berman et al. (2012) argue that larger exporters price discriminate stronger after an exchange rate shock than smaller exporters. Therefore, the second PTM study contains estimations for all firms, Russia's top 5 exporters, and the top 6–10 exporters. The estimation results of the second PTM study largely confirm the findings of Berman et al. (2012). This is particularly evident for Russia's main export market in North Africa and Western Asia. The estimation results of the second PTM study indicate that Russian wheat exporters stabilize the local currency price after an exchange rate shock. This finding is in conflict with the results of the first PTM study which is based on annual data for a shorter data period. However, both PTM studies suggest that Russia behaves competitively in most export markets.

In a third empirical study I apply the RDE approach to estimate Russian market power in Egypt and Turkey, Russia's two main export markets. Thereby, I apply a new instrumental variable based on Russian export restrictions on wheat exports. The estimation results are based on weekly export data for the years 2006–14. The estimation results suggest that Russia behaves competitively in Egypt but exerts market power in Turkey with an estimated markup of 13.5%.

ZUSAMMENFASSUNG

Der internationale Weizenhandel erfährt eine zunehmende Bedeutung für die globale Ernährungssicherung. Das weltweite Handelsvolumen ist in den vergangenen Jahren signifikant gestiegen. So stieg die globale Weizenimportmenge zwischen 2000 und 2016 um über 50%. Die weltweite Nachfrage wird insbesondere durch eine gestiegene Importnachfrage in Afrika und Asien getrieben. Ein reibungsloses Funktionieren des Weltweizenmarktes ist essenziell für die Ernährungssicherung in einigen Importländern. Wohlfahrtsgewinne aus dem Handel können jedoch durch die Ausübung von Anbietermarktmacht schrumpfen.

Die vorliegende Arbeit umfasst eine Beschreibung des globalen Weizenmarktes. Seit der Jahrtausendwende ist es auf dem Weltweizenmarkt zu signifikanten Veränderungen gekommen. Russland, einst Nettoimporteur von Weizen, hat sich seit der Jahrtausendwende als ein bedeutender Weizenexporteur neben den traditionellen Exportländern etabliert und zählt heute zu den wichtigsten Exporteuren von Weizen weltweit. Damit trägt Russland zunehmend zur globalen Ernährungssicherung bei. Die wichtigsten Märkte Russlands liegen in Nordafrika und Westasien. Russland exportiert vornehmlich in Entwicklungs- und Schwellenländer mit einer traditionell auf Weizen basierten Ernährungsweise. So liegt der jährliche Pro-Kopf-Weizenkonsum in Westasien bei 147 kg und in Nordafrika bei 136 kg.

Die deskriptiven Untersuchungen des russischen Weizenexportmarktes zeigen, dass der Großteil der russischen Weizenexporte im Zeitraum 2006–14 durch die zehn größten Exporteure abgewickelt wurde. Der jährliche Anteil des größten Exporteurs an den gesamten russischen Weizenexporten schwankte hierbei zwischen 11% und 19%. Russische Weizenexporte in einzelne Länder weisen teilweise deutlich höhere Konzentrationsraten auf. So wurden beispielsweise bis zu 60% der jährlichen russischen Weizenexporte nach Armenien im Zeitraum 2006–14 durch einen Exporteur abgewickelt. Der jährliche Anteil des größten Exporteurs

nach Ägypten, dem wichtigsten Absatzmarkt von russischem Weizen, lag bei bis zu 23% im selben Zeitraum. Die teilweise hohe Konzentration im russischen Weizenexportmarkt legt nahe, dass die größten Exporteure über Marktmacht in einigen Zielländern verfügen könnten.

Die vorliegende Arbeit befasst sich mit dem Preissetzungsverhalten Russlands im internationalen Weizenhandel und der Messung von Marktmacht Russlands vor dem Hintergrund oligopolistischer Strukturen im internationalen Weizenhandel, der neuen Marktposition Russlands, teils hohen Konzentrationsraten russischer Weizenexporte sowie gestiegener Weltmarktpreise für Getreide seit 2006/07. Bisherige empirische Untersuchungen des russischen Preissetzungsverhaltens im Weltweizenmarkt basieren meinem Wissen nach ausschließlich auf aggregierten Daten. Die empirischen Analysen der vorliegenden Arbeit basieren auf jährlichen firmenspezifischen Daten für den Zeitraum 2002–11 und firmenspezifischen Daten auf Tagesbasis für die Jahre 2006–11.

Die theoretischen Grundlagen für meine empirischen Untersuchungen bilden die *Pricing-to-market* (PTM)-Methode sowie der *Residual demand elasticity* (RDE)-Ansatz, welcher auf einen Beitrag von Baker and Bresnahan (1988) zurückgeht. Die PTM-Methode identifiziert Preisdiskriminierung dritten Grades und somit die Verletzung des *Law of one price* (LOP) nach einer Wechselkursänderung zwischen der Währung des Exporteurs und der Währung eines Importeurs. Der RDE-Ansatz hingegen misst Marktmacht direkt durch die Schätzung der Elastizität der inversen Residualnachfrage des Exporteurs.

Ich untersuche Russlands Preissetzungsverhalten in internationalen Weizenmärkten anhand von zwei PTM-Studien. Die erste PTM-Studie basiert auf Jahresdaten für den Zeitraum 2002–11. Starke Preisschwankungen können zu Parameterinstabilität führen. Daher schätze ich Russlands Preissetzungsverhalten sowohl für den gesamten Zeitraum als auch separat für den Zeitraum mit hohen Weltmarktpreisen ab 2006. Die Schätzergebnisse für die Jahre 2002–11 deuten auf russische Preisdiskriminierung in 25 von 61 Ländern hin; jene für den Zeitraum 2006–11 auf Preisdiskriminierung in 14 von 49 Exportländern. Ein Vergleich der Schätzergebnisse für beide Zeiträume zeigt, dass sich das Vorzeichen der Preiselastizität der Wechselkurse für einige Länder ändert. Die Schätzergebnisse deuten darauf hin, dass Russland in Zeiten hoher Preise den Wechselkurseffekt durch seine Preisanpassung und somit die Preisvolatilität verstärkt.

Die zweite PTM-Studie basiert auf Tagesdaten für die Jahre 2006–14. Im Gegensatz zu der ersten PTM-Studie schätze ich Russlands Preissetzungsverhalten für unterschiedliche Firmengruppen separat. Berman et al. (2012) argumentieren, dass größere Exporteure nach einer Wechselkursänderung Preise stärker diskriminieren als kleinere Exporteure. Daher umfasst die zweite PTM-Studie Schätzungen für drei verschiedene Firmengruppen. Die erste Gruppe umfasst alle Firmen, die zweite Gruppe die Top 5-Exporteure und die dritte Gruppe die Top 6–10-Exporteure Russlands. Die Schätzergebnisse der zweiten PTM-Studie stehen weitestgehend im Einklang mit den Ergebnissen von Berman et al. (2012). Dies ist insbesondere der Fall für Russlands wichtigste Exportmärkte in Westasien und Nordafrika. Die Schätzergebnisse der zweiten PTM-Studie deuten darauf hin, dass russische Weizenexporteure in den meisten Exportländern den Importpreis in der lokalen Währung nach einem Wechselkursschock stabilisieren. Dies steht im Widerspruch zu den Ergebnissen der ersten PTM-Studie, die auf jährlichen Firmendaten und einem kürzeren Beobachtungszeitraum beruhen. Beide PTM-Studien zeigen, dass Russland sich in den meisten Exportländern kompetitiv verhält.

In einer dritten empirischen Studie verwende ich den RDE-Ansatz, um russische Marktmacht in Ägypten und der Türkei, den beiden größten Absatzmärkten Russlands, zu schätzen. Hierbei verwende ich eine neue Instrumentenvariable, die auf Russlands Weizenexportbeschränkungen basiert. Die Schätzergebnisse beruhen auf wöchentlichen Exportdaten für die Jahre 2006–14. Die Schätzergebnisse legen nahe, dass Russland keine Marktmacht in Ägypten ausübt, jedoch auf Weizenexporte in die Türkei einen geschätzten Preisaufschlag von 13,5% erhebt.

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LIST OF ABBREVIATIONS

ADM	Archer Daniels Midland
AER	Amplification of the exchange rate effect
AHDB	Agriculture & Horticulture Development Board
APK-Inform	Agribusiness Information Consulting Company
CAD	Canadian dollar
CCE	Consistent Conjectures Equilibrium
CIDR	Cereal import dependency ratio
CIS	Commonwealth of Independent States
CPI	Consumer price index
CR	Concentration ratio
CWB	Canadian Wheat Board
DOLS	Dynamic ordinary least squares
EEA	European Economic Area
ERPT	Exchange rate pass-through
ERT	Exchange rate transmission
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FAOSTAT	Statistics Division of the FAO
FE	Fixed effects
FMOLS	Fully modified ordinary least squares
FOB	Free on board
FOC	First-order condition
GDP	Gross domestic product
GMM	Generalized method of moments
HHI	Herfindahl-Hirschman index
HRS	Hard Red Spring
HRW	Hard Red Winter
HTS	Harmonized Tariff Schedule
IVPPML	Instrumental variable Poisson pseudo-maximum likelihood

LCPS	Local currency price stabilization
LI	Lerner index
LOP	Law of one price
MC	Marginal cost
MENA	Middle East and Northern Africa
MMT	Million metric tons
MT	Metric tons
NARDL	Nonlinear autoregressive distributed lag
NEIO	New empirical industrial organization
OANDA	Online Forex Trading and Currency Services
PTM	Pricing-to-market
RDE	Residual demand elasticity
RIS	Russia’s import share
ROSSTAT	Russian Federal State Statistics Service
RUB	Russian ruble
RUK	Russia, Ukraine, and Kazakhstan
SSA	Sub-Saharan Africa
SCP	Structure-conduct-performance
SRW	Soft Red Winter
STE	State trading enterprise
SUR	Seemingly unrelated regression
UN Comtrade	United Nations Commodity Trade Statistics Database
US	United States
USD	US dollar
USDA	The United States Department of Agriculture
WIDR	Wheat import dependency ratio
WSSR	Wheat self-sufficiency ratio
3SLS	Three-stage least squares

1 GENERAL INTRODUCTION

1.1 RESEARCH PROBLEM AND MOTIVATION

Trade in agricultural products might create large welfare gains for the participating economies. Welfare gains from trade are generally large whenever the availability of factors of production varies considerably among countries. Favorable climate conditions for wheat production and fertile soil are very unequally distributed around the globe. International wheat trade allows countries with unfavorable conditions for wheat production a wider consumption of wheat products, and thereby produces welfare gains from trade. These welfare gains are particularly large if trade is not impaired by market imperfections, such as market power by wheat exporters.

The world wheat market is oligopolistic with few exporting nations and multinational firms dominating global wheat exports. Since the turn of millennium major shifts have occurred in international wheat trade. On the demand side, growing wheat import demand in Africa and Asia spurs global wheat trade volumes. On the supply side, former Soviet Union members, especially Russia, emerged as major wheat suppliers. Today Russia is a top wheat exporter on a global scale, and dominates wheat exports to several import-dependent developing countries in Northern Africa and Western Asia. Moreover, several Sub-Saharan African states increasingly rely on Russian wheat imports to meet their dietary needs. Thereby, Russian pricing behavior might impact on food availability in these import-dependent developing countries.

1.2 RESEARCH OBJECTIVES

The aim of this doctoral thesis is to analyze Russian pricing behavior in international wheat trade against the background of Russia's growing world market share, and the substantial concentration of Russian wheat exports. I rely on annual firm-level data covering the years 1998–2011, and daily firm-level data for the years 2006–2014. To my knowledge, this doctoral thesis is the first study analyzing Russian wheat export pricing behavior based on firm-level data. The use of firm-level data provides more observations than aggregated data sets, makes it possible to control for firm heterogeneity, and, furthermore, allows for the estimation of firm-group-specific price responses.

1.3 STRUCTURE OF THE DOCTORAL THESIS

My thesis consists of two main parts, as there is a theoretical part, and an empirical part with three essays on Russian pricing behavior. Market power of Russian wheat-exporting firms is constrained by competition from other Russian and foreign wheat suppliers. Therefore, my study of Russian pricing behavior starts with a description of the competitive environment in which Russian wheat traders operate. In this part of my thesis, I draw on trends of the world wheat market in general, and the Russian wheat export industry in particular. The analyses of Russia's wheat export sector points to a high dependency of several wheat-importing countries on Russian wheat exports, and to a high concentration of Russian wheat exports to several countries. In the next section, I apply the theory of oligopoly to the world wheat market and Russian wheat exports, and discuss the exertion of market power in the world wheat market. Furthermore, I discuss methods to detect market imperfections in international trade. In this context, I provide a detailed literature review of the pricing-to-market (PTM) approach, and the residual demand elasticity (RDE) method with a particular focus on agricultural market applications.

It follows the empirical part on Russian pricing behavior in international wheat markets. My estimations of Russian pricing behavior rely on two theoretical frameworks. I apply Krugman's (1986) PTM approach as well as the RDE approach which goes back to Baker and Bresnahan (1988). The PTM as well as the RDE approach are both well-established methods to detect imperfections in international markets. The PTM approach detects destination-specific price discriminations after an exchange rate shock between the currency of the exporter and the currency of an importer, and thereby reveals violations of the law of one price (LOP). The RDE method directly measures market power by estimating the exporter's inverse residual demand elasticity.

In the first section of the empirical part of my doctoral thesis, I apply the PTM method to the annual firm-level data set, and I estimate Russia's pricing behavior for 61 export destinations. The data period 1998–2011 covers different price regimes as in the trade year 2006/07 the world wheat price soared drastically, and has remained above the 2006 level since then. To ensure parameter stability despite the price increase and to compare Russian pricing behavior under different price regimes, I estimate Russian PTM behavior for two different time spans; 2002–2011, and 2006–2011.

I conduct a second PTM study based on daily firm-level data for the years 2006–14 to 49 export markets. This second PTM study is motivated by the finding of Berman et al. (2012) that PTM behavior differs among firms depending on firm size. Therefore, I estimate Russian PTM behavior for three firm groups separately. The first group contains all firms, the second group includes the top 5 exporters in each export market, and the third firm group comprises the top 6–10 exporters in each export destination. My estimation results of both PTM studies point to perfectly competitive pricing behavior by Russia in most export markets, and provide evidence for destination-specific price discrimination in some export destinations.

In the last part of the empirical section of my doctoral thesis, I present the estimation results of a RDE study for Russia's two major export destinations, Egypt and Turkey. Thereby, I apply a new instrumental variable based on Russian export restrictions on wheat exports. The estimation of Russian market power in Egypt and Turkey rests on weekly export data for the period 2006–14. Estimation results suggest that Russia behaves competitively in Egypt but exerts market power in Turkey.

2 THE ROLE OF WORLD WHEAT TRADE IN THE 21st CENTURY

International wheat trade expanded substantially in recent years. Growing wheat import demand spurred production increases and thereby surpluses for export. This chapter of my doctoral thesis will first highlight recent developments in world wheat trade. Secondly, I will relate wheat trade to the concept of food security. Thirdly, I will describe the supply and the demand sides of the world wheat market. Then, I will draw on the emergence of Russia as a major wheat exporter, and I will present Russia's wheat export sector. Finally, I will derive hypotheses regarding Russia's position in international wheat trade based on the findings of this chapter.

2.1 RECENT DEVELOPMENTS IN THE WORLD WHEAT MARKET

Wheat trade has been growing substantially in recent years (see Figure 2.1). 117 million metric tons (MMT) of wheat were imported worldwide in 2000 compared with 184 MMT in 2016. This corresponds to an increase in wheat imports of 57% between 2000 and 2016. According to calculations by the OECD/FAO, the amount of traded wheat between 2007 and 2016 grew annually by 3.86% (OECD/FAO, 2017). As Figure 2.2 illustrates, the growth in world wheat trade was mainly driven by soaring import demand from Asian and African countries. Demand for wheat in Africa is stimulated by population growth, while the key driver of Asia's soaring wheat import demand is income growth. Wheat imports by African countries grew by about 20 MMT between 2000 and 2016, corresponding to an increase of 82%. Wheat imports rose in all African regions (see Table 2.1). However, the rise in wheat imports by Africa was mainly driven by import increases by Northern African states. Between 2000 and 2016 wheat imports by Northern Africa grew by 11.5 MMT, which corresponds to 58% of Africa's wheat import growth. As a result of the strong growth in African wheat imports, Africa overtook Europe in 2007 as the continent with the second largest wheat import volume (see Figure 2.2).

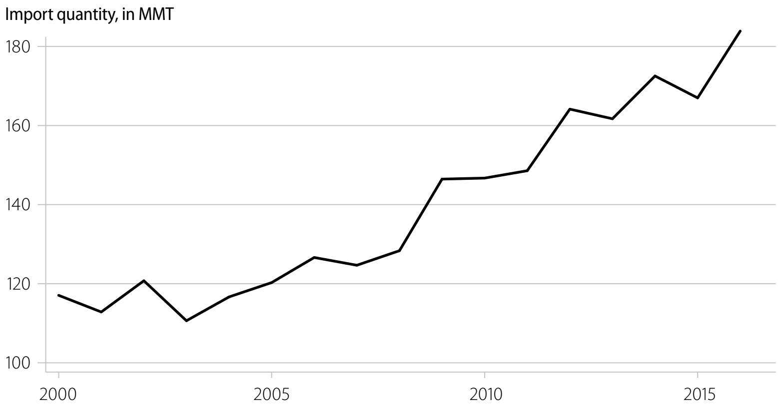

Figure 2.1: World wheat imports

Note: MMT abbreviates million metric tons.

Source: Own illustration based on data provided by FAOSTAT (2018)

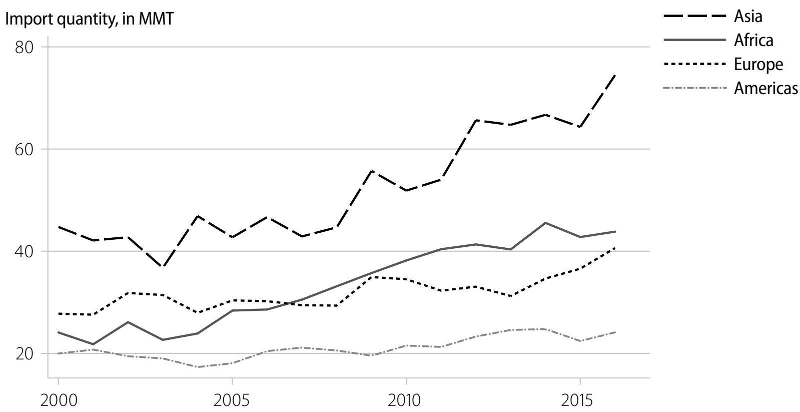

Figure 2.2: Regional wheat imports

Note: MMT abbreviates million metric tons.

Source: Own illustration based on data provided by FAOSTAT (2018)

In the same time period, Asian wheat imports rose by around 30 MMT. Wheat import growth was particularly pronounced in South-Eastern Asia as well as Western Asia (see Table 2.2).

Table 2.1: African wheat imports

	Wheat import quantity, in MMT		Share in African imports, in %	
Region	**2000**	**2016**	**2000**	**2016**
Eastern Africa	2.92	5.46	12.13	12.46
Middle Africa	0.47	1.17	1.95	2.66
Northern Africa	16.51	28.05	68.53	63.99
Southern Africa	0.85	1.79	3.54	4.08
Western Africa	3.34	7.36	13.85	16.8

Source: Own computation based on data provided by FAOSTAT (2018)

Table 2.2: Asian wheat imports

	Wheat import quantity, in MMT		Share in Asian imports, in %	
Region	**2000**	**2016**	**2000**	**2016**
Central Asia	1.13	3.54	2.52	4.75
Eastern Asia	11.92	15	26.65	20.14
Southern Asia	10.87	8.69	24.29	11.67
South-Eastern Asia	8.78	26.58	19.63	35.7
Western Asia	12.05	20.67	26.92	27.75

Source: Own computation based on FAOSTAT (2018)

2.2 WHEAT TRADE AND FOOD SECURITY

As developing countries in Africa and Asia increasingly rely on international wheat trade to meet demand, wheat trade has a growing relevance for food security in the importing regions with wheat-based diets.

The term 'food security' was defined during the World Food Summit in 1996 as follows: "Food security exists when all people, at all times, have physical, and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life". This definition of food security is commonly accepted and points to the distinct dimensions of food security. These dimensions are food availability, access to food, utilization of food as well as stability of the first three dimensions over time (FAO, 2006). Availability of sufficient food at national level is a precondition for access to food. Access refers to the distribution of the available food among households and within households. Food prices are crucial for economic access to food of poor households. The dimension of utilization points to a proper preparation of food to ensure a healthy and nutritional diet. A country can be classified as food secure only if all four dimensions are fulfilled at the same time (Barrett et al., 2010).

The food security status of a country can be measured by means of indicators. The Food and Agriculture Organization of the United Nations (FAO) publishes food security indicators related to the four dimensions of food security. See Table A.2.1 in the Appendix for a complete list of the FAO's food security indicators. The 'Cereal import dependency ratio' (CIDR) relates dependency on cereal imports to stability of food security.[1] High dependence on cereal imports implies high exposure to international price spikes and price volatility. Higher wheat prices imply at national level a deterioration of the terms of trade of net-importers of wheat, and impose a financial burden on import-dependent developing countries that issue food programs. At household level, rising wheat prices might jeopardize food access of the poorest already spending a large portion of their income on food. Abbott and Borot de Battisti (2011) study price transmission of international food prices to domestic prices in Africa and find greater price transmission rates for food import-dependent African countries during the 2007/08 food crisis.

Figure 2.3 depicts the CIDR of the group of developing countries, the group of developed countries, as well as Northern Africa and Western Asia, two regions with wheat-based diets. The figure demonstrates that

1 The CIDR is computed the following way: (cereal imports – cereal exports)/(cereal production + cereal imports – cereal exports) × 100.

the group of developing countries is a net importer of cereals while the group of developed states is a cereal net exporter. Figure 2.3 illustrates that Northern Africa and Western Asia are particularly dependent on cereal imports to meet their diets. Furthermore, Figure 2.3 points out that cereal import dependency of Western Asia has been increasing substantially since the beginning of the 1990s. Another food security indicator compiled by the FAO that is related to food trade is the 'Value of food imports over total merchandise exports' as it measures a country's ability to pay for food imports. Thereby, the ability to finance food imports reduces the vulnerability of cereal import dependent countries to food price spikes. Table 2.4 lists the 'Value of food imports over total merchandise exports' for selected wheat-importing countries, and demonstrates remarkable differences among importing countries. The ratio between the values of food imports and merchandise exports is small for the developed countries Italy and Israel, as well as for the oil-exporters Azerbaijan and Nigeria. In contrast, the ratio is rather high for Armenia, Egypt, Georgia, Jordan, Kenya, Tajikistan, and Yemen. The ratio between value of food imports and merchandise exports is considerably higher for the oil exporter Algeria as compared with the other oil-exporting nations Azerbaijan and Nigeria, however, much lower as compared with the other non-oil exporting developing and middle-income countries.

In a similar vein, Diaz-Bonilla et al. (2000) use indicators for food security to identify the food security status of 163 countries. Thereby, they rely on five food security indicators and apply cluster analysis methods to classify the countries as either food secure, food neutral or food insecure. These indicators are food production per capita, the ratio of total exports to food imports, calories per capita and protein per capita, as well as non-agricultural population. The indicator 'ratio of total exports to food imports' relates food security to food trade, and measures a country's ability to pay for food imports. Thus, this indicator measures a country's vulnerability to food price spikes. Table 2.3 depicts the classification by Diaz-Bonilla et al. (2000) of selected wheat-importing countries as food insecure, food neutral or food secure. Major wheat-importing states in the Middle East and North African (MENA) region are classified as food

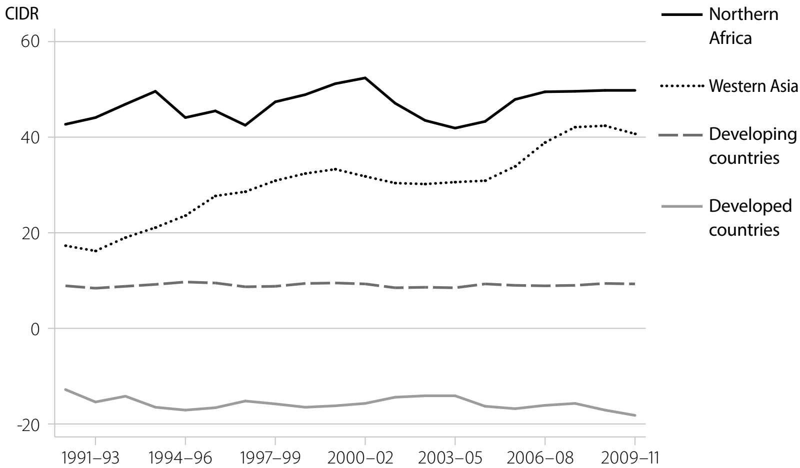

Figure 2.3: Cereal import dependency ratios

Source: Own illustration based on data provided by FAOSTAT (2018)

Table 2.3: Food security status of wheat-importing countries

Country	Classification according to Diaz-Bonilla et al. (2000)
Algeria	Food neutral, trade stressed
Armenia	Food insecure
Azerbaijan	Food insecure
Egypt	Food neutral, trade stressed
Georgia	Food insecure
Indonesia	Food neutral
Iran	Food neutral, trade stressed
Italy	Food secure
Mongolia	Food insecure
Morocco	Food neutral, trade stressed
Nigeria	Food neutral
Tunisia	Food neutral, trade stressed
Turkey	Food secure
Yemen	Food insecure

Source: Diaz-Bonilla et al. (2000)

neutral, yet, are found to be trade stressed. The Caucasian states Armenia, Azerbaijan and Georgia are classified as food insecure, similarly as Yemen and landlocked Mongolia. Italy and Turkey are revealed as food secure countries.

Table 2.4: Value of food imports over total merchandise exports

Country	2000–02	2001–03	2002–04	2003–05	2004–06
Algeria	12	12	12	9	8
Armenia	38	28	25	23	23
Azerbaijan	9	9	10	9	8
Egypt	40	34	29	25	23
Georgia	56	50	56	54	55
Israel	5	5	5	5	5
Italy	6	6	6	6	6
Jordan	30	27	28	28	26
Kenya	21	18	15	15	16
Nigeria	6	8	7	6	6
Tajikistan	16	15	16	19	21
Turkey	4	4	4	4	3
Yemen	22	25	25	21	19

Source: FAO (2018)

	2005–07	2006–08	2007–09	2008–10	2009–11	2010–12	2011–13
	7	8	10	10	11	11	13
	26	35	45	50	48	43	41
	9	3	3	3	3	3	3
	25	27	30	33	37	41	42
	54	55	54	49	44	41	37
	5	5	5	6	6	6	6
	6	6	6	6	7	7	7
	27	28	30	30	31	34	37
	19	22	26	27	29	24	26
	6	6	6	6	6	6	6
	22	22	28	34	40	40	43
	3	4	4	5	5	5	6
	21	26	32	32	30	33	36

2.3 WORLD WHEAT SUPPLY: PRODUCTION AND EXPORTS

Growing wheat import demand has spurred production increases. Figure 2.4 shows the volume of world wheat production for the years 2000–2016, and illustrates that global wheat production has increased significantly since the turn of millennium. 585 MMT of wheat were grown in 2000, and about 750 MMT of wheat were produced in 2016. Thus, global wheat production was 28% higher in 2016 than in 2000.

Wheat production is widespread around the globe. In total, in 2016, wheat was produced in 123 countries, according to FAOSTAT data. The world top wheat producers in recent years were China and India, followed by the United States (US), Russia, and France (see Figure 2.6). These five countries accounted together for about half of world wheat production in recent years (see Figure 2.5). China, the top producer, added 132 MMT to world wheat production in 2016, corresponding to 18% of global wheat production. India, the US, Russia, and France produced 94 MMT, 63 MMT, 73 MMT, and 30 MMT, respectively; with a corresponding share in world wheat production of 12%, 8%, 10%, and 4% in 2016.

China and India produced mainly for the domestic market. China exported only 0.4% of its production volume in 2000–16, and India exported 2.2% of its production quantity in the same time period. Thereby, China's and India's share in world wheat exports in 2000–16 amounted to negligible 0.34% and 1.28%, respectively. In contrast, the US, Russia and France were among the top producers and top exporters on a global scale (see Tables 2.5 and 2.6). Table 2.5 summarizes the wheat export quantities of major exporting nations for the years 2000–16. The volume of wheat exported worldwide has been increasing significantly since 2000. In 2000, 117.2 MMT of wheat were exported worldwide, while in 2016, the wheat export volume was equal to183.6 MMT. The export quantity of the traditional wheat exporters was rather stable over this time span. Growth in wheat exports was driven by increased export activities of the Black Sea exporters Russia and Ukraine, on one hand, and by smaller exporters,

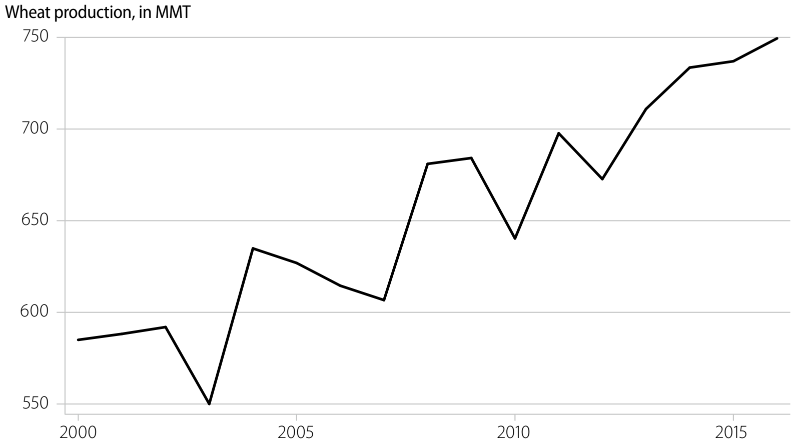

Figure 2.4: World wheat production, 2000–16

Source: Own illustration based on data provided by FAOSTAT (2018)

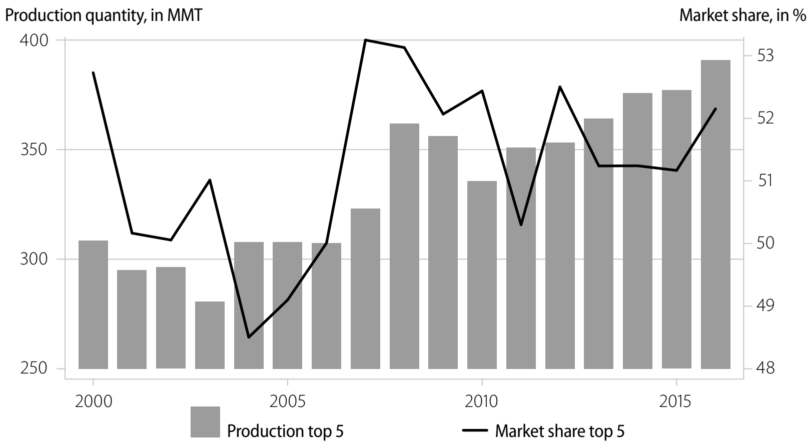

Figure 2.5: Wheat production and market share of the top five producing countries

Source: Own compilation based on data provided by FAOSTAT (2018)

on the other hand. Consequently, the world market shares of Russia and Ukraine have been increasing in recent years while those of the other major exporting nations have been shrinking (see Table 2.6). Figure 2.7, depicting the wheat export volumes of Russia, the US, and France, illustrates these shifts on the supply side of the world wheat market.

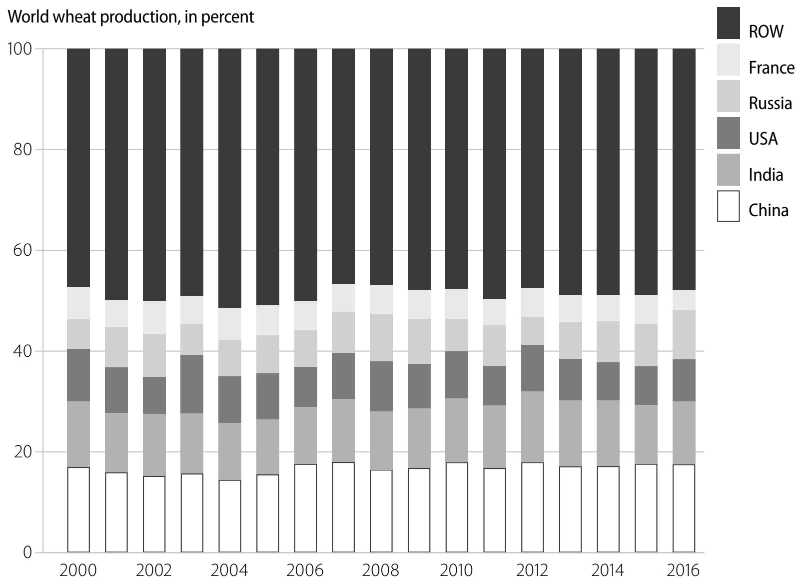

Figure 2.6: World wheat production

Note: ROW abbreviates Rest of the World.

Source: Own compilation based on data published by FAOSTAT (2018)

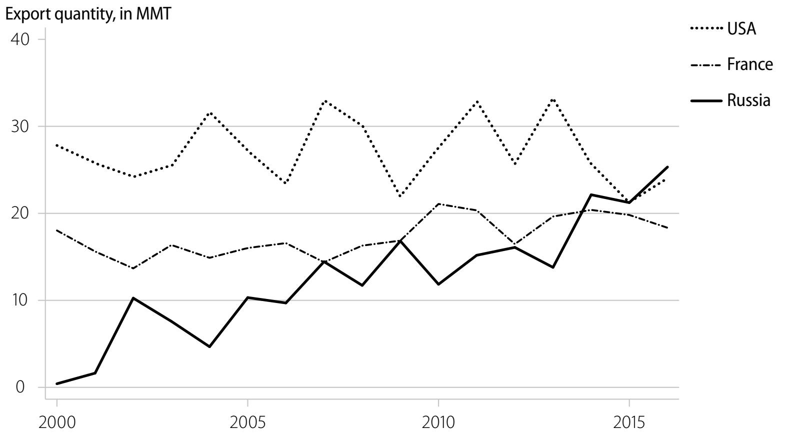

Figure 2.7: Wheat export quantities of major wheat exporters

Source: Own illustration based on data provided by UN Comtrade (2018)

Figure 2.8: Wheat export quantities of the Black Sea exporters

Source: Own illustration based on data provided by FAOSTAT (2018)

Table 2.5: Wheat export quantities of major exporting nations, in MMT

	2000	2001	2002	2003	2004	2005	2006	2007
Argentina	11	10.8	9.1	6.2	10	10.4	9.7	9.6
Australia	17.7	15.5	14.7	9.5	18.5	13.9	15	6.8
Canada	18.8	17.7	12.2	11.7	15.1	13.9	18.5	17.6
France	18	15.6	13.7	16.4	14.9	16	16.6	14.4
Kazakhstan	5	3	3.9	5.2	2.6	1.9	4.2	6.2
Russia	0.4	1.6	10.3	7.6	4.7	10.3	9.7	14.4
Ukraine	0.2	2.9	8.3	0.9	2.6	6	4.7	1.1
US	27.8	25.8	24.2	25.4	31.6	27.2	23.4	32.9
Rest	18.3	20.8	24	26.7	18.9	20.9	24.6	21.6
RUK	**5.6**	**7.5**	**22.5**	**13.7**	**9.9**	**18.2**	**18.6**	**21.7**
World	**117.2**	**113.7**	**120.4**	**109.6**	**118.9**	**120.5**	**126.4**	**124.6**

Note: RUK abbreviates Russia, Ukraine, and Kazakhstan.

Source: Own compilation based on data provided by FAOSTAT (2018)

Table 2.6: World market share of major exporting nations, in %

	2000	2001	2002	2003	2004	2005	2006	2007
Argentina	9.4	9.5	7.5	5.6	8.4	8.7	7.7	7.7
Australia	15.1	13.7	12.2	8.7	15.5	11.6	11.8	5.4
Canada	16	15.5	10.1	10.7	12.7	11.6	14.6	14.1
France	15.4	13.7	11.4	14.9	12.5	13.3	13.1	11.5
Kazakhstan	4.3	2.7	3.3	4.7	2.2	1.6	3.3	5
Russia	0.4	1.4	8.5	6.9	3.9	8.6	7.7	11.6
Ukraine	0.2	2.5	6.9	0.8	2.1	5	3.7	0.8
US	23.7	22.7	20.1	23.2	26.6	22.6	18.5	26.4
Rest	15.5	18.3	19.9	24.4	16.1	17.2	19.6	17.4
RUK	**4.8**	**6.6**	**18.7**	**12.5**	**8.3**	**15.1**	**14.7**	**17.4**

Note: RUK abbreviates Russia, Ukraine, and Kazakhstan.

Source: Own compilation based on data provided by FAOSTAT (2018)

	2008	2009	2010	2011	2012	2013	2014	2015	2016
	8.8	5.1	4	8.4	11.5	2.4	1.9	4.3	10.3
	8.3	15	15.9	17.7	23.5	18	18.3	17.1	16.1
	15.8	19.3	18.4	16.3	17.9	19.8	24.2	23.6	19.7
	16.3	16.9	21.1	20.3	16.5	19.6	20.4	19.8	18.3
	5	3.2	5.1	2.9	7.5	5	4.2	3.6	4.4
	11.7	16.8	11.8	15.2	16.1	13.8	22.1	21.2	25.3
	7.5	12.9	4.3	4.1	8.7	7.8	10.5	13.5	11.7
	30.1	21.9	27.6	32.8	25.8	33.2	25.6	21.3	24
	27.7	35.9	37.5	30.6	37.1	43.2	46.7	46.2	53.8
	24.2	**32.9**	**21.2**	**22.2**	**32.3**	**26.6**	**36.8**	**38.3**	41.4
	131.2	**147**	**145.7**	**148.3**	**164.6**	**162.8**	**173.9**	**170.6**	**183.6**

	2008	2009	2010	2011	2012	2013	2014	2015	2016
	6.7	3.5	2.8	5.7	7	1.5	1.1	2.5	5.6
	6.3	10.2	10.9	11.9	14.3	11.1	10.5	10	8.8
	12	13.1	12.6	11	10.9	12.2	13.9	13.8	10.7
	12.4	11.5	14.5	13.7	10	12.1	11.7	11.6	10
	3.8	2.2	3.5	1.9	4.5	3.1	2.4	2.1	2.4
	8.9	11.4	8.1	10.2	9.8	8.5	12.7	12.4	13.8
	5.7	8.8	3	2.8	5.3	4.8	6.1	7.9	6.4
	22.9	14.9	19	22.1	15.7	20.4	14.8	12.5	13.1
	21.2	24.4	25.7	20.6	22.7	26.5	26.8	27.1	29.2
	18.4	**22.4**	**14.6**	**14.9**	**19.6**	**16.3**	**21.2**	**22.5**	**22.6**

2.4 WORLD WHEAT DEMAND: CONSUMPTION AND IMPORT DEPENDENCY

The bulk of global food wheat is consumed in Asia, with an annual average of more than 250 MMT in the period 2000–13; followed by Europe (80 MMT), the Americas (55.9 MMT) and Africa with an annual food wheat supply of 41.3 MMT (see Table 2.7). While Asia is the largest wheat consumer in absolute terms, per capita food wheat supply varies considerably around the globe. Wheat is of essential significance for food security in some parts of the world with highly wheat-based diets while it plays a minor role for food security in other regions. Table 2.7 shows the average regional annual per capita food wheat supply for the years 2000–13, and demonstrates remarkable differences. Per capita food wheat supply was highest in Central Asia with 150 kg per year. In Western Asia, annual per capita food wheat supply averaged 147 kg, followed by Northern Africa with 136 kg per year and capita. In contrast, food wheat consumption was lowest in South-Eastern Asia and Western Africa with 17 kg and 18 kg per year and capita, respectively.

Table 2.8 shows the average annual food wheat consumption per capita of those states with the highest per capita consumption rates for the years 2000–13. The country with the highest food wheat consumption per capita in 2000–13 was Azerbaijan with about 212 kg per capita, followed by Tunisia with a per capita food wheat consumption of about 200 kg and Turkmenistan with about 195 kg per capita. In Egypt, the world top wheat importer, per capita food wheat consumption amounted to about 142 kg per inhabitant.

Reliance on international wheat trade to meet wheat demand differs among regions. Table 2.9 shows that all African regions as well as all Asian regions except Central Asia were net importers of wheat. In contrast, Australia & New Zealand, and Northern America achieved large wheat export surpluses. Similarly, at national level, among the states with wheat-based diets listed in Table 2.8, reliance on international wheat markets to meet domestic wheat demand differed considerably. While Afghanistan was almost self-sufficient, Georgia and Algeria were highly dependent on wheat imports.

Table 2.7: Regional annual food wheat supply

Region	Food wheat per capita (kg/year), avg. 2000–13	Food wheat (MMT/year), avg. 2000–13
Africa	**48**	**41.3**
Eastern Africa	21	5.9
Middle Africa	22	1.3
Northern Africa	136	25.7
Southern Africa	56	3.2
Western Africa	18	5.2
Americas	**62**	**55.9**
Caribbean	41	1.5
Central America	34	5.3
Northern America	83	28.0
South America	56	21.2
Asia	**64**	**252.5**
Central Asia	150	8.9
Eastern Asia	64	99.3
South-Eastern Asia	17	9.8
Southern Asia	67	107.0
Western Asia	147	27.6
Australia & New Zealand	**71**	**1.8**
Europe	**109**	**80.0**
Eastern Europe	121	36.2
Northern Europe	96	9.3
Southern Europe	117	17.7
Western Europe	89	16.8

Source: Own compilation based on data provided by FAOSTAT (2018)

Table 2.8: Annual food wheat supply per capita

Country	Food wheat per capita (kg/year), avg. 2000–13	WIDR, avg. 2000–16
Azerbaijan	212	40
Tunisia	200	54
Turkmenistan	195	34
Turkey	192	9
Algeria	185	71
Morocco	179	45
Uzbekistan	166	5
Iran	159	20
Georgia	157	84
Italy	148	47
Afghanistan	147	3
Albania	144	48
Egypt	142	49
Malta	142	63
Armenia	141	58

Source: Own compilation based on data provided by FAOSTAT (2018)

Table 2.9: Dependency on wheat imports by region

Region	WIDR, avg. 2000–16	WSSR, avg. 2000–16
Africa	**59**	**41**
Eastern Africa	55	45
Middle Africa	98	2
Northern Africa	56	44
Southern Africa	39	61
Western Africa	98	2
Americas	**–46**	**146**
Caribbean		
Central America	55	45
Northern America	–109	209
South America	9	91
Asia	**13**	**87**
Central Asia	–15	115
Eastern Asia	10	90
South-Eastern Asia	99	1
Southern Asia	5	95
Western Asia	33	67
Australia & New Zealand	**–234**	**334**
Europe	**–16**	**116**
Eastern Europe	–33	133
Northern Europe	–13	113
Southern Europe	40	60
Western Europe	–29	129

Note: WIDR and WSSR abbreviate wheat import dependency ratio and wheat self-sufficiency ratio, respectively.

Source: Own computation based on data provided by FAOSTAT (2018)

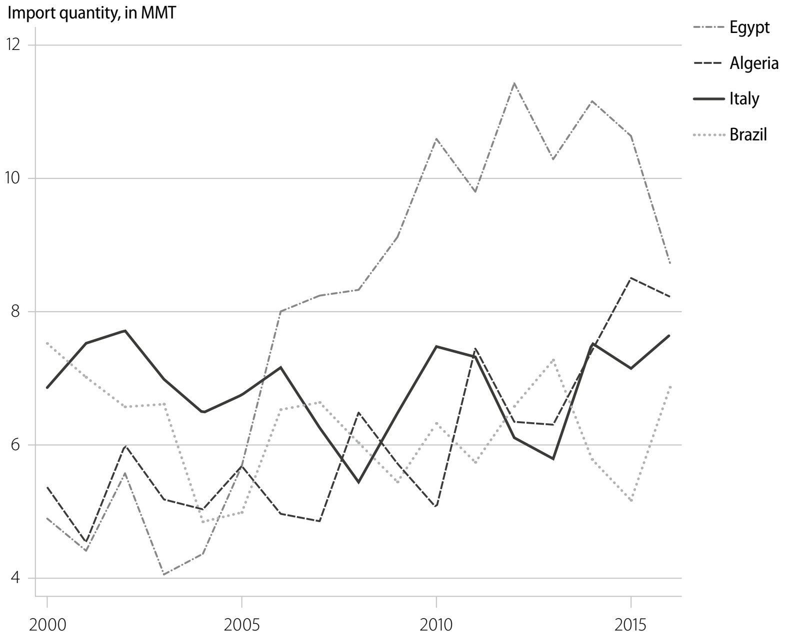

Figure 2.9: Wheat import quantities of major wheat importers

Source: Own illustration based on data provided by FAOSTAT (2018)

Figure 2.9 depicts the wheat import quantities of the top 4 wheat importers in 2000–16, based on FAOSTAT data. In absolute terms, Egypt imported the largest amount of wheat in the period 2000–16, followed by Italy, Brazil, and Algeria. World wheat imports were much more dispersed than world wheat exports. Egypt, the top importer in recent years, had a market share of only 5.6% in the period 2000–16 (see Table 2.10). However, strikingly, the import quantity of the two Northern African countries, Egypt and Algeria, has been increasing over this time span, while the import quantities of Italy and Brazil were rather stable.

Table 2.10: Market share of major wheat importers

	Egypt	Italy	Brazil	Algeria
2000	4.1	5.8	6.3	4.5
2001	3.9	6.6	6.1	4
2002	4.6	6.3	5.4	4.9
2003	3.6	6.2	5.9	4.6
2004	3.5	5.2	3.9	4
2005	4.5	5.4	4	4.5
2006	6.2	5.6	5.1	3.9
2007	6.5	5	5.3	3.9
2008	6.4	4.2	4.7	5
2009	6.1	4.4	3.7	3.8
2010	7.1	5	4.2	3.4
2011	6.5	4.8	3.8	4.9
2012	6.8	3.6	3.9	3.8
2013	6.1	3.4	4.3	3.7
2014	6.3	4.3	3.3	4.2
2015	6.2	4.2	3	5
2016	4.6	4.1	3.6	4.4
All years	**5.6**	**4.8**	**4.4**	**4.3**

Source: Own compilation based on data provided by FAOSTAT (2018)

2.5 RUSSIAN WHEAT PRODUCTION AND EXPORTS

2.5.1 Emergence of a global player

Russia started to export wheat at a significant scale at the beginning of the millennium. While Russia was a wheat importer in Soviet times, today Russia ranks among the top exporters worldwide. Russia was even the world's top wheat exporter in the trade year 2017/18 (see USDA, 2018).

The emergence of Russia as a major wheat exporter was linked to Russia's rebound of wheat production in the 2000s and the drop in domestic demand for feed wheat during transition. The transition process from a planned to a market-oriented economy came along with a dramatic drop in agricultural output. Livestock production, highly subsidized in Soviet times, plummeted during the 1990s, with a corresponding drop in demand for feed wheat (Liefert and Liefert, 2012). Figure 2.10 illustrates the collapse of the demand for animal feed during transition. While in 1992 34.7 MMT of wheat were used as animal feed, in 1995 only 6.8 MMT of wheat were used as fodder in Russia. Figure 2.10 shows that the amount of wheat used for feeding remains below the 1992 level despite a strong rebound of livestock production in the 2000s.

Russian wheat production contracted during transition and rebounded in the beginning of the 2000s. Given the reduced demand for feed wheat in Russia, the strong rebound of wheat generated a surplus for export. Table 2.11 displays Russian 5-year average wheat production for the years 1992–2016.

Table 2.11: Average Russian wheat production, in thous. t

1992–1996	1997–2001	2002–2006	2007–2011	2012–2016
37,358.2	36,736.6	44,533.4	54,524.1	56,920.4

Source: Own compilation based on data provided by FAOSTAT (2018)

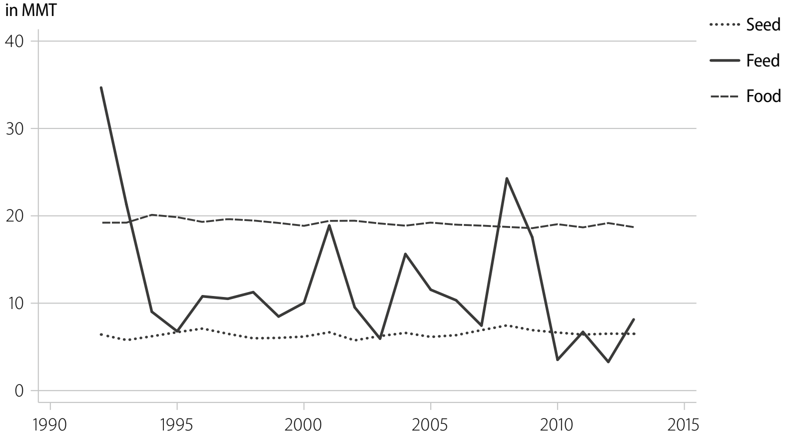

Figure 2.10: Utilization of wheat in Russia, 1992–2013

Source: Own compilation based on data provided by FAOSTAT (2018)

Table 2.12: Acreage of winter and spring wheat in Russia, in thous. ha

	1992	2000	2005	2010	2013	2014	2015	2016
Winter wheat	10,799	7,933	10,363	12,699	12,334	12,161	13,354	14,021
Spring wheat	13,485	15,272	14,979	13,915	12,729	13,116	13,479	13,683

Source: ROSSTAT (2017)

According to these data, Russian average wheat production was 52% larger in 2012–16 than in 1992–96. The upswing in wheat production was largely caused by an increase in yield. Figure 2.11 shows the development of yield of Russian wheat production between 1992 and 2016, and demonstrates its strong upward trend. According to FAOSTAT data, yield of wheat was 41% higher in 2016 than in 1992 (FAOSTAT, 2018).

While growth in wheat production was mainly driven by yield growth, wheat acreage has been recovering since the beginning of the millennium, contributing to production growth. Acreage of winter (spring) wheat in 2016 was 30% (1.5%) above the acreage of winter (spring) wheat in 1992 (see Table 2.12). Figure 2.12 visualizes the upward trend in acreage dedicated to wheat production. The described growth in wheat production, mainly driven by yield increases, enabled Russia to enter international markets as a major wheat exporter.

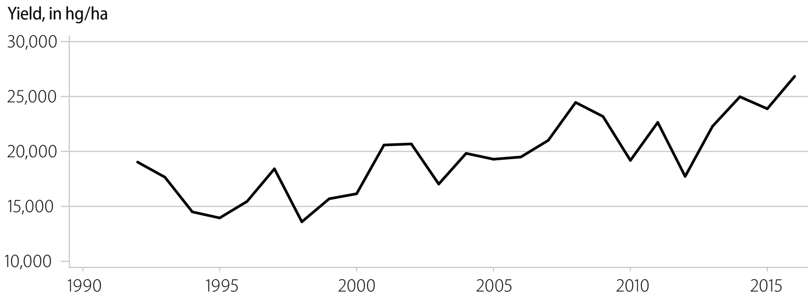

Figure 2.11: Yields in wheat production in Russia

Source: Own illustration based on data provided by FAOSTAT (2018)

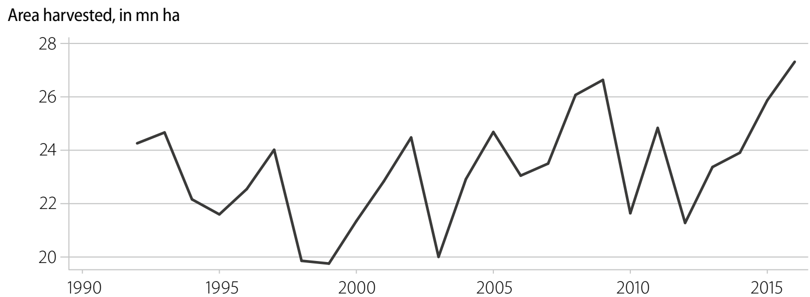

Figure 2.12: Area harvested of wheat in Russia

Source: Own illustration based on data provided by FAOSTAT (2018)

Figures 2.13 and 2.14 illustrate the emergence of Russia as a major wheat exporter. Figure 2.13 depicts Russia's wheat production for the years 1993 to 2014 and Russian wheat export quantity for the period 1993 to 2013. The figure shows that Russia was a minor actor in international

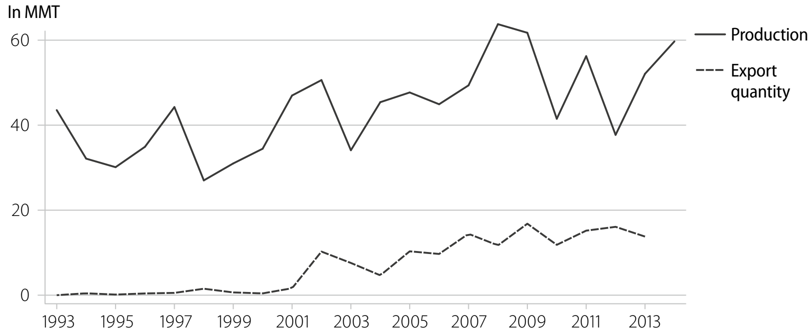

Figure 2.13: Russian wheat production and export quantity

Source: Own illustration based on data provided by FAOSTAT (2018)

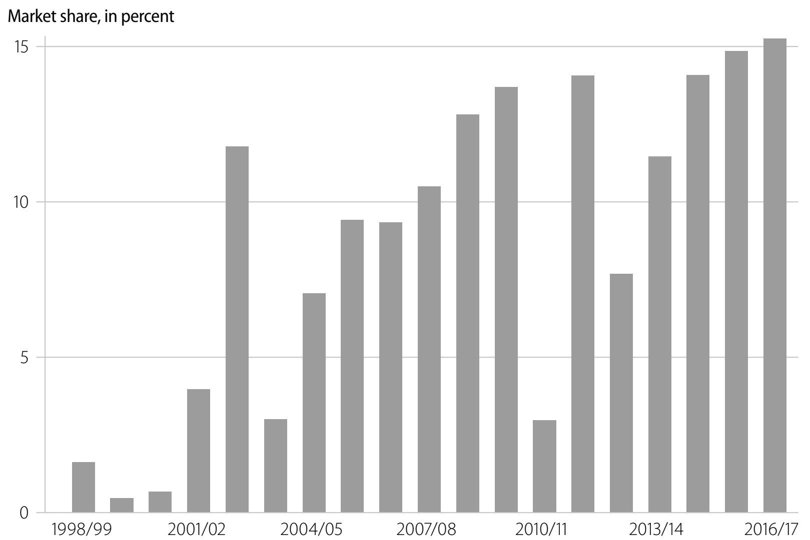

Figure 2.14: Russian wheat world market share

Note: Figures are based on trade years (July/June year).

Source: Own compilation based on USDA (2018) wheat trade around the turn of the millennium. In the trade years 1998/99 and 1999/00 Russia accounted for 1.6% and 0.5% of world wheat exports, respectively. Since then, Russia has established as a major wheat exporter with a world market share of 22% in 2017/18 (see USDA, 2018). Time series of wheat production and export quantity are highly correlated with the correlation coefficient equal to 0.85. Wheat production and export volume have been increasing over the time period, and were subject to fluctuations. Weather conditions heavily influenced year-to-year wheat production and export volumes. As Russia's export quantity fluctuated substantially, so did Russia's world market share. Figure 2.14 depicts Russia's market share in world wheat exports from 1998/99 to 2016/17. Contrary to the trend of an increasing market share, Russia's world market share plummeted in 2010/11. The reason was a severe drought decreasing Russian wheat production substantially. As a reaction, the Russian government imposed a wheat export ban in 2010/11 to stabilize domestic food prices.

2.5.2 Wheat-producing areas

The key wheat-growing areas in Russia are the South District, the Central District as well as the Volga District. In 2017, these three federal districts accounted for 73% of Russian wheat production, with the South District being the top producer. In contrast, the Northwest District and the Far East District produced only negligible quantities of wheat (see Table 2.13 and 2.14).

Russia has experienced a rebound of wheat production since the early 2000s. Apparently, growth in wheat production was largely driven by production increases in the South District. Between 2009 and 2017 wheat output of the South District grew by 75% while output increases were substantially lower in other federal districts. Wheat production grew by 56% in the Central District, 51% in the Volga District, and 25% in the North Caucasus District while production contracted in the Siberian District by 22%. In terms of quantities, wheat production increased by 11.1 MMT in

Table 2.13: Regional wheat production, in MMT

	Federal district								
Year	Central	Crimea	Far East	North Caucasus	North-west	Siberia	South	Ural	Volga
2009	11.93		0.27	6.26	0.29	12.78	14.8	3.49	11.92
2010	5.94		0.1	6.36	0.19	9.31	13.75	2.16	3.7
2011	8.33		0.24	7.39	0.17	9.79	15.37	4.97	9.99
2012	8.41		0.19	3.75	0.23	5.41	11.17	2.15	6.42
2013	11.59		0.11	5.82	0.25	9.27	14.15	2.74	8.17
2014	12.26	0.63	0.25	7.28	0.4	8.25	17.98	2.78	9.88
2015	11.95	0.74	0.24	7.6	0.56	9.23	18.5	3.37	9.6
2016	14.73		0.32	8.35	0.4	9.64	22.45	3.78	13.62
2017	18.65		0.28	8.3	0.42	9.96	25.9	4.38	17.96

Source: ROSSTAT (2018)

Table 2.14: Regional wheat production, in %

	Federal district								
Year	Central	Crimea	Far East	North Caucasus	North-west	Siberia	South	Ural	Volga
2009	19.32	0	0.44	10.14	0.47	20.7	23.97	5.65	19.31
2010	14.31	0	0.24	15.32	0.46	22.43	33.12	5.2	8.91
2011	14.81	0	0.43	13.14	0.3	17.4	27.32	8.84	17.76
2012	22.29	0	0.5	9.94	0.61	14.34	29.61	5.7	17.02
2013	22.25	0	0.21	11.17	0.48	17.79	27.16	5.26	15.68
2014	20.53	1.06	0.42	12.19	0.67	13.82	30.11	4.66	16.55
2015	19.34	1.2	0.39	12.3	0.91	14.94	29.94	5.45	15.54
2016	20.1	0	0.44	11.39	0.55	13.15	30.63	5.16	18.58
2017	21.72	0	0.33	9.67	0.49	11.6	30.17	5.1	20.92

Source: ROSSTAT (2018)

the South District, by 6.7 MMT in the Central District, by 6 MMT in the Volga District, by 2 MMT in the North Caucasus District, by 0.9 MMT in the Ural District, and output decreased by 2.8 MMT in the Siberian District. Rada et al. (2017) ascribe the above average recovery of agricultural output in the South District to comparative advantages in wheat production and the good access to the export markets. Farmers in the South District benefit from fertile soil, favorable climate for wheat production, and the proximity to Russia's main export ports. Given the access to the export ports, the Southern District mainly produces for export. The Southern District exported 18.3 MMT of wheat in 2017, corresponding to 71% of the district's wheat production. Thereby, the Southern District produced 56% of Russian wheat exported in 2017. Beside the Southern District, the Central District produces significant quantities for export with 11.2 MMT in 2017, corresponding to 42% of the district's wheat production (see Table 2.15).

Winter wheat as well as spring wheat is cultivated in Russia. Winter wheat accounted for 72% of Russian wheat production in 2017, and spring wheat had a share of 28%. About 40% of Russian winter wheat was grown in the South District. Other major winter wheat-producing areas are the Central District, and the Volga and North Caucasus Districts (see Table 2.16). The key spring wheat-growing zone spans the Siberian District, the Volga District, and the Ural and Central Districts. All other districts produced negligible amounts of spring wheat (see Table 2.17).

Wheat prices varied substantially among Russian wheat-producing districts. Table 2.17 shows regional average wheat prices for the period 2006–14 for the Central District, the North Caucasus District, the Ural District, the Volga District, and the West Siberian District. Table 2.17 shows that wheat prices were higher in the winter wheat-producing areas North Caucasus and Central with average prices of 6,488 Russian rubles per metric ton and 6,287 rubles per metric ton, respectively. While wheat prices were lower in the regions that are more distant to the main export ports. Lowest prices were paid in West Siberia with 5,837 rubles per metric ton. Hence, wheat prices were more than 11% higher in North Caucasus than in West Siberia. However, during the Russian wheat export ban

Table 2.15: District-level wheat exports, in thous. t

	2013	2014	2015	2016	2017
Central	5,280	9,065	8,066	8,298	11,183
Crimea		10			
Far East	0	4	1	15	25
Northwest	804	1,205	1,219	1,468	2,096
North Caucasus	541	856	934	738	734
Siberia	1	105	73	181	123
Southern	7,086	10,693	10,674	14,295	18,281
Ural	9	17	28	8	58
Volga	75	128	236	293	382

Source: ROSSTAT (2017)

Table 2.16: Regional winter wheat production, in %

	Federal district								
Year	**Central**	**Crimea**	**Far East**	**North Caucasus**	**North-west**	**Siberia**	**South**	**Ural**	**Volga**
2008	25.82		0.01	16.73	0.41	0.13	42.39	0.06	14.45
2009	27.28		0.01	16.05	0.56	0.39	37.9	0.08	17.73
2010	18.73		0	22.76	0.51	0.46	49.11	0.06	8.37
2011	21.83		0.01	21.42	0.29	0.38	44.35	0.03	11.69
2012	30.19		0.02	14.62	0.59	0.36	43.54	0.02	10.67
2013	30.66		0	16.16	0.46	0.51	39.1	0.02	13.1
2014	25.79	1.49	0	17.2	0.6	0.47	42.25	0.03	12.17
2015	24.37	1.76	0	18.03	1	0.77	43.51	0.05	10.51
2016	25.13		0	15.94	0.43	0.86	42.14	0.07	15.42
2017	26.37		0	13.4	0.48	0.79	41.39	0.09	17.49

Source: ROSSTAT (2018)

Table 2.17: Regional spring wheat production, in %

	Federal district								
Year	Central	Crimea	Far East	North Caucasus	North-west	Siberia	South	Ural	Volga
2008	4.79		1.06	0.15	0.43	43.34	0.55	15.82	33.86
2009	5.75		1.16	0.05	0.31	55.42	0.16	15.18	21.98
2010	5.27		0.7	0.05	0.36	67.51	0.32	15.8	9.99
2011	3.72		1.07	0.06	0.34	44.26	0.46	22.74	27.36
2012	5.76		1.5	0.11	0.63	43.59	0.49	17.6	30.33
2013	3.55		0.67	0.1	0.56	56.2	0.61	16.89	21.41
2014	7.77	0.01	1.43	0.07	0.82	46.16	0.7	15.9	27.16
2015	8.6	0.02	1.2	0.06	0.72	45.12	1.01	17	26.27
2016	7.58		1.5	0.06	0.84	43.75	1.93	17.85	26.49
2017	9.75		1.17	0.07	0.51	39.46	1.28	18.02	29.74

Source: ROSSTAT (2018)

Table 2.18: Average wheat price per region, 2006–14

	Central	North Caucasus	Ural	Volga	West Siberia
Wheat price (RUB/t)	6,287	6,488	6,053	6,132	5,837

Source: Own computation based on weekly data provided by APK-Inform (2015)

Table 2.19: Average regional wheat prices during the export ban

	Central	North Caucasus	Ural	Volga	West Siberia
Wheat price (RUB/t)	6,725	5,951	7,328	6,816	6,386

Note: Russian wheat exports were banned from 8/15/2010 to 31/12/2011 and from 1/2/2011 to 6/30/2011.

Source: Own computation based on weekly data provided by APK-Inform (2015) in the trade year 2010/11 the opposite was the case: lowest prices were paid in North Caucasus with an average wheat price of 5,951 Russian rubles per metric ton while 7,328 rubles were paid in average for a metric ton of wheat in the Ural District (see Table 2.19).

The regional wheat price disparity suggests that regional wheat markets in Russia are not perfectly integrated. Regional markets are separated by large distances and high transport costs. A USDA report highlights that high transport costs from Siberia to the main export ports impede the export of Siberian grain. The distance between the major Siberian railway station Novosibirsk-Vostochnyi (Novosibirsk-Eastern) and the Novorossiysk port at the Black Sea is 4,100 km. Thus, wheat exports from Siberia involve substantial transport costs (see USDA, 2013). As Table 2.15 shows, Siberia does indeed not compete with the Central and the Southern Districts in export markets. However, despite the regional price disparity, prices are highly correlated with correlation coefficients between 0.8873 and 0.9939 (see Table 2.20).

Table 2.20: Correlation among regional wheat prices, 2006–14

	Central	North Caucasus	Ural	Volga	West Siberia
Central	1				
North Caucasus	0.9616	1			
Urals	0.9522	0.8873	1		
Volga	0.9939	0.9528	0.9671	1	
West Siberia	0.9556	0.9124	0.9759	0.9622	1

Source: Own computation based on weekly data provided by APK-Inform (2015)

2.5.3 Along the Russian wheat export supply chain

Russia's statistical authorities distinguish between three types of agricultural producers: agricultural enterprises, peasant (farm) enterprises, and household enterprises. Agroholdings are not reported separately by the statistical authorities. Agricultural enterprises, which are former state and collective farms, and peasant (farm) enterprises play a significant role in grain production. Agricultural enterprises had a share of 71.4% in total Russian grain production volume in 2016. 27.7% were grown by peasant enterprises and the remaining 0.9% by household enterprises (see ROSSTAT, 2017).

A large number of exporting firms was involved in Russia's wheat export market. In the period 2006–2014, 890 firms exported wheat from Russia. The number of wheat exporters varied between 165 firms in 2012 and 259 firms in 2007. Concentration ratios (CR) of Russian wheat exports show that few firms possessed substantial market shares. The top exporter had a market share between 11% and 19% in Russia's wheat export market in the time period 2006–2014; and the top 5 (top 10) exporters accounted for at least 35% (52%) and up to 45% (66%) of total Russian wheat exports (see Table 2.21).

The bulk of Russian wheat exports in 2006–14, about 92%, was sold either to African or to Asian countries (see Table 2.22). Table 2.26 shows Russia's top export markets for the years 2006 to 2014. Egypt was the most important market for Russian wheat exporters in the years 2006 to 2012. In 2013 and 2014 Turkey replaced Egypt as Russia's top export destination. Thereby, the share of Russian wheat exports directed to Egypt varied between 16% in 2013 and 38% in 2010; and the share of wheat exported to Turkey ranged between 1% in 2006 and 20% in 2014. Other major destinations were the Caucasian states Azerbaijan and Georgia; Yemen, Israel, Iran, Libya and Jordan. Russia exported substantial quantities of wheat to India in 2006 and 2007, while wheat exports to India went back to zero in the 2010s. In the 2010s, African countries gained in

Table 2.21: Concentration of Russia's wheat export market

	2006	2007	2008	2009	2010	2011	2012	2013	2014
No. of firms	178	259	250	254	184	176	165	159	204
CR 1	14	13	11	13	14	13	19	17	11
CR 5	36	38	37	45	38	45	45	40	35
CR 10	52	56	54	66	59	65	65	60	56

Source: Own compilation based on data provided by APK-Inform (2015)

Table 2.22: Russian wheat exports per region, 2006–14

Region	Export quantity, in MT	Share, in %
Africa	54,050,122	41.7
Asia	65,124,908	50.2
Europe	8,252,688	6.4
The Americas	2,212,129	1.7

Note: MT abbreviates metric tons.

Source: Own compilation based on data provided by APK-Inform (2015)

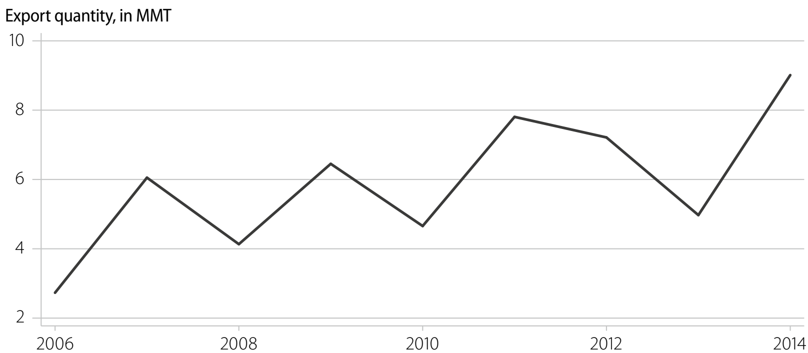

Figure 2.15: Russian wheat exports to Africa

Source: Own compilation based on data provided by APK-Inform (2015)

Table 2.23: Concentration of Russian wheat exports (CR 1)

	2006	2007	2008	2009	2010	2011	2012	2013	2014
Armenia	59.8	29.4	32.1	47.3	34.7	23	33.6	40.3	42.7
Azerbaijan	22.7	31.5	32.6	31.8	22.8	27.7	37	45.6	36.5
Egypt	19.1	11.7	15.5	16.1	13.6	14.4	22.6	13	12.9
Georgia	16.9	28.4	32.5	34.6	33.8	35.6	37.5	24.5	23.4
Israel	18	22.6	38.2	19.9	18.3	20.4	20.2	25.6	38.3
Jordan	32.2	55.3	23	26.6	35	19.2	51.5	35.5	28.4
Kenya	23.9	39	44.6	36.2	58.4	38	47.9	16.8	15.2
Libya	78.7	25.3	27.1	17.4	17.5	40	19.2	38.5	33.6
Mongolia	54.5	38.6	20	21.6	43.5	65.5	50.3	100	20.9
Nigeria	100	50.6	–	40.4	–	62.4	90.8	67.9	55
Tanzania	67.1	18.8	29.5	37	27.6	35.9	51.1	19	19.6
Turkey	17.5	14.5	14.3	13.7	11.4	8.1	20.7	9	12.3
Yemen	30.5	46.3	29.7	61.3	46.4	44.2	58.2	49.7	23.2

Source: Own compilation based on data provided by APK-Inform (2015)

importance for Russian wheat exporters. Figure 2.15 illustrates the emergence of Africa as important export destination for Russian wheat traders. In 2006 Russian wheat exporters sold 2.7 MMT to African states, while exporting 9 MMT to Africa in 2014. As Table 2.26 shows, five out of the top 10 export destinations in 2014 were located on the African continent. Russia's top export markets in Africa in 2006–14 were Egypt with a total Russian export quantity of 33.6 MMT, followed by Libya with 3.5 MMT and Kenya with 2.8 MMT.

Table 2.23 shows the market share of the top exporter in selected export markets, and Table 2.24 the corresponding concentration ratio of the top 5 sellers. These CR detect destination-specific differences in the concentration of Russian wheat exports. The market share of the top seller to Egypt varied between about 12% in 2007 and about 23% in 2012; and the share of the top 5 sellers in Russian wheat exports to Egypt fluctuated between 43.5% in 2007 and 60.5% in 2009. Exports to Turkey were slightly less concentrated. The market share of the top seller to Turkey ranged between around 8% in 2011 and 20.7% in 2012 while the top 5 exporters

Table 2.24: Concentration of Russian wheat exports (CR 5)

	2006	2007	2008	2009	2010	2011	2012	2013	2014
Armenia	84.7	63.7	71.1	87.4	66.5	64.1	77.8	88.8	90.4
Azerbaijan	60.7	57.1	62.1	59.8	60.3	53.8	71.1	76.7	66.5
Egypt	49.2	43.5	46.6	60.5	45.9	55.1	55.8	49.9	52.6
Georgia	43.2	62	70.9	78.2	73.9	69.9	62.6	59.7	60.5
Israel	58.5	59	79.9	72.2	67.8	63	63.9	69.8	85.2
Jordan	99.9	91.6	76.1	74.8	96.9	92.8	96.6	100	100
Kenya	90	84.1	95.3	96.2	100	85.2	91.4	61.8	62.6
Libya	100	75.1	65.9	63.8	60.7	88.9	56.8	79.6	95.6
Mongolia	99.2	98.1	67.2	63.5	77.2	100	100	100	65.5
Nigeria	100	100	–	100	–	100	100	100	91.1
Tanzania	100	73.2	95.7	93.6	100	81.3	99.4	73.1	72
Turkey	60.4	36.8	45	40.9	36.2	33.3	50.4	38	42.9
Yemen	85.5	84	79.1	97.4	100	82.2	94	83.2	74.6

Source: Own compilation based on data provided by APK-Inform (2015)

sold 33.3% in 2011 and a good 60% in 2006. Regarding the Caucasian states, Russian wheat exports were most concentrated in Armenia. The market share of the top seller varied between 23% in 2011 and about 60% in 2006, while the market share of the top 5 exporters was about 64% in 2011 and a good 90% in 2014. The share of the top exporter in total Russian wheat exports to Azerbaijan ranged between 22.7% in 2006 and 37% in 2012; and the market share of the top 5 sellers fluctuated between about 54% in 2011 and about 77% in 2013. The corresponding market shares for Georgia were about 17% of the top seller in 2006 and 37.5% in 2012, while the top 5 exporters accounted for 43.2% in 2006 and 78.2% in 2009. Similarly, Russian wheat exports to other MENA states show a high market share of the top seller. The top exporter accounted for up to 55% of Russian wheat exports to Jordan, the share of the top seller to Libya varied between 17.4% and almost 79%, and the top exporter to Yemen had a market share of up to a good 61%. Moreover, there were remarkable differences in concentration of Russian wheat exports to SSA states that gained in importance for Russian wheat sellers in recent years. The market share of the top Russian exporter in Kenya in 2014 was only about 15% as compared with 55% in case of Nigeria.

Figure 2.16 depicts Russia's wheat export prices to Israel, Georgia, and Kenya. We interpret Israel as a benchmark for a market with competitive prices as Israel is supposed to have a highly competitive wheat import market (see Gafarova et al., 2015). The figure shows that Russian wheat export prices differed by destination market. Prices paid by Israel were lowest over the entire period while wheat export prices tended to be highest in Kenya. These significant differences in wheat export prices by Russian wheat exporters are a first indication of market imperfections and destination-specific price discrimination.

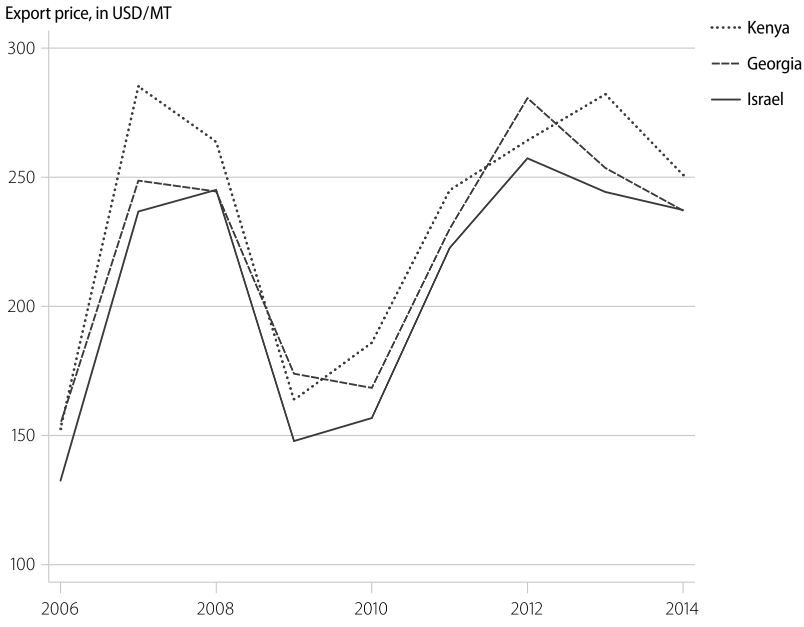

Figure 2.16: Average Russian export prices to selected destinations

Source: Own computation based on data provided by APK-Inform (2015)

Table 2.25 specifies the means of transport of Russian wheat exports for the years 2008–11. The bulk of Russian wheat, 93% of Russian wheat exports for which the means of export transport was specified, was exported by sea route. Russia's major wheat export ports are located at the Black Sea coast as well as in the Volga-Don-Azov basin.

Table 2.25: Means of transport of Russian wheat exports, 2008–11

Means of transport	2008–2011, in t
Railway	2,234,410
Road transport	6,650
Sea route	30,742,706
Not specified	22,167,013
Total Russian wheat exports	**55,150,780**

Source: Own computation based on data provided by ROSSTAT (2018)

According to an USDA report of 2013, the deep-water ports of the Black Sea had an estimated capacity for grain exports of 16.5 MMT a year, and the shallow water ports of the Volga-Don-Azov basin had an estimated capacity of up to 10 MMT a year (USDA, 2013). 7% of Russian wheat was exported by railway, while road transport was of negligible relevance with a share of only 0.02%. Wheat was carried by railway to Russian neighboring countries, and two destinations stand out in the railway transport statistic: 62% of Russian wheat exports transported by railway were destined for Azerbaijan, and 12% were sold to Mongolia.

Table 2.26: Major export destinations of Russian wheat exporters, 2006–14

Top markets, export volume in 1000 MT	2006	2007	2008	2009
1	Egypt, 2084,7	Egypt, 3871,6	Egypt, 2999,1	Egypt, 4788,7
2	India, 1718,4	India, 1242,3	Turkey, 1412,4	Turkey, 2191,7
3	Bangladesh, 1054,9	Turkey, 1108,4	Pakistan, 825,3	Syria, 1357,8
4	Azerbaijan, 618,8	Tunisia, 702,5	Azerbaijan, 615,8	Libya, 738,1
5	Georgia, 585,2	Italy, 633,5	Iran, 541,7	Pakistan, 732,9
6	Italy, 384,4	Bangladesh, 603,2	Jordan, 437,7	Azerbaijan, 654,1
7	Pakistan, 318,7	Libya, 594,6	Syria, 433,9	Iran, 557,5
8	Yemen, 303,4	Israel, 521,6	Bangladesh, 377,5	Israel, 511,1
9	Greece, 256,8	Jordan, 500,8	Yemen, 320,2	Georgia, 486,5
10	Israel, 207,1	Georgia, 438,4	Tunisia, 310,6	Yemen, 439,9

Source: Own computation based on data provided by APK-Inform (2015)

	2010	2011	2012	2013	2014
	Egypt, 3645,2	Egypt, 4802,4	Egypt, 5206	Turkey, 2466,2	Turkey, 4387,7
	Turkey, 1335	Turkey, 2100,9	Turkey, 2689,3	Egypt, 2172,8	Egypt, 4057
	Israel, 412,6	Kenya, 708,4	Iran, 1024,8	Yemen, 798,2	Iran, 1349,1
	Yemen, 400,8	Yemen, 610,3	Yemen, 746,5	Iran, 685,4	Yemen, 1017,3
	Georgia, 345,7	Israel, 512,8	Iraq, 665,2	Azerbaijan, 576,3	Azerbaijan, 924,7
	Libya, 331	Italy, 468,9	Libya, 575,1	South Africa, 499,8	Sudan, 867,3
	Iran, 305,3	Spain, 384,6	Israel, 536,8	Georgia, 497,2	South Africa, 779,8
	Iraq, 302,6	Tunisia, 332,9	Georgia, 432,2	Kenya, 424,6	Nigeria, 710,4
	Jordan, 283,1	Ethiopia, 329,5	Jordan, 291,2	Israel, 414,6	Georgia, 617,6
	Armenia, 235	Djibouti, 323,9	Azerbaijan, 273,3	Libya, 376,3	Kenya, 565

2.6 SUMMARY AND CONCLUSIONS ABOUT RUSSIAN MARKET POWER IN WORLD WHEAT TRADE

The description of the world wheat market of Chapter 2 shows that Russia is today a top wheat exporter on a global scale. Russia mainly exports wheat to emerging economies and developing countries with wheat-based diets in Northern Africa and Western Asia. Several of Russia's major export markets rank among those countries with the highest per capita food wheat demand worldwide; among others Armenia, Azerbaijan, Egypt, Georgia, Iran, and Turkey (see Table 2.8). Furthermore, Table 2.8 reveals that several of these export markets heavily rely on international wheat trade to meet dietary needs.

The emergence of new suppliers intensifies competition in the global wheat market, and should thereby lead to less market power by the wheat-exporting countries. However, descriptive statistics reveal that the world wheat market is segmented, and Russia possesses substantial market shares in its main export markets. Furthermore, Russian wheat exports to several countries are highly concentrated with few firms dominating Russian exports.

Against this background, I suspect that Russia is not able to exert market power in countries that are well integrated into the world market, importing wheat from different source countries. In contrast, Russia might have a substantial price-setting scope in export destinations heavily relying on Russian wheat exports.

3 MARKET IMPERFECTIONS IN INTERNATIONAL WHEAT TRADE

3.1 SOURCES OF MARKET IMPERFECTIONS IN INTERNATIONAL WHEAT TRADE

The world wheat export market is largely served by few exporting nations and multinational trading companies (Scoppola, 2007; Gutierrez et al., 2014). In recent years, the four top exporting countries—the US, Russia, France, and Canada—accounted for about half of global wheat exports (see Chapter 2.3). Hence, wheat is traded internationally in an oligopolistic market setting.

The theory of oligopoly predicts that sellers possess market power in an oligopolistic market setting if the price elasticity of demand is not perfectly elastic. This becomes apparent by transforming the first-order condition (FOC) of the Cournot model.

$$\frac{P - MC_j}{P} = \frac{s_j}{\epsilon} \tag{3.1}$$

MC_j is the marginal cost of seller j, P is the Cournot equilibrium price, s_j is the market share of seller j, and ε is the price elasticity of demand (see Bester, 2007). The left-hand side of equation 3.1 represents the Lerner index (LI). The LI provides a measure for the extent of exercised market power by seller j. Market power is commonly defined as the ability of a seller to set prices above the competitive price level. In a perfectly competitive market price equals marginal cost (MC), and therefore the LI should be equal to zero. The markup over MC can hence serve as a measure for market power by seller j. The right-hand side of equation 3.1 demonstrates that the ability to set the price above MC depends on the price elasticity of demand as well as on the seller's market share. A seller does not have any market power if demand is perfectly elastic, and a seller's market power rises if demand becomes less elastic. Furthermore, equation 3.1 indicates that the extent of a seller's market power rises with his market share.

Relating the insights from equation 3.1 to the world wheat market, the ability of wheat exporters to set prices above the competitive level critically depends on the price elasticity of wheat demand. As pointed out by Krugman (2011), demand for grain is highly inelastic. Abbott et al. (2011) study the drivers of agricultural and commodities prices in 2011, and conclude that demand has become less price elastic, contributing to food price increases. This implies, other things being equal, that sellers possess more market power than before the 2011 price spike.

Likewise the Cournot model, the Hotelling model and the Bertrand-Edgeworth model predict market power in an oligopolistic market. Both, the Hotelling model as well as the Bertrand-Edgeworth model assume price competition à la Bertrand. Hotelling (1929) solves the Bertrand paradox by introducing product differentiation and he demonstrates his argument by means of a model of spatial product differentiation. In Hotelling's model two sellers are located at different places along a line, and customers are allotted equally along that market line. Each customer is willing to buy one unit of the product. The customers incur transport costs per unit of distance acquiring the product, and they seek to minimize the incurred costs, this means price plus transport cost. As a consequence, a seller might increase his price, even if his rival keeps his price fixed, without losing his entire market share. If a seller constantly increases his price, his market share will diminish steadily in the Hotelling framework. As a result, the LOP does not need to hold in a market with (spatial) product differentiation. As pointed out by Hotelling, transport cost "make every entrepreneur a monopolist within a limited class and region" (Hotelling, 1929, p. 44). Thereby, the intensity of competition critically depends on the transport cost per unit of distance. Equation 3.2 describes the price equilibrium in Hotelling's simple two-seller model, abstracting from production costs (Hotelling, 1929).

$$p_j = c\,(l + \frac{a-b}{3}) \tag{3.2}$$

c denotes the transport cost per unit of distance, l is the length of the market line, and a and b are the positions of the two sellers along the line. As noted by Hotelling, his simple two-seller model can be complicated in several ways to adapt the model to actual market conditions. The model can be modified regarding the distribution of customers, the number of sellers, the shape of the market area, the elasticity of demand, the nature of transport cost, as well as the height of production costs.

The world wheat market is spatially segmented. Wheat-exporting countries tend to serve nearby markets. For example, 60% of Kazakh wheat exports in 2012–16 were directed to Central Asian or Caucasian states. France sold 43% (3%) of its wheat exports to other European states (American countries) in 2012–16. In contrast, a large fraction of US wheat exports was directed to American countries in the same time period, about 35% according to UN Comtrade data.

As wheat trade involves substantial transport cost, the observed market segmentation is probably linked to transport cost in wheat trade. The findings of Imamverdiyev (2017) support the relevance of trade costs. Imamverdiyev (2017) applies a gravity trade model to international wheat trade. Generally, gravity trade models relate bilateral trade volumes to a country's gross domestic product (GDP) as well as to trade costs, usually proxied by distance. The estimation results of Imamverdiyev (2017) indicate that more distant states trade less wheat, and his results show a positive effect of a common border on bilateral wheat trade. The relevance of transport cost suggests that spatial price discrimination as modelled by Hotelling is present in international wheat markets.

Besides spatial product differentiation, wheat exporters additionally compete on wheat quality. Wheat quality varies among exporting countries. Protein content is a main quality criterion, and is related to the end use of wheat. Different end uses of wheat in the importing countries contribute to the segmentation of the world wheat market.

The US, the leading wheat exporter for many decades, produces different wheat varieties. 41% of the US wheat production in 2014–18 was Hard Red Winter (HRW) wheat with an average protein content of 12.4%. Hard Red Spring (HRS) wheat had a share of 26% with an average protein content of 14%, and 17% of the US wheat production was classified as Soft Red Winter (SRW) wheat with an 5-year average protein content of

9.7%. It is estimated that in the trade year 2018/19 HRW wheat will contribute 35% to the US wheat exports, followed by HRS wheat with a share of 29% (U.S. Wheat Association, 2018).

Prikhodko (2009) points out that wheat quality varies considerably among the Black Sea wheat exporters Kazakhstan, Russia, and Ukraine. Kazakhstan is considered as a high-quality supplier. About half of Kazakh wheat production has a protein content of more than 14%. In contrast, Russia and Ukraine produce wheat of lower quality (Prikhodko, 2009). Russian wheat is classified as rather low-quality wheat (Imamverdiyev, 2017).

The prevalence for high transport cost is able to explain the observed segmentation of the world wheat market among wheat-exporting states. However, it is not able to explain imperfect competition among sellers from the same country. Concerning the Russian wheat export industry, does competition among exporters ensure competitive prices? The Bertrand model implicitly assumes that there are no binding capacity constraints. Regarding Russia's wheat export industry, there are major bottlenecks in export infrastructure and grain port facilities. These bottlenecks constrain Russian wheat export activities as a whole and those of single exporters. Major grain traders, including Cargill and Glencore, responded to these bottlenecks acquiring stakes in Russian Black Sea grain terminals (see Reuter, 2014; USDA, 2013). Edgeworth (1897) modifies the Bertrand model by introducing capacity constraints. The Bertrand-Edgeworth model predicts pricing power in an oligopolistic market if capacity constraints are binding. Let us consider a two-seller model with capacity constraints. Each firm is able to produce $\tilde{x}$ units of the product at constant marginal cost c. We assume that none of the two firms is able to serve the whole market at the competitive price level c, i.e., we assume that $\tilde{x}<D(c)$. As a consequence, the finding of Bertrand that in equilibrium price equals MC is not valid in the Bertrand-Edgeworth model. As capacity constraints are binding, a seller setting its price slightly above c will still face a positive residual demand. Thereby, the seller can realize a positive profit. In the Bertrand-Edgeworth model the market outcome critically depends on the firms' capacities (Bester, 2007). Consequently, capacity

constraints in the Russian wheat export industry likely impair competition among exporters.

Furthermore, market power by single wheat exporters might be related to reliability as wheat is a staple food with high importance for food security. Investments in grain port facilities probably increase reliability of the investing grain traders as they do not need to compete with other traders on these facilities. Therefore, those grain traders with own stakes in port facilities might realize additional price markups.

3.2 DETECTING IMPERFECTIONS IN INTERNATIONAL WHEAT MARKETS

Market power can be identified directly or inferred from the observation of price discrimination. These two concepts, market power and price discrimination, are related to each other. While market power is defined as the ability of a seller to set prices above the competitive price level, price discrimination refers to deviations from the LOP. A distinction is made between three types of price discrimination. First-degree price discrimination means that a seller charges each consumer the price that is equal to his marginal willingness to pay. As a consequence, the consumer surplus is equal to zero. Second-degree price discrimination occurs when the price charged by the seller depends on the quantity purchased by the consumer. Third-degree price discrimination means that a seller charges distinct prices to distinct consumer groups (Bester, 2007).

Varian (1987) argues that three conditions have to be fulfilled for a firm to engage in price discrimination. Firstly, the seller possesses market power; secondly, the seller must be able to segment the market; and thirdly, the seller has to be able to block resale of the product. The claim of Varian (1987) that market power is a precondition is tackled by a new branch of literature arguing that there is price discrimination without market power. McAfee et al. (2006) argue that there is no strongly positive correlation between price discrimination and market power as often presumed by policy makers and antitrust legislation. McAfee et al. (2006) show within a Hotelling price-competition framework with a monopolist and a competitive fringe that there is no general positive relationship between price discrimination and market power. Therefore, according to McAfee et al. (2006), we are not able to infer the degree of market power from the observed extent of price discrimination.

Levine (2002) focuses on industries in a competitive market with significant common costs and argues that price discrimination might be the optimal strategy to allot these costs among buyers. MC pricing implies that firms achieve losses in declining-cost industries. Therefore, also in a perfectly competitive market, firms in a declining-cost industry are forced to deviate from MC pricing and to engage in price discrimination between customer segments. Levine (2002) claims that firms set prices that are equal to all separable costs plus a share of common costs which is determined by the elasticity of demand of the customer segment. Each firm sells the product to each customer segment for the same price. These equilibrium prices are, according to Levine, reached within a repeated non-cooperative game. Thereby, firms are not able to produce rents since otherwise other firms would enter the market and drive down prices. A precondition for charging different prices is the ability to segment the market. Levine (2002) claims that this strategy can be adopted for all kind of goods provided that the seller is able to make it more expansive for customers to change product characteristics. An example for a portable product is equipment for cars with options only available at expansive car lines. Examples for a service are airline fares with different prices depending on flight characteristics, such as length of the flight. There are fixed costs involved in international wheat trade related to the investments in grain export facilities. However, fixed costs are presumably considerable small as compared with other industries mentioned by Levine (2002), involving high expenditures for research and development activities. Therefore, the pricing strategy described by Levine (2002) should not be relevant for wheat traders, and thus we can interpret the observation of price discrimination as evidence for market power.

3.3 DETECTING PRICE DISCRIMINATION

The PTM method is the dominant approach to detect price discrimination in international markets. The PTM approach goes back to Krugman (1986), and induced a vast empirical literature on PTM behavior (see for instance Knetter, 1989, 1993; Lavoie, 2005).

The PTM approach allows detecting third-degree price discrimination induced by an exchange rate shock. As diverging free on board (FOB) export prices are clearly a violation of the LOP, the exchange rate shock should not result in diverging prices in a perfectly competitive market. In a perfectly competitive market, the exchange rate transmission (ERT) should be complete for a small importing country but might be incomplete for a large importing country[2]. The reason is that a bilateral exchange rate shock impacts on the import price in the domestic currency and thereby on the export volume to this country. An increase in import demand of a large country might lead to increasing marginal cost of production. Increasing marginal cost should be transmitted to all markets in a perfectly competitive environment. In any case, a shock in the bilateral exchange rate between the exporter's currency and an importer's currency should not lead to diverging FOB export prices in a perfectly competitive market.

However, as pointed out by Glauben and Loy (2002), PTM behavior can also be observed in perfectly competitive markets. If there are menu costs or long-term contracts, prices are sticky, and cannot react immediately to exchange rate movements. Hence, we observe significant ERT elasticities, and thereby PTM behavior in presence of menu costs or long-term contracts. Similar to Glauben and Loy (2002), I plot the growth rate of the monthly export price (dlnp) against the growth rate of the monthly bilateral exchange rate (dlne) for main trading partners of Russia. Glauben and Loy (2002) argue that small exchange rate shocks should lead

2 With large importing country I refer to the exporter's main trading partners.

to reverse price changes in presence of menu costs. The reason is that a price adjustment is not profitable for small exchange rate shocks due to the menu costs. Hence, if menu costs are present there should be a negative relationship between the growth rate of the monthly export price and the growth rate of the monthly bilateral exchange rate for small exchange rate movements. Figure 3.1 depicts this relationship for nine main trading partners of Russia; Egypt, Turkey, the Caucasian states Armenia, Azerbaijan, Georgia, Italy as a European Union (EU) member country, the Western Asian states Iran and Yemen, and Sub-Saharan Nigeria. There is no clear relationship between the growth rates of the export price and the exchange rate for any of these states. Páll (2015) studies Russian pricing behavior in international wheat markets, and he argues that menu costs are not present in wheat trade as wheat prices are set day-to-day. Moreover, Glauben and Loy (2002) argue that long-run contracts with prices that are fixed in the importer's currency should result in a complete transmission of the exchange rate shock during the term of contract. If this is the case, exchange rate shocks should lead to a converse movement in the export price. We do not observe opposite movements of the exchange rate and export price for any of these countries. Therefore, we are confident that we can interpret significant ERT elasticities as evidence for market imperfections.

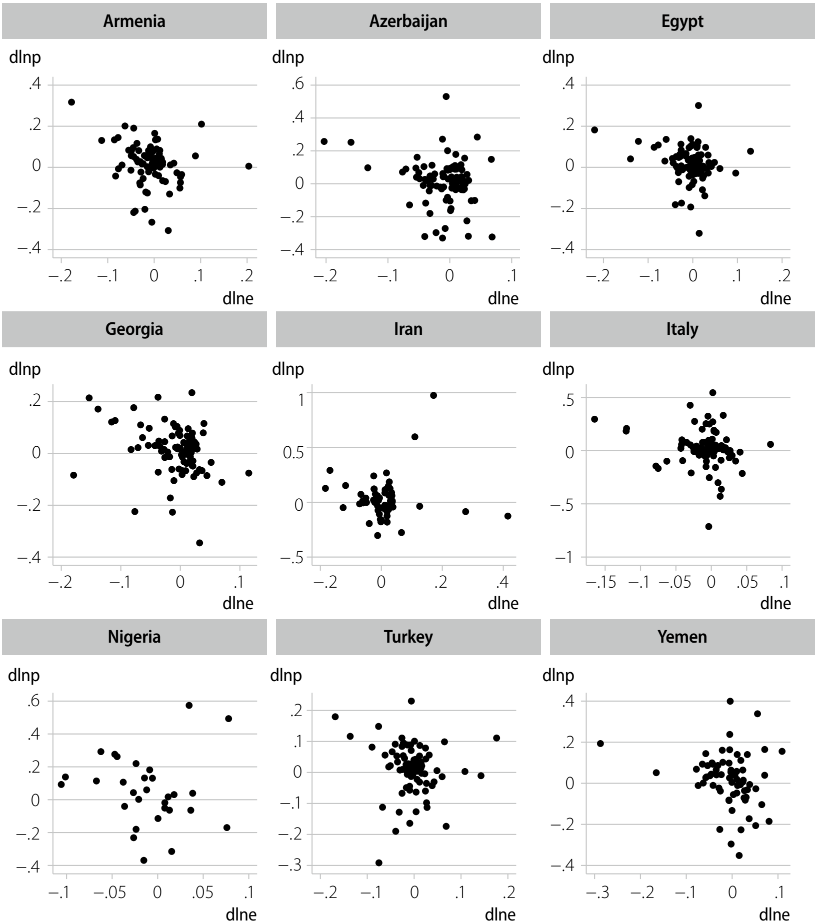

Figure 3.1: Growth rates of export price and exchange rate

Note: Figure is based on use of monthly export prices in Russian ruble (RUB) and monthly exchange rates (Importer's currency per RUB).

Source: Own compilation based on data provided by APK-Inform (2015) and OANDA Corporation (2017)

3.4 MEASURING MARKET POWER

The Lerner index of equation 3.1 relates market power to market structure. The structure-conduct-performance (SCP) method picks up this relationship. SCP studies typically regress performance measures; as there is the rate-of-return, the price-cost-margin or Tobin's q; on market structure indicators, such as market shares of the top sellers (Perloff et al., 2007).

The SCP paradigm has been criticized on the grounds that the method lacks a sound theoretical underpinning. A main criticism of the SCP literature is conceptual. To provide unbiased estimates, the structural variables, i.e., market concentration indicators, have to be exogenous. Thus, market concentration should impact on performance but not vice versa. However, Peltzman (1977) points out that causality in the relationship between concentration and profitability is ambiguous. He argues that a positive correlation between market concentration and profitability may be related to efficiency gains by a firm. Thanks to a cost-reducing innovation the firm is able to expand its market share, and gain higher profits. The concentration-efficiency hypothesis implies that higher profitability, induced by efficiency gains, lead to higher market concentration. Consequently, market concentration is not exogenous in the SCP models, as assumed in the SCP literature.

The SCP method was replaced as the dominant empirical approach by structural models. These new empirical approaches are referred to as "new empirical industrial organization" (NEIO) (see Bresnahan, 1989). The NEIO framework addresses criticisms of the SCP literature and gives a direct estimate of market power. Inference on market power is based on the simultaneous estimation of the supply and demand equations. Thereby, the estimated supply curve is the supply curve of a representative firm. The estimated market power index, commonly referred to as λ, bears information about the strategic interactions of the firms. In a perfectly competitive market, λ is equal to zero, while λ equal to one points to a monopolistic solution. Values of λ between zero and one indicate oligopolistic market outcomes. In a Cournot equilibrium with n identical firms λ is equal to $1/n$ (see Perloff et al., 2007). Deodhar and

Sheldon (1997) and Muazu et al. (2014) provide applications of the NEIO approach to agricultural markets. Deodhar and Sheldon (1997) study the world market for soymeal exports while Muazu et al. (2014) focus on the Malaysian poultry industry.

In a similar vein, the RDE model, which goes back to Baker and Bresnahen (1988), allows the estimation of market power for a single seller based on demand and cost characteristics. In contrast to the NEIO framework, the RDE model allows for firm heterogeneity and product differentiation (Perloff et al., 2007). In the RDE model, inference on market power hinges on a single equation to estimate, the firm's residual demand, rather than on the estimation of the full structural model. Baker and Bresnahen (1988) show that the inverse RDE is directly linked to the Lerner index for firms in a 'Consistent Conjectures Equilibrium' (CCE), and can therefore serve as a measure for market power. In a CCE a firm's actual residual demand curve is equal to the firm's conjectured residual demand curve. This is the case in a market with competition à la Stackelberg, in a market with a dominant firm and a competitive fringe, and in a market with perfect competition. Furthermore, in a market with substantial product differentiation the inverse RDE provides a good estimate for the markup over marginal cost. While Baker and Bresnahen (1988) study the domestic brewery market of the US, Goldberg and Knetter (1999) provide the first empirical application of the RDE approach to an international market context. To date, there are various empirical studies related to agricultural markets based on the RDE approach (see for instance Glauben and Loy, 2003; Pall et al., 2014 or Reed and Saghaian, 2015).

3.5 LITERATURE ON COMPETITION IN INTERNATIONAL MARKETS

The empirical studies in this doctoral thesis are based on the PTM and the RDE approaches. In this subchapter, I will present previous PTM and RDE studies with a particular focus on agricultural markets.

3.5.1 Previous PTM studies

3.5.1.1 Early PTM studies

The PTM approach has attracted much interest since the pioneer paper of Krugman (1986), and has motivated a vast number of early empirical studies on PTM behavior addressing different export industries and exporting countries (see for instance Gagnon and Knetter (1995) studying automobile exports from the US, Germany and Japan; Athukorala and Menon (1994) and Marston (1990) investigating Japanese manufactures; Falk and Falk (2000) and Kasa (1992) focusing on a wide range of German commodities; Pick and Park (1991) and Pick and Carter (1994) examining wheat exports from North America).

Knetter (1989, 1993), studying different export sectors, provide prominent contributions to the empirical PTM literature. Knetter's (1989) empirical framework to estimate PTM behavior has established as "workhorse" in the empirical PTM literature. The key parameters to estimate are the ERT elasticities, and country fixed effects. In Knetter's econometric model a time dummy captures changes in marginal cost that are common to all destination markets. Thereby, Knetter ensures that large country[3] effects are separated from price-discriminatory behavior.

Knetter (1989) estimates the following fixed-effects regression model that allows distinguishing between three different market models:

$$\ln p_{it} = \theta_t + \lambda_i + \beta_i \ln s_{it} + u_{it} \tag{3.3}$$

where θ_t and λ_i are the time fixed effect and the country fixed effect, respectively. p_{it} denotes the export price expressed in the exporter's currency in period t. s_{it} is the exchange rate of the importer's currency per unit of the exporter's currency in period t. u_{it} is a disturbance term. The coefficient β_i denotes the ERT elasticity. The Knetter model allows dis-

3 See Footnote 2.

tinguishing three market settings: a competitive world market, and two noncompetitive market settings.

In Knetter's model, perfect competition requires that both, the ERT elasticities and the country effects, are equal to zero. If the ERT elasticity is equal to zero, exchange rate shocks between the currencies of the exporter and an importer are fully transmitted into the import price while the export price remains unaffected. If the country effects are equal to zero, export prices are the same for all importers. The export price is only altered by changes in MC under the null hypothesis of an integrated competitive world export market. Changes in MC are common to all destinations, and are captured by the time fixed effects.

In the Knetter model, significant ERT elasticities or significant country effects imply third-degree price discrimination. The two scenarios with price discrimination differ regarding characteristics of the elasticity of demand in the importing country. If the demand elasticity in the importing country is constant, the export price is independent of the exchange rate. Hence, we observe insignificant ERT elasticities for import markets with constant demand elasticities. However, significant country effects indicate third-degree price discrimination with fixed markups over MC that differ among importing countries. Significant ERT elasticities, in contrast, reflect non-constant demand elasticities that vary with the local currency price.

Knetter (1993) explicates the interpretation of the sign of the ERT elasticities. A negative sign implies that the exporter's price adjustment compensates for the exchange rate effect. Knetter (1993) terms this variety of PTM as "local currency price stability" (LCPS). In contrast, a significantly positive ERT elasticity implies that the exporter amplifies the exchange rate effect (AER). Knetter argues that the price adjustment, and hence the sign of the ERT elasticity, critically depends on the convexity of the demand curves. LCPS is related to demand schedules that are less convex than constant elasticity schedules while exporters amplify the exchange rate effect if the demand schedule is more convex than the constant-elasticity form.

3.5.1.2 Extensions of the PTM model

The PTM framework has been extended in several ways. Knetter (1993) argues that the econometric model of (3.3) might be extended by other factors, for example a variable accounting for income changes in the importing country. However, he concludes that these other factors are of less importance. Knetter (1989) explains that the ERT elasticity is not affected by correlations between demand shocks and exchange rate fluctuations under perfect competition. The export price is only altered by changes in MC under the null hypothesis of an integrated competitive world export market. Nevertheless, several studies extend (3.3) by a variable capturing income changes in the destination country to control for demand shocks (see for instance Glauben and Loy, 2003; Bugamelli and Tedeschi, 2008 or Fedoseeva, 2013).

Further developments of the PTM approach account for asymmetric price adjustments, nonlinearities and hysteresis of PTM, consider barriers to trade or firm heterogeneity. Benedictow and Boug (2013) incorporate trade barriers in the PTM framework. They apply a PTM model to clothing imports to Norway from 1986 to 2008 and take the gradual trade liberalization in the clothing sector into account. Controlling for the shift from high-cost to low-cost importers, the authors do not find evidence for changes of the ERT elasticity along the process of trade liberalization.

Knetter (1994) provides, to my knowledge, the first PTM study considering asymmetry of PTM behavior. Asymmetry of PTM means that the price adjustment hinges on the direction of the exchange rate shock, i.e. depreciation or appreciation. He justifies the presence of asymmetry of PTM with marketing bottlenecks, referring to Baldwin and Foster (1986). Knetter (1994) argues that PTM asymmetries might also arise by cause of trade restrictions with binding quantity constraints.

Both, the bottlenecks and the trade restriction hypotheses, predict more PTM behavior during depreciations of the exporter's currency vis-á-vis the importer's currency. According to Knetter (1994), another source of asymmetric PTM behavior lies in strategic pricing behavior by exporters who intend to increase their market share but fear anti-dumping or restrictive trade policies. In contrast to the other two hypotheses on the sources of asymmetric PTM, the market share hypothesis anticipates more PTM behavior following appreciations of the exporter's currency vis-à-vis the importer's currency.

Bugamelli and Tedeschi (2008) test the asymmetry hypothesis and examine PTM behavior of five euro area exporting states selling manufactures. Their estimation results clearly support the hypothesis of asymmetric responses to exchange rate movements. Other PTM studies allowing for asymmetric reactions to exchange rate changes are Fedoseeva (2013), Fedoseeva and Werner (2016) and Varma and Issar (2016).

Beside asymmetry of PTM, Fedoseeva (2013) and Fedoseeva and Werner (2016) consider other nonlinearities of PTM stemming from menu costs or sunk cost of entry to a market. Linearity of PTM implies that exporters react similarly to each exchange rate change independent of the magnitude or the persistence of the exchange rate shock. Fedoseeva (2013) argues that menu costs might lead to nonlinearities of PTM behavior. In presence of menu costs, the seller keeps the export price fixed as long as the change of the exchange rate does not surpass a certain threshold. Sunk costs result in hysteresis of PTM. The presence of sunk costs implicates that the exporter keeps his markup fixed within a certain band bounded by an upper and lower threshold. Beyond this threshold the exporter adjusts his markup in order to defend or expand his market share (e.g., Bagnai and Mongeau Ospina, 2015). Consequently, menu costs and sunk costs result in nonlinear responses to exchange rate fluctuations that should be considered in the econometric model.

Another strand of research in the PTM literature links PTM behavior to firm-level characteristics. Thereby, the heterogeneous firm literature contributes to understanding the determinants of PTM behavior. Studies relate heterogeneous PTM behavior across firms to overall firm performance and firm size, efficiency in producing single goods, exporters' import dependency, product quality or the interaction between product quality and consumer income.

Berman et al. (2012) link PTM behavior to firm performance, and find heterogeneity in PTM in dependence on firm performance using an annual French firm-level data covering the years 1995–2005. Their key finding is that high-performance firms price more to market following a real depreciation of the exporter's currency vis-á-vis the importer's currency. Furthermore, the estimation results of Berman et al. (2012) suggest that firm size is related to heterogeneity in PTM behavior. They find that large firms discriminate prices more intensively after a real depreciation than small firms. The empirical findings of Berman et al. (2012) support models where the demand elasticity declines with firm performance. This is the case in at least three models, as there are extensions of the Melitz and Ottaviano (2008) and the Corsetti and Dedola (2005) models as well as the mechanism described by Atkeson and Burstein (2008). Berman et al. (2012) extend the Melitz and Ottaviano (2008) model to include exchange rate fluctuations. They show that the extended Melitz and Ottaviano (2008) model produces heterogeneous PTM behavior. The model predicts that high-productivity firms sell their product at lower prices and hence face a lower price elasticity of demand. Therefore, they raise their markup more than lower-productivity firms following a depreciation of the exporter's currency. In the Atkeson and Burstein (2008) model higher performance firms possess larger market shares. Firms with larger market shares face a lower price elasticity of demand because in the Atkeson and Burstein (2008) model firms compete à la Cournot. A critical assumption of the Atkeson and Burstein (2008) model is that the elasticity of substitution between sectors of an economy is lower than within each sector. As a consequence, a firm with a low market share faces a high elasticity of substitution due to competition within the sector, while a firm with a market share approaching one only faces competition from other sectors, and thus confront with a lower elasticity of demand. Berman et al. (2012) argue that heterogeneous PTM can also be explained by an extension of the model proposed by Corsetti and Dedola (2005) considering distribution costs in the importing country. The extended Corsetti and Dedola (2005) model identifies distribution costs as a source of PTM behavior. On the one hand, the model predicts that there is more PTM behavior in export markets with higher distribution costs as a share of the consumer price. On the other hand, relying on the Corsetti and Dedola (2005) model, distribution costs cause heterogeneous price adjustments to real exchange rate shocks. The authors attribute heterogeneous PTM to the following mechanism. The exporter considers the effect of a change in the export price in the consumer price. A depreciation of the exporter's currency results in a lower share of the export price in the final consumer price, and thereby reduces the elasticity of demand, enabling all firms to raise their markup. High-productivity firms start with a lower elasticity of demand, which allows them to augment their markup more than others.

Chatterjee et al. (2013) provide a theoretical framework to assess the behavior of multi-product firms. They relate heterogeneous PTM behavior to production efficiency. The authors assume that each firm is most efficient in producing its core product, and the firm is less efficient in producing goods further away from its core competency. Furthermore, Chatterjee et al. (2013) assume that there are domestic per-unit distribution costs. The model predicts that, following a depreciation, producer prices of goods closer to the core product rise more than goods further away from it. They apply the model to Brazilian customs data covering the years 1997–2006. Their estimation results conform to the model predictions.

Inspired by Berman et al. (2012) and Chatterjee et al. (2013), Chen and Juvenal (2014) amend the model proposed by Corsetti and Dedola (2005). They allow firms to export wines of different qualities, and relate heterogeneous price adjustments after a real exchange rate shock to differences in product quality. Hence, in contrast to Berman et al. (2012), Chen and Juvenal (2014) analyze the pricing behavior of multi-product firms, and the model differs from the model of Chatterjee et al. (2013) by classifying the different products in terms of quality rather efficiency.

The model of Chen and Juvenal (2014) explains heterogeneity in PTM by quality differences rather than efficiency differences. The mechanism driving heterogeneous PTM is very similar to those described by Berman et al. (2012) and Chatterjee et al. (2013). In the Chen and Juvenal (2014) model the price elasticity of demand an exporter is facing declines with a real depreciation and with quality. Hence, the model predicts that following a real depreciation exporters increase their prices more for higher-quality than for lower-quality products. Chen and Juvenal (2014) apply the model to firm-level data of Argentinian wine exports covering the years 2002–09. Their estimation results suggest a large degree of ERT with an average pass-through of 89%. Moreover, they find significant differences across products. While the estimation results show a complete ERT for the wine of the lowest quality, ERT for the wine of the highest quality is incomplete with an estimated ERT of 86.5%. Furthermore, Chen and Juvenal (2014) conclude that this difference in ERT across products of different qualities rises with the size of local distribution costs. The estimation results of Chen and Juvenal (2014) also suggest stronger PTM behavior in high-income countries than in low-income countries, thereby indicating destination-specific price discrimination.

Amiti et al. (2014) claim that heterogeneous ERT across exporting firms is related to their degree of import dependency. They argue that the ERT into export prices of import dependent exporters is significantly lower because the exchange rate movement has an opposite effect on import prices and hence on marginal cost, neutralizing the exchange rate effect on export prices. Their estimation results, using Belgian micro-data, support this claim. In a recent empirical study, Auer et al. (2018) present a model of vertical product differentiation and link heterogeneous PTM to the interplay between product quality and consumer income. Auer et al. (2018) find a larger ERT for low-quality cars as compared with high-quality vehicles, applying the model to the European car industry.

Basile et al. (2012) provide another empirical study relating quality to heterogeneity in PTM behavior. Their model is based on Melitz and Ottaviano (2008). They amend the framework to consider country-specific quality preferences as well as vertical product differentiation. In their model firms react differently to market-specific shocks to price and preferences for quality. The model predicts heterogeneous PTM behavior across firms when quality matters. They apply the theoretical framework to Italian quarterly export data of manufactures covering the period 2003 Q2 to 2008 Q1. The estimation results show stronger PTM behavior by high-quality sellers than by firms offering low-quality products. To sum up, firm-specific price responses to exchange rate fluctuations are able to provide a more detailed picture of the phenomenon of PTM behavior.

3.5.1.3 PTM studies on agri-food exports

Besides the vast early empirical PTM literature on manufacture exports, there is a growing PTM literature on trade in agricultural commodities, food products or beverages in recent years. Table 3.1 summarizes empirical studies of the PTM approach to test for imperfections in agri-food exports. These PTM studies cover different classes of agricultural products. Most studies examine exports by industrialized economies. Glauben and Loy (2003), Fedoseeva (2013), and Fedoseeva and Werner (2016) investigate the pricing behavior of German food and beverage exporters. Thereby, Glauben and Loy (2003) investigate beer exports as well as the export of cocoa powder, chocolate, and sugar confectionery to six North American and European markets during the 1990s. The estimation results suggest LCPS in two beer export markets, in one export market for cocoa powder, and in one export destination of sugar confectionary. Fedoseeva (2013) studies German sugar confectionary exports, and Feedoseva and Werner (2016) examine German beer exports. Fedoseeva (2013) extends the basic PTM model by allowing for asymmetry, nonlinearity and hysteresis of PTM. She applies a nonlinear autoregressive distributed lag (NARDL) model, thereby assuming cointegration between all model variables. Her estimation results indicate that German sugar confectionary exports exhibit nonlinear and asymmetric responses to exchange rate shocks. In a similar vein, Feedoseva and Werner (2016) conclude that the PTM behavior of German beer exports is asymmetric and features nonlinearities, also applying the NARDL framework. Varma and Issar (2015) investigate Indian pricing behavior for different agri-food products, and thereby provide one of the few PTM studies targeting exports from developing countries or emerging economies. They find evidence for PTM behavior while the exporters tend to stabilize the local currency prices rather than to amplify the exchange rate effect.

Most studies investigating PTM behavior in food and agricultural markets address agricultural commodities with several empirical studies examining wheat exports. As argued by Dawson et al. (2017), wheat is an ideal product for testing the PTM hypothesis since wheat is generally unbranded and a large share of production is exported. Furthermore, they claim that wheat features a low degree of product heterogeneity.

Yumkella et al. (1994) study Thai and US rice exports relying on quarterly data. Griffith and Mullen (2001) examine the pricing behavior of Australian Japonica rice exports applying export data of a single-desk seller. There findings suggest PTM behavior in two out of four export destinations. Brown (2001) provides a PTM study on Canadian canola exports, and finds evidence for PTM behavior in one out of three markets.

There are several early and recent PTM studies examining wheat exports. Early PTM studies cover data for the 1970s, 1980s, and 1990s. These early studies presume a duopolistic market structure with Canada and the US dominating world wheat exports. More recent studies take the shifts on the supply side of the world wheat market into account and examine export pricing behavior of the Black Sea exporters, entering the world wheat market in the 2000s, and the EU, which is today a major wheat supplier on a global scale.

The findings of Pick and Carter (1994) indicate that the US and Canada, the two largest exporters at that time, both exercised PTM in the time period 1978 Q1-1988 Q4. Pick and Carter (1994) estimate PTM behavior for eight US export markets and three Canadian export destinations. Their estimation results indicate that the US priced to market in five destinations, while there is evidence for Canadian PTM behavior in all three markets under study. Furthermore, Pick and Carter (1994) modify Knetter's (1993) empirical model. They include the Canadian dollar (CAD) per US dollar exchange rate as well as the exchange rate between the importer's currency and the US dollar (USD) instead of the exchange rate between the importer's currency and the exporter's currency in the empirical model to test for PTM behavior. The estimation results suggest that the CAD/USD exchange rate significantly influences the pricing decision of the exporters with five significant coefficients in the US equation and one significant coefficient of the CAD/USD exchange rate in the Canadian equation.

Pick and Park (1991) study US wheat exports to eight export destinations for the period 1978–88 based on quarterly data by means of the

PTM approach. They find evidence for US price discrimination in three out of eight export markets applying nominal exchange rate data, and four export destinations relying on real exchange rates, respectively. In a next step, Pick and Park (1991) extend the Knetter model to allow for the possibility of monopsony power by large wheat importers. To this end, they extend the model by an import share variable. The coefficient of the share variable is significantly negative for China and the Soviet Union, the two largest wheat importers of US wheat at that time, suggesting that China and the Soviet Union exercised market power to pay lower prices.

Carew and Florkowski (2003) estimate a similar model as Pick and Carter (1994), and apply the PTM model to wheat, pulse, and apple exports from the US and Canada for the years 1980–98. Their estimation results suggest that US wheat exports were more responsive to exchange rate changes than Canadian wheat exports. The authors attribute the less pronounced sensitivity of Canadian wheat exports to exchange rate movements to a stronger Canadian focus on quality differentiation.

Jin and Milkjovic (2008) study US PTM behavior for wheat, corn, and soybean exports relying on aggregated data running from the first quarter of 1989 to the second quarter of 2004. Thereby, they apply a dynamic panel estimator as well as a fixed-effect estimator for the sake of comparison. To allow for dynamics, Jin and Milkovic (2008) include a lagged dependent variable and estimate the model by means of an instrumental variable approach, referring to Baltagi (2005). Regarding their results for wheat exports, both models produce similar estimates for the ERT elasticities. However, the dynamic model outperforms the commonly applied model in terms of the Akaike information criterion. The estimation results for US wheat exports of both models indicate that the US exerts PTM behavior in 9 out of 22 export destinations. Thereby, the US stabilize the exchange rate effect in six export markets while the US price adjustment amplifies the effect of the exchange rate shock in three export markets.

Jin (2008) studies the pricing behavior of the Canadian Wheat Board (CWB) relying on Knetter's (1989) model. The estimation results indicate Canadian PTM behavior in 5 out of 18 export markets, relying on annual data ranging from 1988 to 2003. However, the authors admit that the detection of PTM behavior might be related to quality differences. Lavoie (2005) sheds light on the ability of the CWB to exert market power in the light of vertical product differentiation. She finds that the CWB has market power arising from product differentiation, and that the CWB exerts third-degree price discrimination. These findings are based on monthly data ranging from 1982 to 1994.

Dawson et al. (2017) provide a recent PTM study focusing on wheat exports of the EU. They apply quarterly panel data for 11 export markets covering the years 2000–13. Dawson et al. (2017) apply two different estimators, the fully modified ordinary least squares (FMOLS) estimator, as well as the dynamic ordinary least squares (DOLS) estimator. The choice of the estimators is motivated by panel unit root tests suggesting non-stationarity of the export unit values and exchange rates. The EU wheat exporters stabilize the local currency price in Belarus after an exchange rate shock, according to both estimators. The estimation results of the DOLS estimator additionally points to LCPS in Iceland, while the estimation results of the FMOLS estimator for Iceland are not significant. There is no evidence of PTM behavior by EU wheat exporters in any other export market. The authors conclude that EU wheat exporters exercise little price discrimination as the estimation results point to no price discrimination in the bulk of the export destinations. Particularly, there is no evidence for PTM behavior for any high-volume export market of the EU, such as Algeria, Morocco, and Egypt. The authors conclude that competition from former Soviet wheat exporters contributes to competitive pricing by the EU.

Pall et al. (2013) estimate Russian PTM behavior for the period 2002–10 applying quarterly wheat export data. They find evidence for Russian PTM behavior in 5 out of 25 destinations. The estimation results suggest that Russia pursued the strategy of LCPS in two export markets while amplifying the exchange rate effect in the remaining three export destinations. Pall et al. (2013) test the time series properties of the panel data and conclude that export unit values and nominal exchange rates are stationary. They apply a fixed-effects (FE) estimator to test the PTM hypothesis.

Table 3.1: Overview of empirical pricing-to-market studies on agri-food trade

Author(s)	Journal [a] (year)	Exporter(s)	(Number of) importers	Product(s)
Brown	AJAE (2001)	Canada	Japan Mexico US	Canola
Carew and Florkowski	CJAE (2003)	Canada US	15 15	Wheat Pulse Apples Wheat Pulse Apples
Chen and Juvenal	IMF WP	Argentina	Not specified	Wine
Dawson, Gorton, Hubbard and Hubbard	JAE (2017)	EU	11	Wheat
Fedoseeva	JAFIO (2013)	Germany	Canada Sweden Switzerland UK US	Sugar confectionery
Fedoseeva and Werner	Empir Econ (2016)	Germany	16	Beer
Gafarova, Perekhozhuk and Glauben	JAAE (2015)	Russia Ukraine Kazakhstan	71 65 48	Wheat
Glauben and Loy	JAFIO (2003)	Germany	4 4 3 3	Beer Cocoa powder Chocolate Sugar confectionary
Griffith and Mullen	AJARE (2001)	Ricegrowers' Cooperative Limited, Australia (New South Wales)	4	Japonica rice
Jin	Appl. Econ. Lett. (2008)	Canada	19	Wheat

Period	Data frequency [b]	Data aggregation [c]	Estimation method(s) [d]	Evidence for PTM
1993–99	Q	C	GLS for panel data	PTM: 1
1980–98	A	C	FE	PTM: 5 PTM: 5 PTM: 2 PTM: 10 PTM: 5 PTM: 9
2002–09	A and M	F	FE	PTM related to product heterogeneity
2000–13	Q	C	FMOLS DOLS	PTM:1 PTM:2
1991 M1–2011 M12	M	C	ADRL NADRL	Long-run PTM: nonlinear, asymmetric
1991 M1–2012 M12	M	C	NARDL	PTM: asymmetric and hysteric
1996–2012	A	C	FE	PTM: 20 PTM: 15 PTM: 7
1991 M4–1998 M5	M	C	SUR estimation of ECM	PTM: 2 PTM: 1 PTM: 0 PTM: 1
1982 M7–1995 M4	M	SD	OLS with AC correction	PTM: 2
1988–2003	A	SD	FE	PTM: 5

Table 3.1: Overview of empirical pricing-to-market studies on agri-food trade (continued)

Jin and Miljkovic	JIES (2008)	US	22 16 14	Wheat Corn Soybean
Pall, Perekhozhuk, Teuber and Glauben	JAE (2013)	Russia	25	Wheat
Pick and Carter	AJAE (1994)	Canada US	4 8	Wheat
Pick and Park	AJAE (1991)	US	12 10 10 6 9	Corn Cotton Soybeans Soybean meal Wheat
Varma and Issar	AE (2015)	India		Cereal preparations Diary Fresh onion Groundnut Guar gum
Yumkella, Unnevehr and Garcia	JAAE (1994)	US Thailand	4 5 4	Parboil rice Long grain rice Long grain rice

Notes:
[a] AE: Agricultural Economics,
Appl. Econ. Lett.: Applied Economics Letters,
AJARE: The Australian Journal of Agricultural and Resource Economics,
AJAE: American Journal of Agricultural Economics,
CJAE: Canadian Journal of Agricultural Economics,
IMF WP: International Monetary Fund Working Paper,
JAAE: Journal of Agricultural and Applied Economics,
JAE: Journal of Agricultural Economics,
JIES: Journal of International Economic Studies

1989 Q1–2004 Q2	Q	C	FE Dynamic FE	PTM: 9 PTM: 9 PTM: 10 PTM: 12 PTM: 5 PTM: 5
2002 Q1–2010 Q2 2002 Q1–2007 Q3 2008 Q3–2010 Q2	Q	C	FE	PTM: 5 PTM: 4 PTM: 3
1978–88	Q	C	Not specified	PTM: 3 PTM:5
1978–88	Q	C	FE	PTM: 1 PTM: 1 PTM: 1 PTM: 1 PTM: 3
2006 M1–2014 M10	M	C	PCSE	PTM: asymmetric
1980–87	Q	C	GLS	PTM: 1 PTM: 2 PTM: 1

[b] A: annual data, M: monthly data, Q: quarterly data

[c] C: country-level data, F: firm-level data, SD: single-desk seller

[d] ADRL: Dynamic autoregressive distributed lag,
DOLS: dynamic ordinary least squares,
FE: fixed effects,
FMOLS: fully modified ordinary least squares,
GLS: generalized least squares,
NADRL: nonlinear ADRL,
OLS: ordinary least squares,
PCSE: OLS with panel corrected standard errors,
SUR: seemingly unrelated regression
AC: auto-correlation
ECM: error correction model

Source: Own compilation in the style of Gafarova (2018)

Gafarova et al. (2015) provide another recent PTM study focusing on wheat exports. They examine the pricing behavior of the Black Sea exporters Russia, Kazakhstan, and Ukraine. Gafarova et al. (2015) apply annual data ranging from 1996 to 2012. Their estimation results indicate price discrimination by all three exporting nations. Strikingly, findings suggest that Russia tends to amplify the exchange rate effect while Ukraine and Kazakhstan rather stabilize the local currency price following an exchange rate shock. Similarly to Pall et al. (2013), Gafarova et al. (2015) preclude non-stationarity, and estimate the model by means of a FE estimator.

All previous PTM studies targeting Russian wheat exports are, to my knowledge, based on data that is aggregated over exporting firms. Therefore, in all these previous PTM studies, the estimated coefficients reflect industry averages. Yet, as discussed above, pricing behavior by individual firms might differ from the industry average pricing behavior.

3.5.2 Previous RDE studies

Despite some desirable properties of the RDE approach (see Glauben and Loy, 2003), the RDE method has attracted less attention in the empirical literature than the PTM method. This may be explained by larger data requirements. The main advantage of the RDE model is that it is derived from an oligopolistic market setting, thereby incorporating cost shifters of the competitors.

The RDE approach was introduced by Baker and Bresnahan (1988) who provide an econometric strategy to identify a firm's residual demand curve without the estimation of demand cross-elasticities. The RDE method estimates a firm's price on the basis of the firm's own quantity as well as cost shifters of its competitors. They apply the approach to estimate the market power of three US breweries over the years 1962–82. Goldberg and Knetter (1999) adopt the methodology proposed by Baker and Bresnahan (1988) to international market applications. They argue that exchange rate shocks provide a suitable cost shifter to identify residual demand elasticities in international trade. Goldberg and Knetter (1999) apply the approach to German beer exports and US linerboard exports, and find plausible estimation results. Their estimation result show that Dutch beer exporters restricted market power by German beer exporters.

Several RDE studies focus on agri-food trade, and address various agricultural products and trading partners. These studies find evidence for market power in a multitude of agricultural markets. Table 3.2 provides a list of empirical RDE studies with agricultural or food market applications. There are some studies targeting beer trade, and findings suggest market power by German and US beer exporters or breweries (see Baker and Bresnahan, 1988; Goldberg and Knetter, 1999; Glauben and Loy, 2003). Other RDE studies focus on Japanese meat imports. Felt et al. (2011) address Japanese pork imports and provide evidence for market imperfections. Poosiripinyo and Reed (2005) examine the pricing behavior of four main chicken meat suppliers to Japan during 1988 and 2002. Their estimation results suggest that Brazil and the US were able to exercise market power with significant markups over MC. Moreover, there is evidence of market power in the EU olive oil import market (Tasdogan et al., 2005), in Thai disaggregated rice exports (Mahanaseth and Tauer, 2014), in Chinese soybean imports originating from the US (Song et al., 2009), as well as in the US avocado import market (Evans and Ballen, 2015).

Pall et al. (2014) and Gafarova (2018) provide two recent RDE studies on international wheat trade. Table 3.3 presents the estimates for the inverse RDE elasticities. Pall et al. (2014) applies the RDE approach to assess Russian market power in eight main export markets. They estimate the model for the period 2002–09, using quarterly data. The estimation results suggest Russian market power in Albania, Georgia, and Greece, relying on an instrumental variable Poisson pseudo-maximum likelihood (IVPPML) estimator, and indicate market power in Albania, Azerbaijan, Egypt, Georgia, and Greece, applying a generalized method of moments (GMM) estimator. The estimation results of both, the IVPPML estimator and the GMM estimator, suggest that Russia does not possess market power in Lebanon, Mongolia, and Syria.

Table 3.2: Overview of empirical residual demand elasticity studies on agri-food trade

Authors	Journal [a] (year)	(No. of) Sellers/ exporter(s)	(No. of) importers
Baker and Bresnahan	IJIO (1988)	Anheuser-Busch Coors Pabst	–
Evans and Ballen	JFDR (2014)	Belize Brazil Mexico	US
Evans and Ballen	JFDR (2015)	Dominican Republic	US
Felt, Gervais, and Larue	AB (2011)	Canada Denmark US	Japan
Glauben and Loy	JAFIO (2003)	Germany	4 4 3 3
Goldberg and Knetter	JIE (1999)	Germany	4
Mahanaseth and Tauer	JAFIO (2014)	Thailand	4
Poosiripinyo and Reed	JIATD (2005)	 4 4 4	Japan
Song, Marchant, Reed, and Xu	IFAMR (2009)	US	China
Tasdogan, Tsakiridou, and Mattas	SEEJE (2005)	Greece Italy Spain	EU

Notes:
[a] AB: Agribusiness,
IFAMR: International Food and Agribusiness Management Review,
IJIO: International Journal of Industrial Organization,
JAFIO: Journal of Agricultural & Food Industrial Organization,
JFDR: Journal of Food Distribution Research,
JIE: Journal of International Economics,
SEEJE: South-Eastern Europe Journal of Economics;

Product(s)	Period	Data frequency[b]	Estimation method(s)[c]	Evidence of market power
Beer	1962–82	A	3SLS	2/3
Papaya	2003 M1–2012 M12	M	GLS	0/3
Avocado	2004 M1–2013 M12	M	2SLS IV/GMM	1/1 1/1
Pork	1994 M1–2006 M4	M	GMM	3/3
Beer Cocoa Chocolate Sugar confect	1991 M4–1998 M5	M	IV/OLS	2/4 1/4 0/3 1/3
Beer	1975–1993	A	IV SUR 3SLS	3/4 3/4 4/4
Rice aggregated Hommali rice Glutinous rice Parboiled rice	1998–2011	Q	3SLS IV	0/4 0/3 2/3 1/1
Chicken meat: Whole birds Legs with bone Other cuts	1988 M1–2002 M12	M	GLS	 2/4 1/4 1/4
Soybean	1999 M1–2005 M2	M	FIML	1/1
Olive oil	1970–2001	A	2SLS	3/3

[b] A: annual, M: monthly, Q: quarterly

[c] FIML: full information maximum likelihood,
GLS: generalized least squares,
GMM: generalized method of moments,
IV: instrumental variable,
3SLS: three-stage least squares,
SUR: seemingly unrelated regression

Source: Own compilation based on cited studies in the style of Gafarova (2018)

Table 3.3: Residual demand elasticity studies on wheat exports

Author(s)	Journal [a] (year)	Exporter(s)	Importers
Gafarova	2018	Kazakhstan	Azerbaijan
			Georgia
		Russia	Armenia
			Azerbaijan
			Georgia
Pall, Perekhozhuk, Glauben, Prehn, and Teuber	AE (2014)	Russia	Albania
			Azerbaijan
			Egypt
			Georgia
			Greece
			Lebanon
			Mongolia
			Syria

Notes:
[a] AE: Agricultural Economics

Product	Period	Data frequency[b]	Estimation methods[c]	Results for the inverse RDE
Wheat	2004 Q1–2014 Q4	Q	3SLS SUR	−0.012 −0.0131 −0.0131 −0.0219** −0.1510*** −0.1056*** −0.0045 −0.0054 −0.0267* −0.0218*
Wheat	2002–09	Q	IVPPML GMM	−0.0883* −0.0628* −0.173 −0.1647** −0.0048 −0.0238* −0.0730* −0.0550*** −0.0527** −0.0650*** −0.0564 −0.0684 −0.2497 −0.0698 −0.0543 −0.0338

[b] Q: quarterly

[c] GMM: generalized method of moments,
IVPPML: instrumental variable Poisson pseudo-maximum likelihood,
3SLS: three-stage least squares, SUR: seemingly unrelated regression

Asterisks ***, ** and * denote the 1%, 5%, and 10% level of significance, respectively.

Source: Own compilation based on cited studies in the style of Gafarova (2018)

In her doctoral thesis, Gafarova (2018) examines the pricing behavior of the Black Sea wheat exporters Russia and Kazakhstan in the Caucasus during the period 2004–14 by means of the RDE approach. Thereby, she relies on quarterly data. Gafarova's (2018) estimation results indicate that neither Russia nor Kazakhstan exercise market power in wheat exports to Azerbaijan. In contrast, her estimation results show that Russia has substantial market power in the Armenian wheat import market. The estimated markup over MC is more than 15%, using a three-stage least squares (3SLS) estimator, and about 11% in a seemingly unrelated regression (SUR) model. Moreover, her estimation results suggest moderate Russian market power in Georgia with an estimated markup over MC of 2.2% in the SUR model and 2.7% applying a 3SLS estimator, respectively. Concerning Kazakh wheat exports to Georgia, the estimation results based on the SUR model suggest Kazakh market power with an estimated markup of 2.2% while the estimated markup, using the 3SLS estimator, is smaller and insignificant. Gafarova (2018) explains the dominant Russian position in Armenia with its landlocked position, the conflict with Azerbaijan favoring trade via the Black Sea and Georgia, as well as Armenia's weak wheat import infrastructure.

4 PRICE DISCRIMINATION IN RUSSIAN WHEAT EXPORTS: EVIDENCE FROM A PTM STUDY BASED ON ANNUAL FIRM-LEVEL DATA[4]

4 This chapter is based on the paper "Price discrimination in Russian wheat exports: evidence from firm-level data" by Uhl, Kerstin M., Oleksandr Perekhozhuk, and Thomas Glauben published in the *Journal of Agricultural Economics 67*(3), 2016: 722–740.

4.1 BACKGROUND AND MOTIVATION

We study the pricing behavior of Russian wheat-exporting firms in international markets motivated by the relevance of international wheat trade for global food security, and Russia's new strong position as a main supplier of wheat on a global scale in general, and to developing countries in particular (see Chapter 2).

As Russian wheat exports are mainly directed to developing countries, worries about discriminatory pricing behavior are nourished by the rise in world wheat prices with price peaks in 2008 and 2011. Developing countries are particularly vulnerable to high and volatile wheat prices (FAO, 2010). Lagi et al. (2011) demonstrate the coincidence of the global food price spikes with hunger riots in developing countries. In 2008 there were more than 60 incidents of unrest in 30 different countries ascribed to food scarcity. The empirical study presented in this chapter is based on data covering the years 2002–2011, thereby comprising periods of low world wheat prices as well as the high-price regime. This allows us to estimate Russian pricing behavior in international wheat markets for these two price regimes separately.

Our study amplifies the existing literature on Russian pricing behavior by, to our knowledge, being the first PTM study relying on firm-level data. Expanding on the PTM study of Pall et al. (2013), we use firm-level data which allows for the inclusion of firm-level fixed effects and should provide more robust estimates. Furthermore, in comparison to Pall et al. (2013), we are able to extend the analysis to more export destinations. Another merit of our disaggregated firm-level data set is that we mitigate the problem of 'pseudo PTM', i.e., a false detection of pricing-to-market. Lavoie and Liu (2007) show theoretically that the use of unit values aggregating differentiated products causes a false detection of PTM. A shock in the exchange rate alters the product-quality mix sold to a country if preferences are non-homothetic, thereby affecting unit values. Relying on firm-level data alleviates this problem as the level of product differentiation is likely to be smaller within a firm than within an industry.

The aim of this econometric analysis is to study the pricing behavior of Russian wheat-exporting firms in international markets and to identify the implications for food security in the export markets for the period 2002–2011. We base our analysis on Krugman's (1986) PTM approach. Methodologically, we adopt Knetter's (1989) panel data approach, extended by a firm fixed effect capturing firm heterogeneity. We confirm the prevalence of imperfections in international wheat trade, investigating exports to 61 countries over the period 2002 to 2011.

This chapter is organized as follows. Section 4.2 describes our firm-level data set and Section 4.3 the Russian wheat export market. Section 4.4 introduces the theoretical and econometric framework of our study. Section 4.5 presents the empirical findings and Subchapter 4.6 concludes.

4.2 OUR FIRM-LEVEL DATA SET

We applied a firm-level data set provided by the Agribusiness Information Consulting Company APK-Inform which included all wheat export activities of Russian wheat sellers over the period 1998 to 2011. APK-Inform is a well-reputed consulting company in the Commonwealth of Independent States (CIS) countries, and is considered as a highly reliable source of information. The annual data set covered wheat export prices and quantities for all destination countries. In total, Russian firms exported wheat to 122 countries around the globe over the years 1998–2011 and the data set comprised 7,862 observations. However, we based our econometric estimation solely on data for the years 2002–2011 as Russia has only become established as a major exporter since 2002. A comparison with aggregated trade data, as reported by UN Comtrade, confirmed the completeness of our data set. The correlation coefficient between our data aggregated across firms and the UN Comtrade data was almost one, and aggregated export quantities and average export prices were very similar to those reported by UN Comtrade.

The application of a firm-level data set allowed the elimination of implausible observations that might result in misleading findings and interpretations. An underlying assumption of the PTM analysis is that we observe a homogeneous product. Our data set comprised also export activities of seed-exporting companies, which are typically associated with higher export prices. Neglecting this fact might result in biased estimation results. Therefore, in order to eliminate this source of bias in our estimation results, we excluded all export activities of seed-exporting firms. This is a major merit of the application of our firm-level data set. In contrast, relying on highly aggregated data ignores differences across firms. In addition, the firm-level data set allowed the inclusion of firm-level fixed effects which might help account for differences in product qualities more generally.

The data set comprised also minor export activities with only few tons or even few kilograms. These minor transactions often featured implausible average prices. We excluded all exports with a quantity of less than five tons to avoid that our results were dominated by minor export quantities. Furthermore, we removed two more observations which were most likely typing errors as these two observations deviated by a factor of ten from the average export price of the respective countries, Turkey and Tanzania, for 2007 and 2008, respectively, although we could not identify the exporting firms as seed sellers.

We restricted our estimation to 61 destination countries accounting for 98 percent of total Russian wheat exports over the period 2002 to 2011. We selected these destinations by the following criteria: exports were conducted in more than three different years for each country in order to assure some variation in the exchange rate, which was our variable of interest. Moreover, we included only those countries with more than five observations.

Data on bilateral exchange rates was extracted from the IMF International Financial Statistics. The exchange rate data of Uzbekistan was taken from the Central Bank of the Republic of Uzbekistan. Data on the Uzbek exchange rate was published in a weekly frequency. We computed the annual exchange rate of Uzbekistan as the average of all weekly observations. Exchange rate data for North Korea was provided by OANDA Corporation. The dataset that we used for our estimation covered 61 importing countries and 1,252 exporting firms comprising 6,471 observations. Summary statistics for the entire estimation period 2002–2011 and the high-price period 2006–2011 are reported in Tables A 4.1 and A 4.2 in the Appendix.

4.3 THE RUSSIAN WHEAT EXPORT INDUSTRY

Chapter 2.5 of this doctoral thesis describes the revival of Russia's wheat export sector since the early 2000s with its corresponding growing world market share. In this subchapter, we provide relevant statistics for our data period 1998–2011. Figure 4.1 depicts Russia's wheat export volume as well as the number of Russian wheat-exporting companies for this time period and illustrates the remarkable increase in Russian wheat exports.

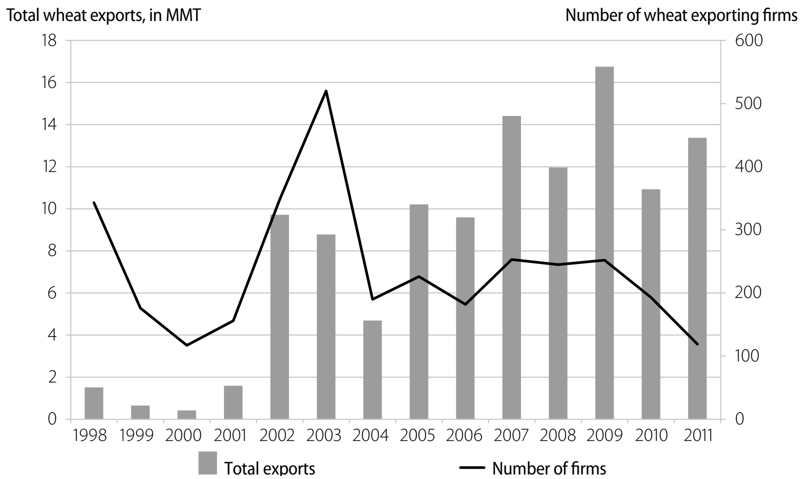

Figure 4.1: Total Russian wheat exports and number of wheat-exporting firms

Source: Taken from Uhl et al. (2016). Figure is based on data provided by APK-Inform.

About 83 percent of Russian wheat exports between 1998 and 2011 were directed to developing countries[5]. Table 4.1 summarizes Russian wheat exports to its top ten export destinations over the period 1998–2011. Egypt is by far the most important destination of Russian wheat with an export share of more than 25 percent in 1998–2011. Russia's top five (ten) destination markets accounted for about 47 (62) percent of total Russian wheat exports in 1998–2011, corresponding to an export quantity of 53.7 (70.7) million tons.

Table 4.1: Russia's major wheat export destinations, 1998–2011

Top export destination	Country	Export quantity (million tons)	Share in Russian exports (%)
1	Egypt	28.7	25.1
2	Turkey	9.7	8.5
3	Italy	5.5	4.8
4	Azerbaijan	5.4	4.7
5	Israel	4.4	3.8
Top 5		**53.7**	**46.9**
6	Georgia	4.3	3.7
7	Yemen	3.4	2.9
8	Bangladesh	3.2	2.8
9	India	3.1	2.8
10	Greece	3.0	2.7
Top 10		**70.7**	**61.7**

Note: The export destinations are ranked according to the total export quantity.

Source: Taken from Uhl et al. (2016). Table is based on firm-level data provided by APK-Inform.

Figure 4.2 reveals some changes over time regarding the destination of Russian wheat exports. The figure confirms the high importance of the MENA region for Russian wheat sellers. Furthermore, it shows that the share of Russian wheat directed to European countries has been

5 Countries are classified as developing countries according to the classification scheme of the World Bank.

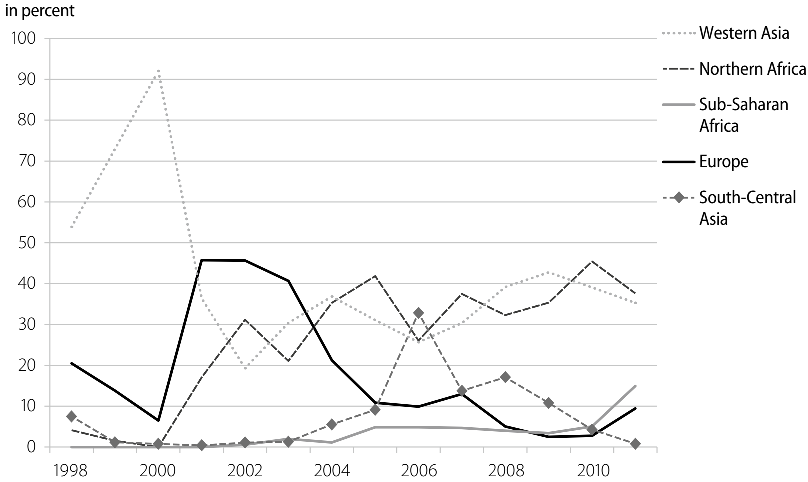

Figure 4.2: Composition of Russian wheat exports per region

Notes: Geographical regions according to the classification of the United Nations. The considered regions accounted for 97 percent of total Russian wheat exports.

Source: Taken from Uhl et al. (2016). Figure is based on data provided by APK-Inform covering 122 export destinations.

shrinking over time while exports to Sub-Saharan Africa have been increasing. Figure 4.2 illustrates that wheat exports to South-Central Asia feature a high variability.

Table 4.2 depicts the life durations of the 1,899 Russian wheat-exporting firms covered in our sample and suggests a structural change around 2001/02. We define life duration as the number of years within 1998–2011 in which a firm exported wheat. Note that there is no Russian firm exporting wheat in 11, 12, 13 or all 14 years of our data period. Our firm-level data shows that none of the ten largest Russian wheat exporters over the period 1998–2011 started business prior to 2002. It is striking that 1,216 firms exported only once within our data period, i.e., they failed to establish in the market. Remarkably, there are two peaks with 256 firms exporting wheat only in 1998 and about 500 firms exporting wheat in only one year in 2001–2003. The market exit of such a large number of firms might also be related to Russian agricultural policies. As described by Liefert, Liefert, and Lueberhusen (2013), Russia dropped subsidies granted to the agricultural sector substantially (–26% in 2001–05 as compared with 1996–2000). Short survival on export markets is, however, not unique to Russian wheat exporters. Sabuhoro et al. (2006) analyze the survival time of Canadian establishments on international markets and find that the probability of exit within one year is 42.2 percent.

Table 4.2: Life duration of Russian wheat-exporting firms

Year	Life duration of wheat-exporting firms (in years)										Total
	1	2	3	4	5	6	7	8	9	10	
1998	256	54	22	11	0	0	0	0	0	0	343
1999	78	61	26	11	0	0	0	0	0	0	176
2000	52	36	18	11	0	0	0	0	0	0	117
2001	99	31	15	11	0	0	0	0	0	0	156
2002	135	124	29	11	8	9	6	7	7	12	348
2003	259	159	32	14	11	10	7	8	8	12	520
2004	36	45	36	9	13	11	9	12	7	12	190
2005	49	31	41	23	19	14	15	15	7	12	226
2006	26	28	35	16	18	11	13	16	7	12	182
2007	54	40	48	27	15	19	14	16	8	12	253
2008	54	40	40	33	12	17	14	15	8	12	245
2009	63	44	55	25	8	10	12	15	8	12	252
2010	44	40	39	17	3	9	8	13	8	12	193
2011	11	23	29	9	3	10	7	11	4	12	119
Total	**1,216**	**378**	**155**	**57**	**22**	**20**	**15**	**16**	**8**	**12**	**1,899**

Notes: The entries give the number of firms which exported in the respective year and which have the respective life duration. The last row gives the number of firms which exported wheat in one, two… ten different years over the period 1998–2011. The last column shows the number of firms which exported wheat in the respective year.

Source: Taken from Uhl et al. (2016). Table is based on firm-level data provided by APK-Inform.

Port infrastructure and facilities are a major bottleneck of Russian grain exports. In recent years, major grain trading companies including Glencore and Cargill acquired substantial stakes in Russian Black Sea port facilities, hampering access of smaller traders to the Russian wheat export market. Smaller traders, without their own terminal capacity, are likely to be squeezed out of the market (Reuters, 2014).

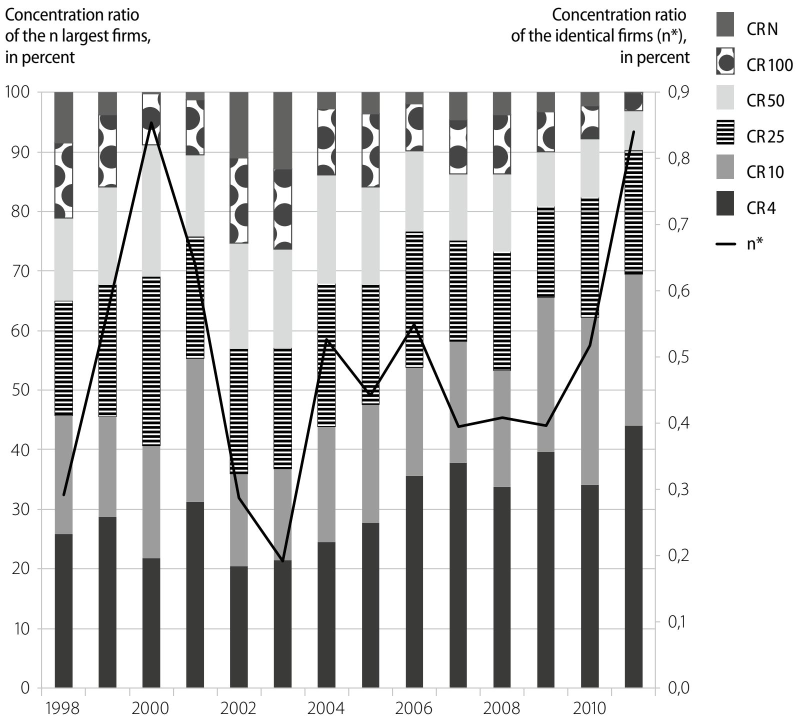

Figure 4.3: Concentration ratios of the n largest Russian wheat-exporting firms and of the identical firms

Notes: The market share of the 4, 10, 25, 50, 100 largest firms and all firms N are given on the left axis. The right axis gives a firm's market share if all firms had been identical (n*). Hence, n* equals 1/N.

Source: Taken from Uhl et al. (2016). Figure is based on firm-level data provided by APK-Inform.

Given this background, our firm-level data set reveals a remarkable concentration of the Russian wheat export industry. Ten out of 1,899 firms traded almost half of all Russian wheat exported within 1998–2011. These main wheat-exporting firms possess a substantial market share in several destination markets and dominate Russian wheat exports to Sub-Saharan Africa, among other countries (see Table A. 4.3 in the Appendix).

In the majority of the destination countries, four firms export at least half of the wheat originated from Russia. Figure 4.3 illustrates the high and continuing concentration of the Russian wheat export sector.

In 2011 ten firms exported roughly 70 percent of all Russian wheat while in 2003 the ten largest firms conducted less than 40 percent of Russian wheat exports. The solid line in Figure 4.3 shows the hypothetical market share if all Russian firms were identical, i.e., if each firm had the same market share, and underlines the remarkable concentration in Russia's wheat export sector. In 2011 the four largest wheat sellers had a market share in Russian wheat exports of about 45 percent while the market share of four firms—if all firms had been identical—would have been about 3.5 percent.

The analysis of the Russian wheat export market suggests a structural change around 2002, since Russian wheat exports stepped up after 2002 as illustrated by Figure 4.1, and since none of the large Russian wheat traders started business prior to 2002 (see Table 4.2). Therefore, to avoid biased estimation results, we do not consider data for the years 1998–2001 in our econometric analysis.

4.4 THE THEORETICAL AND ECONOMETRIC FRAMEWORK

The 'new trade theory' recognizes oligopolistic market structure as a source of price discrimination in international trade. The underlying consideration is that a firm's optimal mark-up over marginal cost hinges on the functional form of its (perceived) residual demand. A firm's residual demand is perfectly elastic in a perfectly competitive market, implying a zero mark-up. In an imperfectly competitive market, a firm faces a downward-sloping residual demand curve. The elasticity of the residual demand, and therefore the optimal mark-up, varies along the residual demand curve.

Krugman's (1986) PTM approach builds on this argument. A change in the exchange rate drives a wedge between the import price in the importer's currency and export price, denoted in the exporter's currency. The export price adjustment gives insight into the market structure. Krugman argues that in a perfectly competitive market an exchange rate shock should not result in diverging export prices across destination markets. However, if a firm possesses market power in an export market, its optimal price might vary with the exchange rate, resulting in an imperfect exchange rate pass-through. Thereby, the ratio between the export prices to different countries is altered. Please see Chapter 3.3 for further discussions on the theoretical concept.

Knetter picks up Krugman's (1986) PTM hypothesis and derives a testable econometric model. To test for PTM behavior econometrically, we adopt Knetter's panel model (see Chapter 3.5.1.1) which allows testing for alternative market structures. Please see Chapter 5.3 for the derivation of the theoretical and empirical model based on Gagnon and Knetter (1995). Thereby, we extend the Knetter (1989) model by a firm fixed effect.

$$\ln p_{ijt} = \lambda_i + \theta_t + \delta_j + \beta_i \ln e_{it} + u_{ijt} \; \forall \; i = 1, \dots, N; j = 1, \dots, J; t = 1, \dots, T. \quad (4.1)$$

with p_{ijt} denoting the nominal wheat export price (FOB price) in Russian rubles, by firm j to importing nation i in year t. e_{it} refers to the bilateral nominal exchange rate put in units of the domestic currency of country i per Russian ruble. The parameters λ_i, θ_t and δ_j measure the country effect, the time effect and the firm effect, respectively. Due to the double-log functional form, β_i is interpreted as elasticity. u_{ijt} denotes the error term.

As discussed in Chapter 3.5.1.1, the ERT elasticity allows drawing conclusions on the underlying market structure. An insignificant ERT elasticity signifies that import prices change in proportion to the change in the exchange rate, implying either a perfectly competitive market or imperfect competition with common mark-ups across destination countries. However, it is not possible to distinguish these two cases econometrically.

Furthermore, as we are not able to identify the reason for differences in the country effect across markets. A beta equal to zero is also consistent with an imperfect market but where the firm faces a constant elasticity of residual demand.

While an insignificant ERT elasticity does not give us a clear answer regarding the market structure, a significant ERT elasticity implies an imperfectly competitive market structure. The direction of the change in the export price, i.e., the sign of the beta coefficient, depends on the curvature of the demand schedule. Knetter (1995) derives the following proposition: The sign of beta depends on the convexity of the demand schedule, in the sense that beta is positive (negative) if demand is more (less) convex than the constant elasticity form. A positive beta implies that the effect of the exchange rate shock is amplified, while a negative beta signifies a condition of LCPS.

A shock in the exchange rate can affect export prices via two channels: via changes in marginal cost or via the elasticity of demand. Only the latter refers to PTM. The time fixed effect controls for all variables which vary over time but are the same for all countries; hence, the approach allows distinguishing changes in marginal cost from those in the mark-up. Further, it controls for changes in the oil price which we supposed to be a potential confounder. The firm fixed effect captures all factors which differ across firms but are stable over time, e.g., management quality. Serova (2007) points out the high diversity in the management structure in the Russian agri-food sector. The inclusion of firm fixed effects is therefore a major advantage of our study. The country effect captures the mark-up of price over marginal cost charged by the exporting firm (Knetter, 1989). While Knetter argues that significant country effects imply third-degree price discrimination, this assumption critically hinges on the assumption of product homogeneity of the traded good. As pointed out by Falk and Falk (2000), a significant country effect might reflect heterogeneity in preferences among export destinations if the product is not homogenous. Our data set comprises different wheat qualities (HS code 1001). Therefore, the interpretation of our country fixed effects is not straightforward, and we are not able to extrapolate from significant country fixed effects to price discrimination.

4.5 RESULTS AND DISCUSSION

All statistical and econometric analyses were performed using Stata (version 13.1). Note that all statistical inferences were made on the assumption that the model variables are stationary. We applied the Fisher unit root test which allows for unbalanced panel data. The test results are summarized in Table 4.3.

Table 4.3: Fisher unit root test for the export price and the exchange rate

Test specification	Modified inverse chi-squared			
	Sample A (2002–2011)		Sample B (2006–2011)	
	Export price	Exchange rate	Export price	Exchange rate
1 lag demeaned	23.6148***	12.3713***	27.7295***	2.9381***
1 lag with trend	0.0311	10.5599***	0.2259	1.6295*
1 lag demeaned with trend	27.8577***	26.3058***	16.2079***	5.3618***

Note: Asterisks ***, * indicate the 1% and 10% level of significance.

Source: Taken from Uhl et al. (2016)

Prior to conducting the unit root test, we had to aggregate the firm-level data for each destination country. Thereby, we obtained a two-dimensional panel data set. Otherwise, we would have too many time series gaps in the panel to conduct a unit root test. Our test results clearly rejected the null that all panels contain a unit root, for both the export price as well as the exchange rate variable (see Table 4.3).

We also conducted the Hausman specification test in order to choose the appropriate estimation method. The null hypothesis of uncorrelated effects was rejected at any reasonable level of significance, and we hence chose a fixed effects specification. The panel model in equation (4.1) was estimated using a within-group estimator. We used variance estimators which were clustered by firms. F-tests were applied to test the joint significance of country and exchange-rate effects. The null hypothesis that all country effects are equal ($H_0: \lambda_1 = \lambda_2 = \cdots = \lambda_N$) and all exchange-rate effects are zero ($\beta_1 = \beta_2 = \cdots = \beta_N = 0$), was rejected at the one percent level of significance (see Table 4.4).

Table 4.4: F-tests of the model variables

Null hypothesis	Sample A (2002–2011)	Sample B (2006–2011)
$H_0: \beta_1 = \beta_2 = \cdots = \beta_N = 0$	33.96***	7.85***
$H_0: \lambda_1 = \lambda_2 = \cdots = \lambda_N$	10.44***	5.84***

Note: Asterisks *** indicate the 1% level of significance.

Source: Taken from Uhl et al. (2016)

This means that there is evidence for PTM and country-specific markups. Knetter (1995) derives, as described in the last section, that a firm's optimal response to an exchange rate shock depends on the price elasticity of demand in the importing country. The sign of beta depends on the price elasticity of demand and consequently the ERT elasticity might change with the price. This implies a potential violation in the assumption of parameter stability. The wheat world market price has seen a drastic increase in 2006/07 and has remained on a high level since. We estimated our model for a second sample covering the high-level price period, i.e., 2006–2011. Thereby, we sought to mitigate the potential problem of parameter instability and to check the validity of our estimation results for the period 2002–2011.

Table 4.5 shows the estimation results for both samples and Table 4.6 summarizes the statistical inference of the models. First, we discuss our estimation results for the longer period from 2002 to 2011.

4.6 ESTIMATION RESULTS FOR SAMPLE A

Knetter's model allows discriminating between different market structures as discussed in Section 4.4. The null hypotheses of beta equal to zero could not be rejected for 36 countries, i.e. for most export destinations.

We do not find evidence for price discrimination in most of Russia's main destination markets (see Table 4.1); with the exception of India, Georgia and Turkey (see Table 4.5 for the estimation results). Some of Russia's main markets did not rely on Russian wheat, accounting only for a minor share of their total imports (Israel: ~4 percent and Italy: ~7 percent; see Table A.4.3 in the Appendix). Thus, we did not expect to find evidence for price discrimination in these countries, and our econometric results conform to our a priori expectations. For the other countries, however, Russian wheat covered a substantial share of total imports, ranging from 19 percent in Yemen up to 63 percent in Georgia. As Table A.4.3 shows, the concentration ratios of the top four and top ten Russian exporters are moderate, except for India. In India, the four (ten) largest Russian exporters accounted for 68 (87) percent of total Russian wheat exports in the period 2002–2011. Consequently, the detection of price discrimination in India confirms our suspicions of Russian price-setting behavior.

Empirical findings indicate price discrimination by Russian wheat-exporting firms in 25 destinations, i.e., for 25 countries the ERT elasticity is significantly different from zero. We distinguish the case of a positive from a negative beta coefficient. We find a negative beta, implying a stabilization of the local currency wheat price, for 13 countries. These 13 countries are Denmark, Eritrea, Iraq, Kazakhstan, Latvia, Lebanon, Mauritania, Nigeria, Norway, Rwanda, Spain, Turkey and Uzbekistan. However, the estimation results of Iraq are dominated by few observations due to a strong appreciation of the Iraqi dinar in 2003 in the aftermath of a currency reform. The ERT elasticity turns to be (insignificantly) positive if we do only consider the post-2003 observations.

There is evidence for price discrimination in six member states of the European Economic Area (EEA), viz. in Denmark, Latvia, Norway, Poland, Romania, and Spain. Notably, we find a negative coefficient for all EEA member states but Poland and Romania, and the estimation results for these two countries are dominated by Russian exports prior to EU accession. Poland entered the EU in 2004, and Romania in 2007, and both states almost stopped importing Russian wheat after accession to the European Union. The EU is itself a large wheat-producing region, accounting for about 15 percent in global wheat exports in 2011/12 (USDA, 2014). EEA member states have an advantage vis-à-vis Russia due to the geographical closeness and the tariff-free access to the EEA-market. Knetter (1993) argues that the probability of observing a negative beta increases if we add competitors. Against this background, a firm's strategy aiming at maintaining its market share seems plausible for the EEA market.

For 12 countries we find a positive ERT elasticity, implying, as stated above, an amplification of the exchange rate effect. These countries are Albania, Ethiopia, Georgia, India, Jordan, Morocco, North Korea, Pakistan, Poland, Romania, Saudi Arabia, and Sudan.

The country effects vary among destinations, implying different export prices across markets. These differences might reflect price discrimination or heterogeneous preferences in quality. We are not able to distinguish these two possibilities. Note that Israel was treated as reference country, i.e., the country effect for Israel was set equal to zero. We chose Israel as reference country because Israel is well integrated into international trade with direct access to sea ports. As we did not expect that Russian wheat-exporting firms possesses market power in Israeli wheat imports, Israel seemed to be a good reference case. Nevertheless, estimation results for the ERT elasticity, our variable of interest, are robust to switches in the reference country.

4.7 ESTIMATION RESULTS FOR SAMPLE B

Table 4.5 shows the estimation results for Sample B, covering the years 2006–2011, i.e., a period with high global wheat market prices. Table 4.6 summarizes the statistical inference of the model. Sample B encompassed Russian wheat exports to 49 destination markets.

First, we want to emphasize that the estimation results are similar for the majority of the destination countries as compared to the longer sample. This suggests that the assumption of parameter stability is unproblematic for most countries in our sample.

There is evidence for price discrimination in 14 of 49 export markets in the period 2006–2011 as compared with 25 of 61 states in the period 2002–2011. At the first glance one might have the impression that the threat to food security has been shrinking over time as the share of export markets with evidence of market power is higher in Sample A than in Sample B. Yet, these figures mask the fact that several countries started importing Russian wheat solely or predominantly after 2005. These countries, however, entered both samples. Examples are Ethiopia, India, Mauritania, Rwanda, and Uganda. There is evidence for price discrimination in Ethiopia, India, Mauritania, and Rwanda. This finding is dominated by Russian price setting during the high-price period. Figure 4.2 depicts the direction of Russian wheat exports over time. Evidently, SSA became a significant market for Russian wheat exporters in recent years while exports to SSA were negligible prior to 2005. Similarly, the bulk of Russian wheat destined for South-Central Asia was exported in the period 2006–2011.

Nevertheless, Russia lost the ability to exert market power in some export markets. Russia's export quantity to new EU member states decreased substantially after entry to the European Union, e.g., Latvia, Poland, and Romania. There is strong evidence of price discrimination by Russian firms in the sample 2002–2011 in these three countries. As there are only few observations for Latvia, Poland, and Romania after accession to the EU, this finding is dominated by Russian price setting in the lower-price period. However, arguably, these new EU members are not threatened by food insecurity. To conclude, the threat to food security has likely not been shrinking over time as Russian wheat has increasingly been directed to developing countries, and there is evidence for price discrimination in a range of these new export markets.

A comparison of the empirical findings for the two time periods reveals that Russian firms tend to amplify the effect of the exchange rate shock in the case of developing countries in times of high wheat prices. There is evidence for price discrimination in seven developing countries: Ethiopia, India, Mauritania, Morocco, Nigeria, Pakistan and Sudan. The ERT elasticity of all these countries, except Mauritania, is positive.

Krugman (1986), analyzing international trade in the automobile sector, argues in favor of negative ERT elasticities, considering the negative effect of price changes on a firm's reputation. However, the observation

Table 4.5: Estimation results

Destination	Sample A (2002–2011)			
	β		λ	
Afghanistan	−0.39	[−1.09]	0.43	[1.45]
Albania	0.28***	[2.74]	−0.30	[−1.32]
Algeria	−0.02	[−0.04]	0.02	[0.04]
Armenia	−0.02	[−0.15]	0.18	[0.42]
Austria	0.40	[1.50]	1.45	[1.52]
Azerbaijan	0.06	[0.53]	0.24	[0.60]
Bangladesh	0.05	[0.25]	−0.05	[−0.21]
Congo Republic	−0.01	[−0.11]	0.11	[0.25]
Cyprus	−0.36	[−1.05]	−1.26	[−1.01]
Denmark	−0.79**	[−2.05]	−1.21**	[−2.24]
Egypt	−0.06	[−1.36]	−0.01	[−0.08]
Eritrea	−0.33***	[−5.95]	−0.15	[−0.83]

of a positive beta seems plausible in case of wheat trade. A positive beta is the best response if a firm faces a demand curve more convex than the constant elasticity form. This implies that the elasticity of demand decreases with price. Amplifying the exchange rate effect is the firm's optimal response if the reduction in wheat imports by a country decreases with surging prices. This is likely the case for a staple crop, in particular if we face a high global wheat price. A country, depending on imports to feed its population, can reduce its imports following a price surge at increasingly high costs. It is plausible that a country's import demand is particularly inelastic if a further reduction in wheat imports might result in a hunger crisis. This scenario seems to be a good description of the global markets for staple food in our data period, with high prices for staple food, accompanied by revolts in poor wheat-importing countries.

Sample B (2006–2011)			
β		λ	
−0.273*	[−1.83]	0.359	[1.14]
0.256	[0.67]	−0.340	[−0.74]
−0.023	[−0.11]	0.174	[0.30]
1.184***	[5.08]	4.396***	[5.30]
−0.046	[−0.39]	−0.141	[−0.32]
0.273	[1.28]	−0.280	[−0.97]
−0.330	[−1.60]	−1.160	[−1.40]
0.048	[0.51]	0.140	[0.57]

Table 4.5: Estimation results (continued)

Destination	Sample A (2002–2011)			
	β		λ	
Ethiopia	0.39***	[3.23]	0.28	[1.33]
Georgia	0.53***	[4.02]	1.60***	[4.29]
Germany	−0.12	[−0.47]	−0.43	[−0.47]
Greece	−0.05	[−0.54]	−0.14	[−0.40]
India	3.56***	[3.64]	−1.69***	[−3.31]
Indonesia	−0.16	[−0.48]	0.96	[0.50]
Iran	0.09	[0.81]	−0.55	[−0.83]
Iraq	−0.03***	[−6.63]	0.22	[1.20]
Israel	−0.00	[−0.01]		
Italy	−0.03	[−0.27]	−0.12	[−0.34]
Jordan	0.32*	[1.68]	1.23*	[1.67]
Kazakhstan	−4.95**	[−2.06]	7.70**	[2.10]
Kenya	0.15	[0.81]	−0.06	[−0.25]
Kyrgyzstan	2.14	[0.74]	−0.49	[−0.51]
Latvia	−1.88***	[−2.60]	−7.51***	[−2.61]
Lebanon	−0.24*	[−1.69]	1.03*	[1.71]
Libya	0.22	[1.16]	0.70	[1.18]
Lithuania	−0.49	[−1.39]	−1.30	[−1.56]
Malaysia	−0.01	[−0.01]	0.08	[0.09]
Mauritania	−1.52**	[−2.53]	3.55***	[2.75]
Moldova	−0.89	[−0.54]	−0.39	[−0.29]
Mongolia	−0.55	[−0.79]	2.04	[0.79]
Morocco	0.30**	[2.10]	0.41*	[1.83]
Mozambique	0.27	[1.06]	0.12	[0.67]
Nigeria	−0.88***	[−3.47]	1.30***	[3.28]
North Korea	0.19***	[22.83]	0.04	[0.22]
Norway	−1.91***	[−3.61]	−2.97***	[−3.61]

Sample B (2006–2011)			
β		λ	
0.417***	[3.72]	0.308	[1.20]
0.022	[0.16]	0.134	[0.32]
−0.122	[−0.73]	−0.392	[−0.62]
3.286***	[3.69]	−1.566***	[−3.26]
0.030	[0.10]	−0.156	[−0.09]
−0.276	[−1.12]	1.620	[1.10]
0.203	[1.60]	−0.640	[−1.07]
−0.005	[−0.04]		
−0.096	[−0.62]	−0.345	[−0.62]
0.175	[0.94]	0.701	[0.98]
−5.457***	[−2.77]	8.369***	[2.77]
0.131	[0.60]	−0.045	[−0.14]
2.247	[0.78]	−0.551	[−0.55]
−0.102	[−0.63]	0.445	[0.62]
0.220	[1.18]	0.711	[1.20]
−0.838***	[−4.66]	−1.976***	[−4.30]
0.261	[0.72]	0.674	[0.89]
−1.199**	[−2.30]	2.857**	[2.47]
−2.887	[−1.43]	10.879	[1.44]
0.382*	[1.80]	0.633*	[1.87]
0.335	[1.46]	0.122	[0.52]
2.186***	[3.12]	−3.591***	[−3.10]
−4.757***	[−4.50]	−7.630***	[−4.29]

Table 4.5: Estimation results (continued)

Destination	Sample A (2002–2011)			
	β		λ	
Oman	0.29	[0.44]	1.39	[0.48]
Pakistan	0.42***	[4.12]	−0.29	[−1.35]
Peru	−0.09	[−0.25]	−0.02	[−0.03]
Poland	2.03***	[3.33]	4.93***	[3.84]
Romania	1.79***	[3.00]	4.29***	[3.22]
Rwanda	−0.60*	[−1.75]	1.86*	[1.76]
Saudi Arabia	1.28***	[3.69]	2.59***	[3.66]
South Korea	0.04	[0.06]	−0.33	[−0.12]
Spain	−0.48***	[−3.35]	−1.81***	[−3.18]
Sudan	0.69**	[2.25]	1.77**	[2.30]
Switzerland	−0.35	[−1.16]	−1.19	[−1.12]
Syria	−0.19	[−1.47]	−0.13	[−0.62]
Tajikistan	0.27	[1.23]	0.69	[1.20]
Tanzania	−0.10	[−0.78]	0.48	[0.91]
Tunisia	−0.25	[−0.86]	−0.71	[−0.74]
Turkey	−0.26**	[−2.52]	−0.70**	[−2.00]
Uganda	0.25	[1.22]	−1.02	[−1.11]
Ukraine	0.23	[0.95]	0.57	[1.34]
U. Arab Emirates	0.03	[0.14]	0.14	[0.28]
Uzbekistan	−1.50***	[−11.59]	5.87***	[11.30]
Vietnam	−0.05	[−0.11]	0.29	[0.11]
Yemen	0.12	[0.73]	−0.19	[−0.54]
Constant	8.77***	[49.45]		

Notes:
Table 4.5 shows the estimation results for the two time periods, i.e., Sample A (2002–2011) and B (2006–2011). Israel is the reference country. Values in parentheses are t-statistics. Asterisks ***, **, * indicate the 1%, 5%, and 10% level of significance.

Sample B (2006–2011)			
β		λ	
0.256	[0.40]	1.243	[0.45]
0.529***	[2.87]	−0.403	[−1.22]
−0.528	[−1.53]	1.646	[1.51]
0.685**	[2.39]	1.442**	[2.27]
−0.674	[−1.38]	2.478	[1.34]
0.759*	[1.83]	2.810*	[1.83]
0.674**	[2.06]	1.724**	[2.07]
−0.159	[−1.09]	−0.113	[−0.45]
−2.073	[−0.76]	−3.940	[−0.73]
0.232	[1.60]	−0.820	[−1.33]
−0.181	[−0.47]	−0.526	[−0.43]
−0.022	[−0.20]	−0.009	[−0.02]
0.273	[1.35]	−1.104	[−1.22]
−0.004	[−0.01]	0.180	[0.24]
−0.004	[−0.02]	0.070	[0.14]
2.530	[1.27]	−10.251	[−1.30]
0.096	[0.23]	−0.649	[−0.25]
0.301	[1.20]	−0.544	[−0.97]
8.196***	[34.26]		

Source: Taken from Uhl et al. (2016)

4.8 ROBUSTNESS CHECK

There were structural changes in the Russian wheat export sector, as described above, with large wheat exporters starting business around 2002. Therefore, we restricted our estimation to the period 2002–2011, i.e., a period when Russia was a wheat net-exporter. As a robustness check we estimated our model for the entire data period, i.e., 1998–2011. Our estimation results for the ERT elasticity are robust with only few changes in the estimation results, implying that fixed effects capture the structural changes.

Table 4.6: Statistical inference of the models

Statistical indicators	Sample A	Sample B
Observation numbers	6,471	3,455
Time series numbers	10	6
Cross section numbers	1,252	579
R-sq. adjusted	0.7006	0.5253
R-sq. within	0.7066	0.5393
R-sq. between	0.5181	0.1062
R-sq. overall	0.7040	0.3871
AIC	−5,933.1354	−3,407.6839
BIC	−5,052.3742	−2,780.6309

Notes: Sample A covers the years 2002 to 2011, and sample B the years 2006 to 2011.

Source: Taken from Uhl et al. (2016)

We also included the export quantity as control variable as a robustness check, for the following consideration: The export quantity is correlated with the price if there are quantity discounts. On the other side, the exchange rate might determine the international allocation of wheat imports. The estimation results for both samples are robust to the inclusion of the export quantity variable, with only modest changes in the estimation results.

4.9 CONCLUDING REMARKS

International wheat markets feature an oligopolistic supply structure with Russia emerging as a major exporter in recent years. Our firm-level data set reveals the high concentration of the Russian wheat export industry, with only a handful firms dominating exports. This raises the concern of price discrimination by Russian wheat exporters in those countries which depend on Russian wheat. This concern is particularly pronounced in times of high wheat prices, which raises food security concerns especially because many developing countries rely on wheat imports.

We analyze the pricing behavior of Russian wheat-exporting firms in 61 destination countries. We use a rich firm-level data set comprising all export prices and export quantities over the period 2002–2011. Our study is based on Krugman's (1986) pricing-to-market approach. PTM is defined as destination-specific price discrimination induced by an exchange rate shock. Methodologically, we adopt Knetter's panel model which we extend by a firm fixed effect capturing firm heterogeneity. We conduct our estimations for two different time periods, 2002–2011 and 2006–2011, i.e., the periods of moderate and of high world wheat prices, respectively.

Our estimation results contradict the hypothesis of an integrated world market with evidence for price discrimination in 25 of 61 destination markets in the longer period and 14 of 49 export markets in the shorter data period. Yet, our estimation results also imply that Russia behaves competitively in most of its export markets for wheat. Our findings are largely in line with Pall et al. (2014)'s empirical study using the RDE method. They analyze Russian wheat exports to eight export markets and find evidence for market power in Albania, Georgia and Greece, while their estimation results suggest perfectly competitive pricing in Azerbaijan, Egypt, Lebanon, Mongolia and Syria.

We find positive ERT elasticities for the majority of the 14 destination countries in which we find evidence for price discrimination for the high-price period 2006–2011. This implies that Russian wheat-exporting firms tend to amplify the effect of the exchange rate shock. According to Knetter (1995), this is the optimal firm response if the elasticity of import demand decreases with the price. We argue that this is likely the case in markets for a staple crop, as wheat, especially in times of high global wheat prices. A positive ERT elasticity implies that there is an additional source of volatility in the wheat import price. This is a worrying finding for unstable economies with highly volatile exchange rates that largely rely on wheat imports.

5 FIRM-GROUP-LEVEL EVIDENCE ON RUSSIAN PRICING BEHAVIOR IN INTER-NATIONAL WHEAT TRADE

5.1 BACKGROUND AND MOTIVATION

International wheat trade is geographically highly concentrated and dominated, on the one hand, by few exporting countries, and, on the other hand, by four world-leading commodity traders, known as the "ABCD-companies", an acronym for Archer Daniels Midland (ADM), Bunge, Cargill, and Louis Dreyfus. Well-functioning wheat trade is of relevance for global food security since a substantial share of world production is traded internationally—about 20 percent—and wheat is predominantly imported by developing countries. Russia has been among the top exporters on a global scale since the beginning of the 2000s, and thereby plays an important role for food security. Russia's main export destinations are import-dependent developing countries with wheat-based diets in North Africa and Western Asia. Annual per capita wheat demand is 165 kg in North Africa and 122 kg in West Asia, corresponding to 40–43% of calories and protein intake (Shiferaw et al., 2013), and are thereby among the regions with the highest per capita wheat consumption worldwide. Russia's main export destinations in North Africa and Western Asia are highly dependent on cereal imports to meet their dietary needs; with CIDR of about 50 and 40 in Northern Africa and West Asia, respectively (see Chapter 2.2).

Price discrimination in international wheat trade is an issue studied for a long time (Skully, 1992; Lavoie, 2005). In recent years, several studies focusing on Russian pricing behavior in international wheat markets were conducted on grounds of Russia's new position in international wheat trade as a major supplier and its role for food security in its destination markets (see Pall et al., 2013; Pall et al., 2014; Gafarova et al., 2015; Imamverdiyev, 2017). Most studies find evidence for price discrimination or market power in Russian wheat exports; however, evidence is mixed. The PTM studies by Pall et al. (2013) and Gafarova et al. (2015) as well as the RDE study by Pall et al. (2014) provide evidence for Russian price discrimination and market power in international wheat trade, respectively. Imamverdiyev (2017) analyses wheat trade between the exporters Russia, Ukraine and Kazakhstan (RUK) and importing countries in Central Asia and the South Caucasus by means of a gravity trade model. In contrast to the already mentioned PTM and RDE studies, he concludes that there is no evidence for market power by the RUK countries in Central Asia and the South Caucasian states. Please see Chapters 3.5 and 6.1 for a more detailed discussion on the mentioned PTM and RDE studies.

The PTM approach builds the theoretical framework of this empirical study. In this chapter, we apply the PTM approach to a firm-level data set of Russian wheat exports over the period 2006–14. As discussed in Chapter 3.3, PTM refers to third-degree price discrimination induced by exchange rate movements.

Recent contributions to the PTM literature include studies considering firm heterogeneity (Basile et al., 2012; Berman et al., 2012), as discussed in Chapter 3.5.1.2 on extensions of the basic PTM model. Basile et al. (2012) fit the Melitz and Ottaviano (2008) model to a market with country-specific quality preferences and firms offering different quality varieties. They show in a theoretical model and in an empirical application to Italian firms that firms selling different quality varieties react differently to exchange rate shocks if quality matters. Berman et al. (2012) address firm heterogeneity in a PTM framework relying on a firm-level data set comprising French export activities. Their key finding is that firms respond heterogeneously to exchange rate shocks depending on their level of productivity. Berman et al. (2012) argue that a heterogeneous reaction to exchange rate shifts can be explained by at least three different theoretical models. These are the Melitz and Ottaviano (2008) model, a Cournot model provided by Atkeson and Burstein (2008) and an extension of the model of Corsetti and Dedola (2005) taking into account distribution costs in the importing country. In all three theoretical models the perceived elasticity of demand of the exporting firm falls with its productivity. As a consequence, high-productivity firms increase their markups by a larger amount after depreciation than low-productivity firms. Another finding of Berman et al. (2012) is that PTM behavior is related to firm size since firm size is correlated with productivity. They find that larger firms discriminate prices more intensively after currency depreciation than smaller firms.

So far, evidence regarding Russian pricing behavior in international wheat trade has been based on aggregated data, thereby ignoring firm characteristics. Yet, the findings of Berman et al. (2012) suggest that exchange rate pass-through elasticities in a PTM model should be firm-specific if firms differ according to size. Our firm-level data set reveals that firm size varies considerably among Russian wheat exporters. Russia's top 10 exporters in terms of export volume exported 618,080,28 metric tons in the period 2006–14 while the 10 smallest Russian wheat-exporting-firms in terms of export quantity sold only 11 metric tons internationally in the same time period. We estimate the model for three different firm groups. These are all firms, the top 5, and the top 6–10 exporters. Firms are grouped according to export quantity in each export market and for each year. By doing so, our study does not only provide average effects but firm-group-specific responses to exchange rate movements. We expect that the top 5 exporting firms react stronger to exchange rate changes than the top 6–10 firms and the aggregate of all firms, based on the findings of Berman et al. (2012). Furthermore, the LI, a measure for market power, shows that a seller's price-setting scope is a function of its market share. Consequently, the top 5 firms should have a larger price-setting scope as compared with the top 6–10 firms.

Another merit of this PTM study is that estimation results are based on daily data. The other studies analyzing Russian pricing behavior in international wheat trade rely on quarterly or annual data to infer pricing behavior. Using daily data, we have more observations to estimate our model. Our estimation results are based on 33,219 observations while other PTM studies rely on much less observations. Therefore, we expect to provide more precise estimation results.

Furthermore, exchange rates feature substantial volatility within three months or a year. Daily exchange rates capture these oscillations. Pricing decisions critically depend on the relevant bilateral exchange rate. In the PTM model detection of price discrimination relies on the response to exchange rate movements. Using daily data, the exchange rate assigned to a transaction corresponds more accurately to the exchange rate costs faced by the exporter. Using quarterly or annual exchange rate data might result in less precise estimation results if the exchange rate was subject to substantial volatility.

With this study, we expect to contribute to empirical analysis and provide more robust and accurate estimation results of Russian pricing behavior in international wheat markets by applying a rich firm-level data set. Our estimation results confirm the exertion of third-degree price discrimination by Russian wheat exporters and the finding of Berman et al. (2012) that large firms tend to price discriminate more intensively following an exchange rate shock than firms exporting only smaller quantities.

The rest of this chapter is organized as follows. In Section 5.2 we draw on Russia's relevance as a wheat exporter for food security. In the following section we derive the PTM model, describe our data set, and we continue with the specification of the empirical model. In Section 5.5 we discuss our estimation results, and finally we draw a conclusion.

5.2 RUSSIAN WHEAT EXPORTS AND FOOD SECURITY

Russia emerged as a major wheat exporter around the turn of the millennium while being a significant wheat importer in Soviet times (Rada et al., 2017; Gallagher, 1990). Today Russia is an important wheat supplier on a global scale (see Chapter 2.5). Figure 5.1 illustrates the emergence of Russia in international wheat trade. In the trade year 1999/00 Russia exported about 0.5 million metric tons of wheat while in 2016/17 Russia supplied 27.8 million metric tons of wheat to international markets. Thereby, Russia accounted for 0.5% of global wheat exports in 1999/00 and 15.3% in 2016/17.

As a major wheat supplier Russia contributes to food security in its export markets. Please see Chapter 2.2 for a discussion of the relevance of wheat trade for food security.

Russia supplies wheat to several regions around the globe, and, dominates wheat exports to some countries. In total, Russia exported wheat

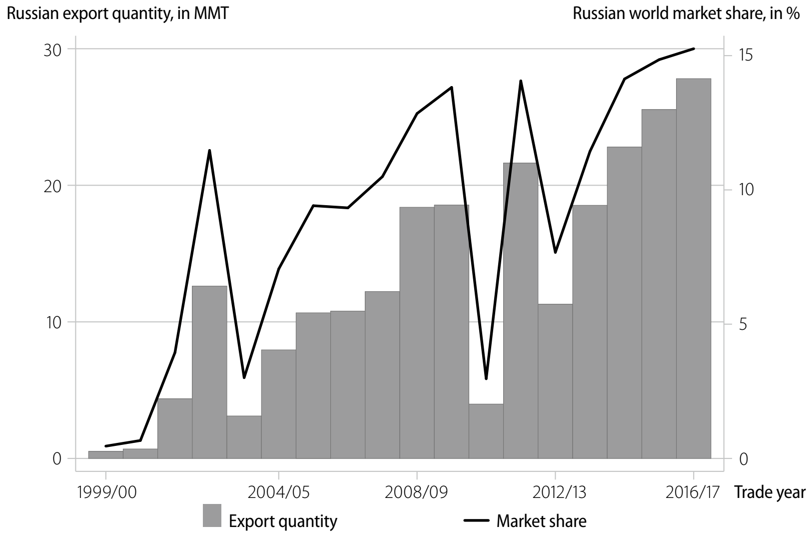

Figure 5.1: Russian wheat export quantity and world market share

Source: Own compilation based on USDA (various years)

to 109 countries in the years 2006 to 2014.[6] The bulk of Russian wheat was exported to Northern African countries and Western Asia. About 71% of Russian wheat exports in 2006–14 were sold either to Northern Africa or Western Asia (see Table 5.1). Besides Northern Africa and Western Asia, Russia exported wheat to Southern Asia, SSA and Europe, with 10.3%, 8.4% and 6.4% of total Russian wheat exports, respectively. All other regions were markets of minor importance for Russian wheat exporters. Among Russia's export destinations Egypt stands out in terms of total export quantity with more than 34 million tons, corresponding to 26% of Russian wheat exports in 2006–14. From a food security perspective, per capita export volumes are equally interesting as these indicate import-dependency to meet dietary needs. The right column of Table 5.1

6 Russia recognizes Abkhazia and South Ossetia as independent states.

Table 5.1: Russian wheat exports by region, 2006–14

Export destination	Total Russian wheat export quantity (MT)	Share in total Russian wheat exports (%)	Total Russian wheat exports per capita (kg)	Russian wheat exports per capita and year (kg)
All	**129,709,488**	**100.0**		
Northern Africa	**43,149,706**	**33.27**		
Algeria	162,765	0.13	4.4	0.5
Egypt	34,335,368	26.47	439.5	48.8
Libya	3,554,450	2.74	591.7	65.7
Morocco	924,473	0.71	29.1	3.2
Sudan	2,029,667	1.56		
Tunisia	2,142,983	1.65	203	22.6
Sub-Saharan Africa	**10,900,416**	**8.40**		
Burundi	52,710	0.04	5.7	0.6
Cameroon	3,501	0.00	0.2	0
Chad	1,432	0.00	0.1	0
Congo	65,909	0.05	16.1	1.8
Congo, DR	125,290	0.10	2	0.2
Djibouti	401,417	0.31	480.6	53.4
Eritrea	177,298	0.14	30.8	3.4
Ethiopia	499,977	0.39	5.7	0.6
Gambia	7,904	0.01	4.7	0.5
Ghana	95,585	0.07	3.9	0.4
Kenya	2,825,049	2.18	68.9	7.7
Madagascar	45,440	0.04	2.2	0.2
Malawi	124,150	0.10	8.3	0.9
Mauritania	240,637	0.19	66.7	7.4
Mozambique	747,406	0.58	31.2	3.5
Nigeria	1,068,053	0.82	6.7	0.7
Rwanda	133,134	0.10	12.3	1.4
Senegal	193,194	0.15	14.9	1.7
Sierra Leone	2,000	0.00	0.3	0
South Africa	1,527,209	1.18	30	3.3
Tanzania	1,875,634	1.45	41.6	4.6
Uganda	611,425	0.47	17.9	2
Zimbabwe	76,062	0.06	0	0

Table 5.1: Russian wheat exports by region, 2006–14 (continued)

Export destination	Total Russian wheat export quantity (MT)	Share in total Russian wheat exports (%)	Total Russian wheat exports per capita (kg)	Russian wheat exports per capita and year (kg)
Central Asia	**265,315**	**0.20**		
Kazakhstan	122,181	0.09	7.5	0.8
Kyrgyzstan	51,217	0.04	9.3	1
Tajikistan	37,150	0.03	4.9	0.5
Turkmenistan	4,485	0.00	0.9	0.1
Uzbekistan	50,282	0.04	1.8	0.2
Eastern Asia	**792,487**	**0.61**		
China	63	0.00	0	0
Japan	58,411	0.05	0.5	0.1
North Korea	120,961	0.09	4.9	0.5
South Korea	235,824	0.18	4.8	0.5
Mongolia	372,935	0.29	137.3	15.3
Taiwan, China	4,294	0.00		
South-eastern Asia	**1,674,173**	**1.29**		
Indonesia	949,432	0.73	3.9	0.4
Malaysia	77,250	0.06	2.7	0.3
Myanmar	1,480	0.00	0	0
Philippines	381,263	0.29	4.1	0.5
Singapore	234	0.00	0	0
Thailand	125,120	0.10	1.9	0.2
Viet Nam	139,393	0.11	1.6	0.2
Southern Asia	**13,355,175**	**10.30**		
Afghanistan	37,736	0.03	1.3	0.1
Bangladesh	3,105,116	2.39	20.5	2.3
India	3,154,228	2.43	2.6	0.3
Iran	4,545,185	3.50	60.9	6.8
Pakistan	2,377,701	1.83	13.7	1.5
Sri Lanka	135,208	0.10	6.6	0.7
Western Asia	**49,037,758**	**37.81**		
Armenia	1,990,766	1.53	668.6	74.3
Azerbaijan	4,610,679	3.55	510.7	56.7
Bahrain	9,293	0.01	7.7	0.9
Cyprus	196,556	0.15	178.3	19.8

Georgia	3,866,021	2.98		
Georgia*	3,867,204	2.98	870.1	96.7
Iraq	1,777,279	1.37	57.3	6.4
Israel	3,774,572	2.91	495.2	55
Jordan	2,819,245	2.17	465.5	51.7
Kuwait	542	0.00	0.2	0
Lebanon	1,809,811	1.40	420	46.7
Oman	879,667	0.68	292.3	32.5
Qatar	123,748	0.10	73.3	8.1
Saudi Arabia	372,315	0.29	13.6	1.5
Palestine	5,335	0.00	1.4	0.2
Syria	2,354,690	1.82	110.5	12.3
Turkey	17,886,250	13.79	247.8	27.5
United Arab Emirates	1,491,262	1.15	190.2	21.1
Yemen	5,069,728	3.91	222.5	24.7
The Americas	**2,212,129**	**1.71**		
Belize	5,600	0.00	18.1	2
Brazil	28,715	0.02	0.1	0
Cuba	48,065	0.04	4.3	0.5
Ecuador	87,431	0.07	5.8	0.6
Haiti	53,861	0.04	5.4	0.6
Mexico	759,266	0.59	6.4	0.7
Nicaragua	250,588	0.19	43	4.8
Peru	975,802	0.75	33.3	3.7
United States	2,800	0.00	0	0
Eastern Europe	**512,940**	**0.40**		
Bulgaria	27,635	0.02	3.7	0.4
Czech Republic	60	0.00	0	0
Hungary	15,182	0.01	1.5	0.2
Moldova	14,629	0.01	4.1	0.5
Poland	4,965	0.00	0.1	0
Romania	35,913	0.03	1.8	0.2
Slovakia	21	0.00	0	0
Ukraine	414,533	0.32	9	1
Northern Europe	**831,243**	**0.64**		
Denmark	21,221	0.02	3.8	0.4
Iceland	1,205	0.00	3.8	0.4

Table 5.1: Russian wheat exports by region, 2006–14 (continued)

Export destination	Total Russian wheat export quantity (MT)	Share in total Russian wheat exports (%)	Total Russian wheat exports per capita (kg)	Russian wheat exports per capita and year (kg)
Latvia	553,923	0.43	263.3	29.3
Lithuania	113,654	0.09	36.7	4.1
Norway	135,805	0.10	27.8	3.1
Sweden	2,864	0.00	0.3	0
United Kingdom	2,571	0.00	0	0
Southern Europe	**6,617,420**	**5.10**		
Albania	1,613,407	1.24	551.1	61.2
Croatia	2,941	0.00	0.7	0.1
Greece	1,615,046	1.25	145.3	16.1
Italy	2,270,031	1.75	38.2	4.2
Malta	3,020	0.00	7.3	0.8
Montenegro	9,721	0.01	15.7	1.7
Portugal	47,493	0.04	4.5	0.5
Serbia	9,046	0.01	1.2	0.1
Spain	1,046,715	0.81	22.7	2.5
Western Europe	**291,085**	**0.22**		
Austria	108,982	0.08	13	1.4
Belgium	18,227	0.01	1.7	0.2
France	0	0.00	0	0
Germany	44,002	0.03	0.5	0.1
Netherlands	65,300	0.05	3.9	0.4
Switzerland	54,574	0.04	7	0.8

Notes: Russia's export quantity is rounded off to whole metric tons. No population data available for Taiwan in World Development Indicators Database. Our firm-level data set does not distinguish between Sudan and South Sudan. *Including the regions Abkhazia and South Ossetia.

Source: Own compilation based on our firm-level data set provided by APK-Inform. Population data were extracted from the World Development Indicators Database from the World Bank.

shows the average annual wheat export quantity exported by Russia per inhabitant of the importing country. These figures point up that several export destinations of Russian wheat exporters are highly dependent on Russian wheat. In Western Asia the Caucasus stands out in terms of per capita wheat imports from Russia. Armenia imported on average each year 74.3 kg per capita wheat from Russia in the period 2006–14, Azerbaijan and Georgia 56.7 kg per capita and 96.7 kg per capita, respectively. Among Western Asian states, besides the Caucasus, Israel, Jordan and Lebanon bought substantial per capita wheat quantities from Russia, with 55 kg, 51.7 kg and 46.7 kg, respectively. In Northern Africa, Egypt and Libya imported substantial per capita volumes of wheat originated from Russia, with 48.8 kg and 65.7 kg, respectively. Other countries with high per capita wheat imports from Russia are Albania and Djibouti with 61.2 and 53.4 kg annually, respectively.

The competitive environments in which Russian wheat-exporting firms interact determine their price-setting scopes. Russian wheat exporters face competition from other Russian exporters, from domestic producers as well as from firms located in other wheat-exporting countries. If Russia possesses a substantial market share in an import-dependent market and Russian exports to that destination are highly concentrated, we suspect market imperfections. Table 5.2 shows Russia's market share in selected export markets as well as market shares of other main trading partners (competitors). Figure 5.2 shows concentration ratios of Russian wheat exports for selected markets.

The trade relations, as depicted in Table 5.2, suggest that geographical closeness plays an important role in international wheat trade. The Black Sea exporters Russia and Kazakhstan dominate wheat exports to the Caucasus and the Black Sea neighboring country Turkey. In Northern Africa, European Union member states, particularly France, are main wheat suppliers, besides Russia, Ukraine and the United States. Australia and India are major competitors on the Arabian Peninsula; in Oman, the United Arab Emirates, and Yemen; three countries with direct access to the Indian Ocean.

Russia is the top wheat supplier to Albania, Armenia, Georgia, Jordan, Lebanon, Tanzania, Turkey, Egypt, and Libya. More concretely, Russia dominated the Armenian wheat import market with a market share of 87% in 2006–14 and served 63% and 64% of Armenian and Georgian wheat imports, respectively. In the North African states Egypt and Libya Russia contributed to 39% and 27% of wheat imports, respectively. In

Table 5.2: Exporters' (competitors') market share in major destinations, 2006–14

Destination country	Exporters (competitors)	Market share (in %)	CR 3
Albania	Russia	63.1	78.3
	Ukraine	9.0	
	Hungary	6.2	
Armenia	Russia	87.4	98.4
	Kazakhstan	6.9	
	Ukraine	4.1	
Azerbaijan	Kazakhstan	56.2	97.9
	Russia	40.3	
	Ukraine	1.4	
Egypt	Russia	39.0	69.4
	USA	17.8	
	France	12.6	
	Ukraine	8.4	
	Australia	6.9	
Georgia	Russia	63.8	97.2
	Kazakhstan	31.2	
	Ukraine	2.2	
Israel	Switzerland	37.4	77.8
	Netherlands	21.6	
	USA	18.8	
	Russia	1.3	
Jordan	Russia	32.2	74.6
	Ukraine	27.9	
	Romania	14.5	
	Syria	11.9	
	USA	6.4	
Kenya	Ukraine	33.9	74.5
	Russia	26.9	
	Argentina	13.7	
	USA	9.1	
Lebanon	Russia	42.7	72.4
	Ukraine	19.2	
	Kazakhstan	10.5	

Libya	Russia	27.0	59.5
	Germany	20.1	
	Ukraine	12.4	
	France	8.4	
Mongolia	Kazakhstan	52.2	99.0
	USA	25.8	
	Russia	21.0	
Oman	Australia	22.2	48.5
	Germany	13.4	
	India	12.9	
	Russia	12.8	
	Canada	10.4	
Tanzania	Russia	29.6	56.2
	Argentina	15.9	
	Germany	10.7	
	Ukraine	9.1	
	Australia Canada	9.1 5.1	
Tunisia	Ukraine	24.8	52.3
	Russia	14.2	
	France	13.3	
	Italy	9.6	
	Canada	8.7	
Turkey	Russia	56.8	75.8
	Kazakhstan	13.5	
	USA	5.5	
	Ukraine	4.8	
United Arab Emirates	Canada	23.3	52.4
	India	14.9	
	Australia	14.2	
	Russia	12.6	
	Germany	8.8	
Yemen	Australia	25.3	66.2
	Russia	20.7	
	USA	20.2	
	France	12.5	

Notes: Statistics based on import data for HS commodity code 1001—wheat and meslin.

Source: Own compilation based on import data published by UN Comtrade the Western Asian countries Jordan, Lebanon and Turkey Russia's market share was 32%, 43% and 57%, respectively. In Tanzania Russian firms possessed a market share of about 30% in our data period 2006–14, according to import data published by UN Comtrade. Most of Russian destination markets were highly concentrated and monopolized by exporters. The concentration ratio of the top three wheat-exporting countries (CR 3) ranges from 48.5% in Oman to 99.0% in Mongolia, a level that indicates that the trade in these destination markets was imperfectly competitive and markets were segmented.

Table A.5.1 in the Appendix shows CR of Russian wheat exports for our data period for those 49 export destinations for which we estimated Russian pricing behavior. Thereby, firms were ranked according to wheat export volume, and the order of the firms varied by export market and export year. The top 5 (top 10) exporters accounted for at least about 50% (70%) of Russian wheat exports in all export markets, with the exception of Turkey with market shares of the top 5 (top 10) exporters of 41.2% (59.6%).

Figure 5.2 depicts the annual CR of the top 5 and top 6–10 exporters for five destinations in which Russia is the main wheat supplier, namely Armenia, Egypt, Lebanon, Tanzania and Turkey. Concentration of Russian wheat exports differed substantially by export market. Russian wheat exports to Armenia and Tanzania were more concentrated than those to Egypt, Lebanon, and Turkey. Furthermore, we see that CR in these five destinations were rather stable during the period 2006–14. In Egypt and Lebanon, we observe that the market share of the top 6–10 was slightly increasing during our data period. Regarding Turkey, CR of Russian wheat exports were more concentrated in 2006 than in the following years. As we point out in Chapter 6, Turkey started to import wheat in large volume in 2007. Therefore, we observe a change in Russian wheat exports to Turkey in 2007.

Figure 5.3 summarizes the previous thoughts, and shows Russia's market share in Northern Africa and Western Asia and the corresponding concentration ratio of Russia's top 5 exporters in one figure for the years 2006–14. Armenia clearly stands out in Figure 5.3 with a high Russian

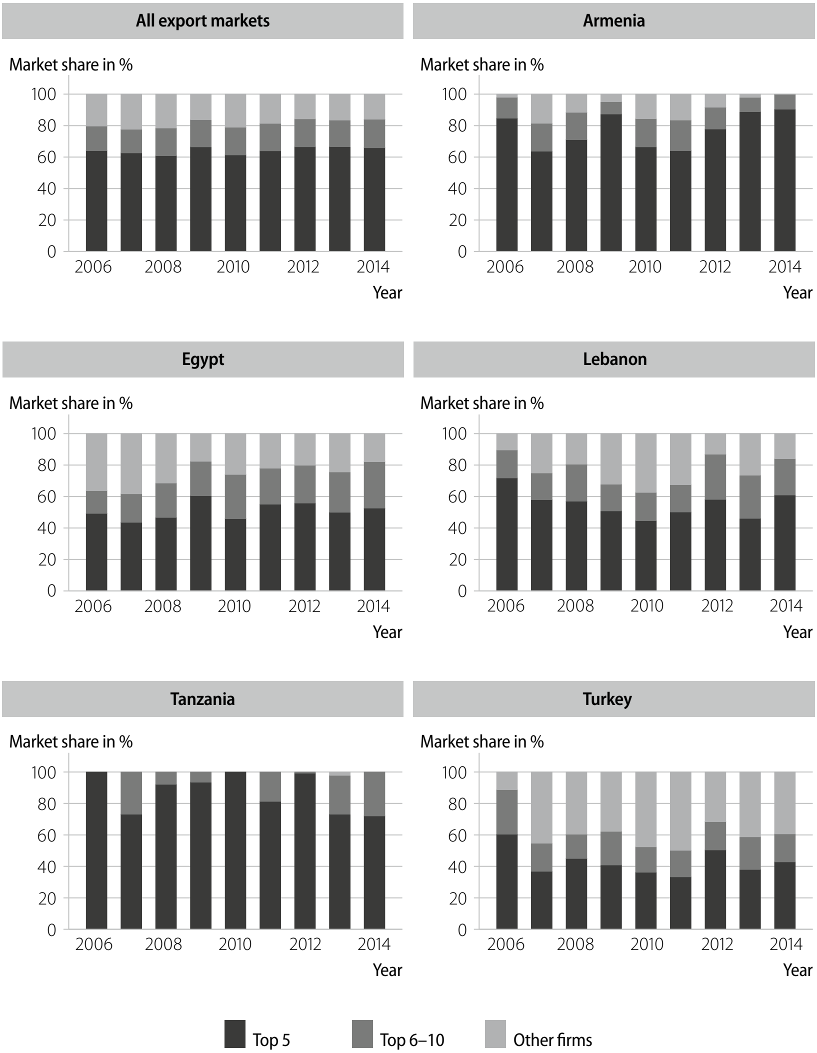

Figure 5.2: Concentration of Russian wheat exports in major destinations

Source: Own compilation based on firm-level data provided by APK-Inform (2015)

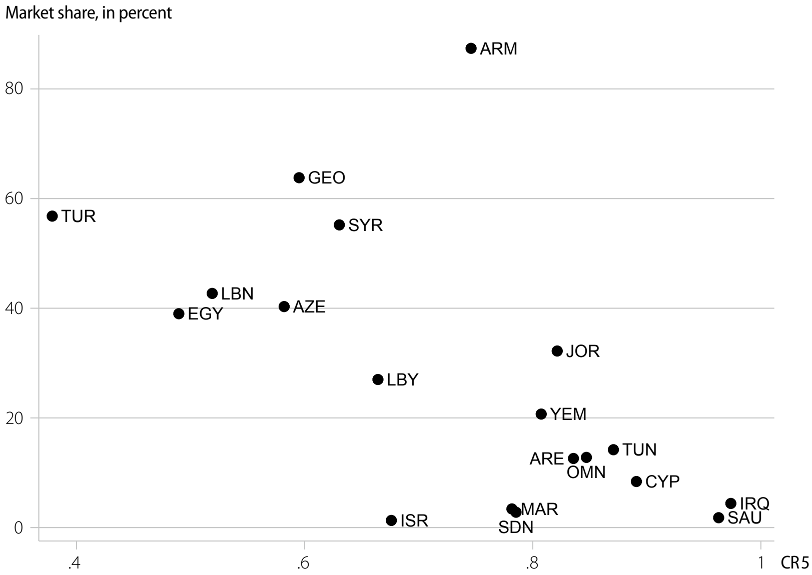

Figure 5.3: Russian wheat exports to Northern African and Western Asian countries in 2006–14

Notes: CR5 is the concentration ratio of the top 5 exporters. Figure includes all Northern African and Western Asian states that we considered in our estimation.

Source: Own compilation based on firm-level data provided by APK-Inform (2015) and import data published by UN Comtrade (2018)

market share and a rather high concentration ratio of the top 5 exporters, implying that single Russian sellers possess a substantial market share in Armenian wheat imports, and might therefore possess a considerable price-setting scope. Beside Armenia, Russian firms hold a substantial market share in Georgia, Syria, Turkey, Egypt, Lebanon, and Azerbaijan, while Russian firms do not enjoy a dominant position in other North African and Western Asian destinations, such as Morocco, Iraq or Saudi Arabia. To conclude, we are suspicious of Russian market power in several export markets due to its high market share and highly concentrated wheat exports.

5.3 THEORETICAL AND EMPIRICAL FRAMEWORK

PTM is a form of third-degree price discrimination and is induced by an exchange rate shock between the currencies of the exporter and one of its multiple importers. After the exchange rate shock, the exporter either fully passes the exchange rate change to the importer or the exchange rate pass-through is incomplete. The price adjustment hinges on residual demand characteristics as well as on the effect of the exchange rate shock on marginal cost. In an imperfectly competitive market, the exporter's residual demand curve is downward sloping, and the profit-maximizing exporter adjusts its mark-up after the exchange rate shock depending on the residual demand elasticity. In a perfectly competitive market, in contrast, the residual demand elasticity faced by the exporter is infinite, and mark-ups above marginal cost are equal to zero. Beside mark-up adjustments, exchange rate fluctuations can alter marginal cost by changes in input prices or quantities (Gagnon and Knetter, 1995). The former effect results in price discrimination as relative prices among export destinations are changed. The latter effect, however, is not related to market imperfections and exchange rate pass-through is incomplete also in a perfect market setting.

In the following we derive the PTM model. The derivation of the theoretical and empirical model is similar to Gagnon and Knetter (1995). The key challenge is to control for changes in marginal cost econometrically in order to separate the effect of exchange rate changes on marginal cost and demand elasticities. The starting point builds a firm exporting to N different destination markets that are separated from each other. In a perfectly integrated world market, arbitrage would ensure the validity of the LOP and pricing-to-market behavior would not be feasible. Let P_i be the firm's export price in export market $i\,(i = 1, \dots, n)$, denoted in the exporter's currency, and Q_i the corresponding demanded export quantity. e_i is the exchange rate expressed as the importer's currency per unit of the exporter's currency and consequently, $e_i * P_i$ denotes the import price, i.e. the price in the importer's currency. Z_i is a vector of demand shifters in the export destination. C is the exporting firm's cost function and W is a vector of other cost shifters. Then the exporting firm faces the following profit-maximization problem:

$$\max_{P_i} \Pi_i = \sum_i P_i * Q_i(e_i * P_i, Z_i) - C\left(\sum_i Q_i(e_i * P_i, Z_i), W\right). \quad (5.1)$$

The first-order condition (FOC) of the exporter's profit maximization problem is equal to (5.2) and can be rearranged to the expression of equation (5.3).

$$Q_i + \frac{\partial Q_i}{\partial P_i} * P_i - \frac{\partial C}{\partial Q_i} * \frac{\partial Q_i}{\partial P_i} = 0 \quad (5.2)$$

Dividing each term by $(\partial Q_i/\partial P_i)P_i$, equation (5.2) can be expressed in terms of elasticities:

$$P_i = MC\,(\frac{\varepsilon_i}{\varepsilon_i - 1}). \quad (5.3)$$

ε_i is the absolute value of the price elasticity of demand the exporter is facing in destination market i and MC is equal to $\frac{\partial C}{\partial Q_i}$. By the pricing rule of equation (5.3) it is obvious that the price set by a profit-maximizing company depends on MC as well as on the sensitivity of demand to price shifts. While the PTM approach is derived from a monopolistic model, please note that no assumption regarding the market structure is needed. The underlying market structure is reflected by the price elasticity of demand. In a perfectly competitive market, the term in brackets approaches one as the price elasticity of demand is infinite. In an oligopolistic market the price elasticity of demand is a function of the exporter's residual demand function, and therefore of its competitors' exports prices.

To derive an estimable equation of the theoretical model of equation (5.3), we first take the logarithm of equation (5.3).

$$\ln P_i = \ln MC + \ln \frac{\varepsilon_i(e_i * P_i)}{\varepsilon_i(e_i * P_i) - 1}. \tag{5.4}$$

In a next step, we compute the first-order Taylor series approximation of the term $\ln \frac{\varepsilon_i(e_i * P_i)}{\varepsilon_i(e_i * P_i)-1}$. We plug in the first-order Taylor series approximation into equation (5.4) and by rearranging terms we obtain the following estimable relationship:

$$\ln P_i = \mu_i + (1-\beta)\ln MC - \beta \ln e_i, \tag{5.5}$$

with

$$\beta = \frac{\delta \ln \varepsilon_i}{\delta \ln(e_i * P_i)} * \left(\varepsilon_i - 1 + \frac{\delta \ln \varepsilon_i}{\delta \ln(e_i * P_i)}\right)^{-1}. \tag{5.6}$$

We formulate the following econometric model to test for PTM behaviour:

$$\begin{gathered} \ln p_{ijt} = \lambda_i + \theta_q + \delta_j + \beta_i \ln e_{it} + u_{ijt}, \\ \text{with } i = 1, \dots, N; j = 1, \dots, J; t = 1, \dots, T; q = 1, \dots, Q. \end{gathered} \tag{5.7}$$

p_{ijt} is firm j's export price in Russian ruble to export market i in time period t. e_{it} denotes the nominal bilateral exchange rate between the Russian ruble and the importer's currency in t, expressed as units of the importer's currency per Russian ruble. θ_q are quarterly time fixed effects. By the inclusion of time fixed effects, we follow the strategy of Gagnon and Knetter (1995) to disentangle cost effects from PTM behavior. Marginal cost and changes in marginal cost are identical for all export markets and time fixed effects capture these common cost effects on prices. Beside price changes induced by changes in marginal cost, wheat prices are subject to seasonal fluctuations. Wheat prices tend to be lower after the harvest and rise during the marketing year as storage is costly. These seasonal variations in wheat prices are common to all destinations and therefore time fixed effects also reflect seasonal price patterns. λ_i, and δ_j are country fixed effect, and firm fixed effect, respectively. The country fixed effect captures country-specific price differences while the firm-fixed effect measures constant firm-specific price differences that are for example a result of different management quality (see Chapter 4). u_{ijt} denotes the error term. β_i is the ERT elasticity net of cost effects. An ERT elasticity significantly different from zero implies that the exporter price discriminates between its export destinations while an ERT elasticity equal to zero indicates perfectly competitive pricing behavior. Knetter (1993) points out that the sign of β_i critically depends on the convexity of the residual demand function. If the exporter faces a demand schedule that is less convex than the constant-elasticity demand schedule, the optimal response to an exchange rate shock is to stabilize prices in the importer's currency. Knetter (1993) terms this reaction to an exchange rate change as "local-currency price stability" (LCPS). LCPS corresponds with a negative sign of β_i. Knetter (1993) stresses the relevance of LCPS in oligopolistic markets because adding competitors increases the chance that sellers stabilize local currency prices. In contrast, if the exporter faces a demand function that is more convex than the constant-elasticity form, the exporter amplifies the exchange rate effect, implying a positive sign of β_i.

5.4 DATA SET DESCRIPTION

We used confidential firm-level data provided by APK-Inform to estimate our econometric model. Our firm-level data set included daily FOB export prices and export quantities for the years 2006 to 2014 for each export destination. In total, there were 35,147 daily business transactions of Russian wheat-exporting firms. We could not use 1,833 of these observations for estimating our model due to missing firm identifier. Beside information about export price and quantity, our data set comprised the Harmonized Tariff Schedule (HTS) 8-digit code of the traded product. Therefore, we were able to eliminate seed exports and exports of other grains than wheat from the data set. Doing so, we eliminated 1,295 wheat seed exports and 47 exports of other grains. The reason for eliminating these grain exports was that the PTM approach critically relies on the assumption of homogeneity of the traded good. Furthermore, we deleted observations of less than one metric ton because these transactions were associated with highly questionable average prices. Thereby, we dropped five observations. To estimate our PTM model, we additionally needed daily exchange rate data, denoted in the importer's currency per Russian ruble. We extracted these daily exchange rate data from OANDA Forex Trading and Exchange Rates Services (see OANDA Corporation, 2017). Daily exchange rate data were published for all countries, but for Armenia and Georgia only from 6th of January 2006 and 10th of January 2006, respectively, and for Uzbekistan and Tajikistan from 20th of November 2007 and 28th of June 2008, respectively. Therefore, our estimations of Russian price-setting behavior for these Caucasian and Central Asian countries were based on a shorter time period. For the descriptive statistics of the variables included in our econometric model please see Table A.5.2 in the Appendix.

Figure 5.4 shows daily exchange rate data, as included in our data set and its annual averages for our data period for selected export markets. Apparently, bilateral exchange rates fluctuated substantially within each year during our data period. This implies that quarterly or annual data might differ substantially from the exchange rate relevant for the export transaction. Applying daily exchange rate data, we expected more precise estimation results.

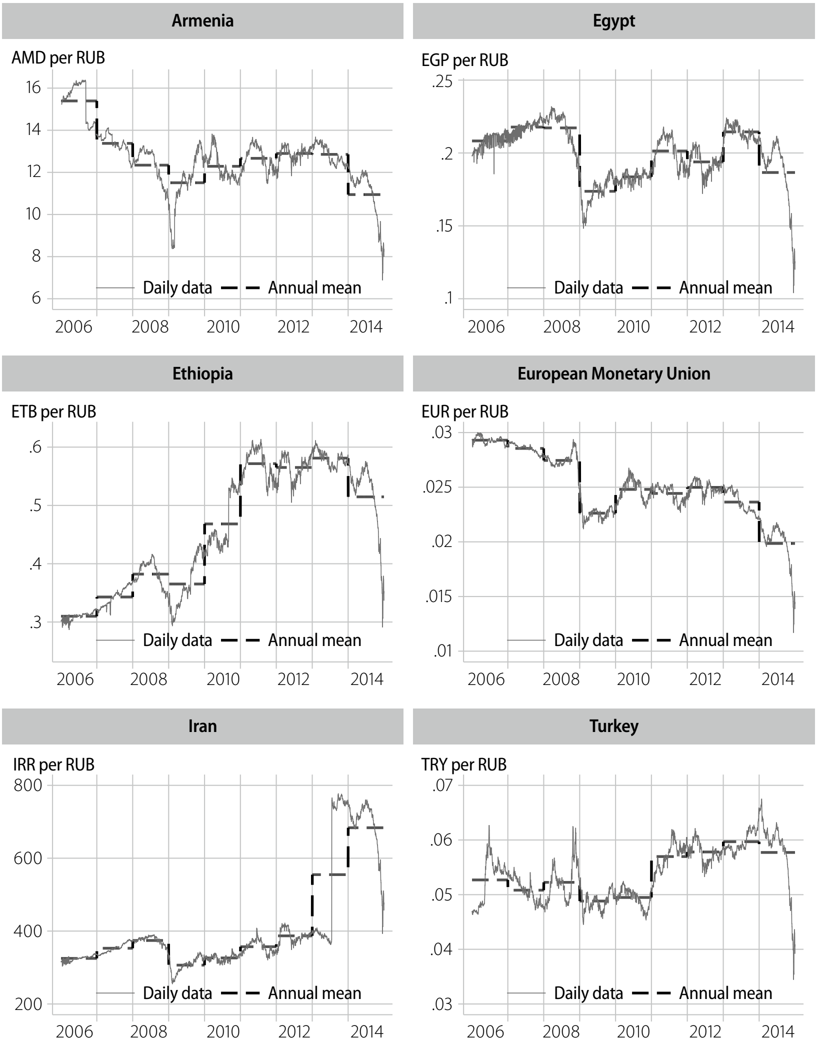

Figure 5.4: Daily and annual exchange rate time series of selected destinations

Source: Own compilation based on daily exchange rate data provided by OANDA Corporation

5.5 DISCUSSION OF THE ESTIMATION RESULTS

We estimated the econometric model of equation (5.7) using a fixed effect estimator with robust standard errors. The fixed effect estimator was chosen based on the results of a Hausman test (see Table 5.3). We confined our estimations to those export destinations with at least 50 observations, and we estimated the econometric model for three different firm groups, namely for all firms, for the top 5 exporters, and the top 6–10 exporting firms. Thereby, firms were ranked according to wheat export volume, and the order of the firms varies by export market and export year.

Table 5.3: Hausman test results

All firms	Top 5	Top 6–10
191.33***	123.13	118.26***

Notes: H_0: difference in coefficients is not systematic. *** indicates the 1% level of significance.

As we applied panel data to our econometric model, we conducted a panel unit root test to preclude non-stationarity. The test results clearly rejected the null hypothesis that all panels contain a unit root (see Table 5.4).

Table 5.4: Fisher unit root test for the export price and the exchange rate

Test specification	Modified inverse chi-squared	
	All firms	
	Monthly export price	Daily exchange rate
30 lags demeaned with drift		12.6261***
5 lags demeaned with drift	9.1330***	

Note: *** indicates the 1% level of significance.

To get a first indication for the prevalence of imperfections in the Russian wheat export market we conducted F-tests to check for the joint significance of country as well as exchange rate effects. The null hypotheses that all country effects are of the same size and that all exchange rate pass-through elasticities are zero were rejected at the 1 percent level of significance (see Table 5.5). Thereby, the F-test results suggest the conduct of Russian pricing-to-market behavior.

Table 5.5: F-tests of the model variables

Null hypothesis	All firms	Top 5	Top 6–10
$H_0: \beta_1 = \beta_2 = \cdots = \beta_N = 0$	11.22***	8.81***	4.37***
$H_0: \lambda_1 = \lambda_2 = \cdots = \lambda_N$	11.60***	8.73***	4.31***

Note: *** indicates the 1% level of significance.

Based on the highly significant F-test results, we expected deviations from perfect competition for at least some export markets.

Table 5.6 summarizes the estimation results for the three firm groups. Indeed, we find evidence for Russian price discrimination in 17 out of 49 export markets with exchange-rate pass-through elasticities significantly deviating from zero for at least one firm group.

All signs of the ERT elasticities are negative with the exceptions of Albania and India. A negative ERT elasticity means that the exporter stabilizes the wheat price expressed in the importer's currency, termed as LCPS by Knetter (1993). Knetter (1993) argues that the likelihood to observe LCPS increases with competition. Consequently, the finding of LCPS indicates that Russian firms face competition by other wheat exporters. Table 5.2 shows that Russian exporters indeed faced competition from other wheat-exporting countries as most import-dependent countries obtained wheat from various sources.

While we find evidence for Russian price discrimination in 17 states, we want to point out that our results suggest that Russia behaves competitively in 32 export markets, thus in most export destinations under study. Strikingly, our estimation results indicate that Russia behaves

Table 5.6: Estimation results

Destination	All firms β	All firms λ	Top 5 β	Top 5 λ	Top 6–10 β	Top 6–10 λ
Afghanistan	−0.240	0.312	−0.308			
	[−0.47]	[0.96]	[−0.43]			
Albania	−0.104*	0.146	−0.062	0.187	−0.151	0.177
	[−1.70]	[1.13]	[−0.61]	[1.19]	[−1.07]	[0.87]
Armenia	−0.372***	0.984***	−0.448***	1.216***	−0.326***	0.866***
	[−6.88]	[5.40]	[−7.09]	[5.70]	[−3.21]	[3.05]
Austria	0.263**	1.014**	0.166	0.731		
	[2.15]	[2.23]	[1.20]	[1.41]		
Azerbaijan	−0.229***	−0.782***	−0.304***	−1.000***	−0.186***	−0.653**
	[−6.10]	[−4.43]	[−4.35]	[−3.52]	[−2.79]	[−2.36]
Bangladesh	0.216	−0.208	0.064	−0.010	0.165	−0.159
	[0.97]	[−0.87]	[0.25]	[−0.03]	[0.42]	[−0.43]
Cyprus	−0.328***	−1.379***	−0.470***	−1.903***		
	[−3.75]	[−3.67]	[−3.46]	[−3.23]		
Egypt	−0.149**	−0.217	−0.249*	−0.303	−0.056	−0.049
	[−2.19]	[−1.35]	[−1.79]	[−1.13]	[−0.60]	[−0.27]
Ethiopia	0.010	0.074	0.020	0.151		
	[0.09]	[0.48]	[0.16]	[0.88]		
Georgia	0.011	0.103	−0.032	0.068	0.100	0.344
	[0.14]	[0.40]	[−0.23]	[0.16]	[1.41]	[1.39]
Germany	−0.027	−0.056	0.128	0.644		
	[−0.06]	[−0.04]	[0.26]	[0.34]		
Greece	−0.251***	−0.906***	−0.227***	−0.750***	−0.378**	−1.386**
	[−5.25]	[−4.82]	[−3.10]	[−2.64]	[−2.24]	[−2.15]
India	0.101	−0.046	0.056	0.068	1.514**	−0.747**
	[0.26]	[−0.21]	[0.09]	[0.20]	[2.52]	[−2.14]
Indonesia	0.084	−0.430	−0.147	0.987		
	[0.41]	[−0.36]	[−0.45]	[0.53]		
Iran	0.006	0.046	0.009	0.076	0.009	0.057
	[0.23]	[0.25]	[0.16]	[0.19]	[0.15]	[0.14]
Iraq	0.262	−0.838	0.231	−0.651		
	[1.26]	[−1.18]	[1.22]	[−1.02]		
Israel	0.011		−0.020		0.012	
	[0.22]		[−0.34]		[0.18]	

Table 5.6: Estimation results (continued)

	All firms		Top 5		Top 6–10	
Destination	β	λ	β	λ	β	λ
Italy	−0.371***	−1.387***	−0.302*	−1.083*	−0.661***	−2.436***
	[−3.90]	[−4.14]	[−1.92]	[−1.91]	[−3.31]	[−3.28]
Jordan	−0.139	−0.448	−0.106	−0.237		
	[−1.03]	[−0.84]	[−0.65]	[−0.37]		
Kazakhstan	0.467	−0.681	0.158			
	[1.49]	[−1.42]	[0.37]			
Kenya	0.084	−0.032	0.082	0.042		
	[1.13]	[−0.27]	[0.73]	[0.27]		
North Korea	−1.492***	2.320***	−1.559***	2.505***		
	[−7.52]	[8.76]	[−6.41]	[7.62]		
South Korea	0.251	−0.930	0.302	−1.038		
	[1.12]	[−1.15]	[1.24]	[−1.18]		
Latvia	−0.048	−0.146	0.128	0.676	−0.389	
	[−0.20]	[−0.15]	[0.54]	[0.68]	[−1.20]	
Lebanon	−0.017	0.095	−0.141	0.642	0.172	−0.629
	[−0.28]	[0.39]	[−1.18]	[1.45]	[1.56]	[−1.37]
Libya	0.023	0.120	−0.046	−0.013	−0.144	−0.422
	[0.36]	[0.58]	[−0.47]	[−0.04]	[−0.78]	[−0.66]
Lithuania	−0.051	−0.061	−0.148	−0.214		
	[−0.47]	[−0.22]	[−0.98]	[−0.56]		
Mongolia	−1.764***	6.898***	−1.229***		−3.565***	
	[−4.70]	[4.71]	[−2.94]		[−3.76]	
Morocco	0.056	0.146	−0.014	0.124		
	[0.51]	[0.85]	[−0.14]	[0.78]		
Mozambique	−0.413***	0.004	−0.456***	0.085		
	[−4.81]	[0.04]	[−5.14]	[0.69]		
Nigeria	−0.380***	0.626***	−0.622***	1.098***		
	[−3.56]	[3.38]	[−4.05]	[4.09]		
Norway	0.116	0.268	−0.044	0.133		
	[1.04]	[1.13]	[−0.31]	[0.46]		
Oman	0.003	0.071	0.121	0.658		
	[0.02]	[0.11]	[0.96]	[1.22]		
Pakistan	0.045	−0.012	−0.059	0.160		
	[0.68]	[−0.09]	[−0.75]	[1.15]		

Saudi Arabia	−0.269	−0.573	−0.188	−0.347		
	[−0.63]	[−0.62]	[−0.39]	[−0.34]		
South Africa	−0.332***	−0.360**	−0.223**	−0.136		
	[−3.83]	[−2.55]	[−1.99]	[−0.72]		
Spain	−0.431	−1.617	−0.478*	−1.722*		
	[−1.63]	[−1.61]	[−1.73]	[−1.69]		
Sudan	−0.015	0.113	−0.046	0.262		
	[−0.27]	[0.69]	[−0.72]	[1.37]		
Syria	0.010	0.030	−0.105	0.146	0.316	−0.102
	[0.20]	[0.27]	[−1.45]	[1.10]	[1.63]	[−0.62]
Tajikistan	−0.064	−0.106	0.054	0.385		
	[−0.14]	[−0.10]	[0.19]	[0.61]		
Tanzania	−0.212***	0.857***	−0.291***	1.228***		
	[−2.69]	[2.69]	[−2.75]	[2.96]		
Tunisia	0.179	0.636	−0.325	−0.842	−0.236	−0.632
	[0.96]	[1.13]	[−1.61]	[−1.40]	[−0.64]	[−0.56]
Turkey	−0.149***	−0.384**	−0.162***	−0.344	−0.044	−0.105
	[−4.14]	[−2.35]	[−2.91]	[−1.59]	[−0.44]	[−0.31]
Uganda	−0.035	0.219	−0.107	0.605		
	[−0.38]	[0.55]	[−1.02]	[1.39]		
Ukraine	−0.072	−0.085	−0.192	−0.200	2.276	3.976
	[−0.31]	[−0.24]	[−0.65]	[−0.44]	[1.38]	[1.47]
United Arab Emirates	0.059	0.189	0.018	0.169		
	[0.62]	[0.81]	[0.15]	[0.58]		
Uzbekistan	0.846	−3.475				
	[0.69]	[−0.72]				
Vietnam	−0.280	1.855	−0.284	1.957		
	[−1.45]	[1.51]	[−1.42]	[1.53]		
Yemen	0.117	−0.161	0.021	0.109	0.226	−0.410
	[1.57]	[−0.81]	[0.22]	[0.46]	[1.04]	[−0.93]
Constant	8.118***		8.171***		8.637***	
	[76.64]		[66.65]		[48.69]	
Observations	**33,219**		**18,603**		**5,251**	
R-sq.	**0.7801**		**0.8033**		**0.7259**	
Adj. R-sq.	**0.7793**		**0.8020**		**0.7222**	

Notes: Israel is set as reference country. Values in brackets are t-statistics.
***, **, * indicate the 1%, 5% and 10% level of significance, respectively.

Source: Own computations using Stata version 14.2 statistical software (StataCorp, 2015) competitively in most North African and Western Asian countries. The region is, as described in Section 5.2, highly dependent on wheat imports and Russia is a major supplier of wheat to many North African and Western Asian states. Therefore, the finding of competitive Russian price-setting behavior in most North African and Western Asian countries is an interesting and important result. Most import-dependent countries in Northern Africa and Western Asia are well integrated into international markets, thereby intensifying competition among wheat suppliers (see Table 5.2). Our estimation results imply that Russian firms are able to exercise price discrimination in Armenia, Azerbaijan, Cyprus, Egypt and Turkey.

Russia possessed a substantial market share in these export markets with an average share in total Armenian wheat imports of 87.24% during 2006–14, 42.12% in Azerbaijan, 34.13% in Egypt, and 52.40% in Turkey. Estimated ERT elasticities are the largest in absolute values for the top 5 exporters in Armenia, Azerbaijan, Cyprus, Egypt and Turkey. The finding of a larger reaction of the top exporters to exchange rate changes is in accordance with Berman et al. (2012). Berman et al. (2012) argue that firms of different size react differently to exchange rate shocks and that larger firms discriminate prices more intensively after currency depreciation than smaller firms. Thus, our estimation results verify the finding of Berman et al. (2012) that PTM behavior is firm-specific. Regarding Armenia and Azerbaijan, our estimation results suggest price discrimination by all three firm groups, while for Egypt and Turkey; our results indicate price discrimination by the top 5 exporters, and by the aggregate of all firms, presumably driven by the pricing of the top 5 exporters. Yet, there is no evidence of PTM behavior by the top 6–10 exporters in Egypt and Turkey. Among these states, the estimated ERT elasticities are the lowest in absolute values for Turkey, arguably reflecting the fact that Russian wheat exports to Turkey were less concentrated than in all other export markets.

Russia's dominant position as wheat supplier in the Caucasus and Turkey arises due to its geographical location as a Black Sea neighboring country, and as Russia shares a common border with Azerbaijan. Geographical closeness to the export market is a substantial competitive advantage in wheat trade because wheat is a bulky product and, consequently, trade involves substantial transportation costs. Therefore, Russia possesses a competitive advantage in this region as compared with other main wheat-exporting countries, such as Australia, Canada, the US or the European Union, and Russian exporters have a larger price-setting scope. In contrast to the Black Sea neighboring states, however, Russia does not have a competitive advantage in countries bordering the Mediterranean Sea or Indian Ocean.

Apart from Northern African and Western Asia, we find evidence for PTM behavior in EU member states, namely Austria, Cyprus, Greece, Italy, and Spain. However, regarding the EU members we only observe larger absolute values for the ERT elasticities of the top 5 exporters for Cyprus and Spain. Furthermore, our estimation results suggest Russian price discrimination in some Sub-Saharan African countries. These are Mozambique, Nigeria, South Africa, and Tanzania. SSA is a growing market and wheat import demand is pushed by urbanization and income growth (Shiferaw et al., 2013). Russian wheat exports to SSA states were rather concentrated with an average market share of the top 5 exporters of 76.6% in Mozambique, 67.3% in Nigeria, 69.6% South Africa, and 79.9% in Tanzania. The estimated response of the top 5 exporters to exchange rate fluctuations is stronger than those of all firms together, in accordance with Berman et al. (2012). Moreover, we find strong evidence for PTM behavior in Mongolia and North Korea. Regarding Mongolia, competition is again limited by geography. As a landlocked state Mongolia is not well integrated into international markets and Russia, bordering Mongolia, is a major supplier of wheat to Mongolia.

Beside the ERT elasticities, Table 5.6 comprises the estimation results for the country fixed effects. Most country fixed effects are not significantly different from zero; hence, our estimation results suggest that Russian wheat export prices are similar to those paid by Israel, as Israel's country effect was set equal to zero. We decided for Israel as reference country as we did not suspect Russian market power in Israel as Israel is well integrated into international wheat markets, and Russian wheat was not a major source of Israeli wheat imports. We find, among others, significantly negative country effects for some European Union member states, namely for Cyprus, Greece, and Italy. In contrast, country effects are significantly positive for Armenia, North Korea, Mongolia, Nigeria, and Tanzania. Significantly negative (positive) ERT elasticities can be interpreted as deviations from perfect competition as they imply lower (higher) prices paid by different importers. However, this interpretation is only valid if all importers demand the same quality of wheat as different qualities are associated with different prices. Hence, if quality matters different prices are not suggestive of market imperfections. Regarding wheat, different properties are required depending on the final product; such as bread, pasta or animal feed. We did not have any information regarding the quality of wheat exported to the different countries. Hence, the interpretation of the country fixed effects was not straightforward.

Table 5.7 shows the estimates for the time dummies. There are significant differences among time dummies reflecting overall global price trends. Time dummies are supposed to mirror market trends and changes in marginal cost that affect all exporters.

Therefore, estimates for the quarterly time dummies should be correlated with Russia's quarterly wheat export price. Indeed, we find a strong correlation between our estimates for the time dummies and Russian wheat export prices. The correlation coefficient between Russia's quarterly average export price and the quarterly time dummy is equal to 0.99, 0.98, and 0.99 for the estimates including all firms, the top 5 exporters, and the top 6–10 exporters, respectively. These strong correlations argue for a good specification of our econometric model.

5.6 CONCLUSION

Russia is a major wheat exporter on a global scale, and particularly in its main export markets in Northern Africa and Western Asia. Several wheat-importing developing countries rely on Russian wheat to meet their dietary needs. Among these export destinations are the Caucasian

Table 5.7: Estimation results for the time dummies

TD	All firms	Top 5	Top 6–10	TD	All firms	Top 5	Top 6–10
Q 2	0.050*** [2.80]	0.076*** [3.44]	-0.025 [-0.90]	**Q 16**	0.264*** [8.41]	0.240*** [5.07]	0.202*** [4.39]
Q 3	0.058** [2.40]	0.071* [1.95]	-0.007 [-0.26]	**Q 17**	0.315*** [9.97]	0.321*** [6.48]	0.259*** [5.51]
Q 4	0.247*** [11.51]	0.249*** [8.57]	0.200*** [6.28]	**Q 18**	0.284*** [8.41]	0.277*** [5.59]	0.220*** [4.89]
Q 5	0.314*** [11.37]	0.305*** [7.25]	0.233*** [4.74]	**Q 19**	0.410*** [11.16]	0.383*** [6.79]	0.316*** [5.69]
Q 6	0.329*** [13.32]	0.330*** [9.07]	0.249*** [5.18]	**Q 22**	0.639*** [19.33]	0.639*** [12.07]	0.523*** [10.21]
Q 7	0.601*** [20.47]	0.607*** [13.21]	0.535*** [8.78]	**Q 23**	0.697*** [21.96]	0.685*** [13.40]	0.594*** [12.99]
Q 8	0.703*** [24.24]	0.705*** [16.06]	0.636*** [13.41]	**Q 24**	0.757*** [23.87]	0.745*** [15.90]	0.727*** [14.46]
Q 9	0.778*** [28.37]	0.743*** [15.80]	0.745*** [12.93]	**Q 25**	0.789*** [26.90]	0.776*** [18.44]	0.724*** [15.52]
Q 10	0.675*** [9.77]	0.551*** [9.97]	0.787*** [9.63]	**Q 26**	0.917*** [33.01]	0.913*** [22.50]	0.824*** [18.42]
Q 11	0.592*** [20.22]	0.588*** [13.36]	0.543*** [11.38]	**Q 27**	1.026*** [33.67]	1.007*** [25.43]	0.969*** [20.16]
Q 12	0.470*** [16.55]	0.470*** [11.23]	0.362*** [6.88]	**Q 28**	1.033*** [27.77]	1.042*** [21.88]	0.962*** [18.07]
Q 13	0.485*** [11.26]	0.462*** [6.73]	0.358*** [7.06]	**Q 29**	0.984*** [28.82]	0.975*** [19.43]	0.921*** [16.62]
Q 14	0.393*** [13.75]	0.371*** [8.81]	0.295*** [5.95]	**Q 30**	0.791*** [29.43]	0.777*** [20.61]	0.722*** [16.04]
Q 15	0.321*** [10.09]	0.293*** [6.36]	0.244*** [5.33]	**Q 31**	0.868*** [31.66]	0.854*** [22.06]	0.786*** [16.99]
Q 32	0.972*** [32.66]	0.951*** [21.02]	0.909*** [19.58]	**Q 34**	0.830*** [29.26]	0.811*** [19.47]	0.798*** [17.65]
Q 33	1.012*** [33.45]	1.009*** [22.73]	0.946*** [20.06]	**Q 35**	1.193*** [38.70]	1.152*** [21.83]	1.165*** [21.16]

Note: Q abbreviates quarter, TD time dummies. Values in brackets are t-statistics.
*** and ** indicate the 1% and 5% level of significance, respectively.

Source: Own computations using Stata version 14.2 statistical software (StataCorp, 2015) states Armenia, Azerbaijan and Georgia and the North African countries Egypt and Libya with high per capita imports from Russia.

Given Russia's dominant market position in some export markets and the relevance of wheat for food security, we study Russian price-setting behavior by means of Krugman's PTM approach. The PTM approach is a standard method in international trade to detect spatial price discrimination. We apply a firm-level data set comprising Russian wheat export activities during the years 2006–14. We estimate Russian pricing behavior for three different firm groups, following the argument of Berman et al. (2012) that the extent of price discrimination following an exchange rate shock depends on firm size.

Our estimation results suggest that Russia behaves competitively in most export markets. However, we find evidence for Russian PTM behavior in some of Russia's main export markets. The finding of market imperfections in Russia's main export markets correspond with economic theory stating that market power increases with a seller's market share. These main export markets are Egypt, Turkey, as well as the Caucasian states Azerbaijan and Armenia. Furthermore, our results suggest that geography matters in international wheat trade as our results point to price discrimination in Black Sea neighboring countries as well as in landlocked Mongolia, bordering Russia. Furthermore, our estimation results suggest market imperfections in SSA and some European states.

Our estimation results largely confirm the finding of Berman et al. (2012) that PTM is firm-specific as our estimation results show larger ERT elasticities in absolute values for the top 5 exporters as compared with all exporters and the top 6–10 exporting firms. This finding is particularly evident for Russia's main export markets in North Africa and Western Asia as well as for Sub-Saharan African states.

To conclude, our estimation results, based on daily firm-level data, point to market imperfections in some export markets. However, the PTM approach does not allow any quantification of market power. Further analyses are therefore needed. This is particularly true for Armenia where we find strong evidence of Russian price discrimination and that is particularly dependent on Russian wheat exports.

6 DOES RUSSIA EXERCISE MARKET POWER IN WHEAT EXPORTS TO EGYPT AND TURKEY?

EMPIRICAL EVIDENCE FROM A RESIDUAL DEMAND ELASTICITY ANALYSIS[7]

7 This chapter is based on the paper "Russian market power in international wheat exports: Evidence from a residual demand elasticity analysis" by Uhl, Kerstin M., Oleksandr Perekhozhuk, and Thomas Glauben published in the *Journal of Agricultural & Food Industrial Organization 17*(2), 2019: 1-13.

6.1 BACKGROUND AND MOTIVATION

Recent years have witnessed unstable food commodity prices in international markets (see Wright, 2011). Notably, prices of staple foods, such as wheat, maize, and rice, were subject to significant increases and fluctuations. The price index comprising monthly average world market prices of wheat, rice, maize and soybean soared by 226% from January 2002 until June 2008, and by 70% from June 2010 until March 2011 (Trostle et al., 2011). In more detail, prices of wheat rose by 127%, of maize even by almost 300% and of rice by 170% from January 2005 until the price peak in June 2008 (Mitchell, 2008). The FAO Cereals Price Index, comprising price information on wheat, maize and rice, shows that cereal prices have been persistently higher since 2006 with price peaks in 2006/07 and 2010/11. After the 2011 price peak, cereal prices have been declining, yet remaining substantially above the pre-2006 price level. Abbott et al. (2011) point out that the price elasticity of demand for staple foods has been lower in recent years than previously contributing to price volatility. A less price-responsive demand might enable exporters to better exploit a dominant market position since the Lerner index as a measure for the exertion of market power is a function of the price elasticity of demand. In Chapter 4, we argue that prices of staple foods are less price-responsive in years of scarcity. This implies that the issue of market power is particularly relevant in periods of scarcity and high prices. Wheat exporters exercising market power may contribute to rising and volatile prices and hence jeopardize food security in the developing world (see Chapter 4).

Oligopolistic market structures are a source of market power, and the global wheat market is undoubtedly supplied by a few exporting nations (see Chapters 2.3 and 3). Competition among these states is restricted by geography as wheat belongs to the category of bulky products that always involve substantial transportation costs when traded. Geographic proximity hence might imply pricing power. Russia entered the global wheat market at the beginning of the 2000 and since then has established itself as a major wheat exporter. Today, Russia possesses a dominant position in several wheat-importing countries in the MENA region (see also Chapter 5.2). In Chapter 4.3, we describe the Russian wheat export market for the period 1998 to 2011 and observe a steady process of concentration in Russian wheat exports. While, in 2003, the ten largest Russian wheat-exporting firms exported less than 40% of all Russian wheat, in 2011, they controlled roughly 70% of Russia's wheat exports. Our calculations for the years 2011 to 2014, based on our firm-level data set provided by APK-Inform, show that the concentration of the Russian wheat export market, as measured by the ten-firm concentration ratio, declined between 2011 and 2014, yet remaining above the concentration level of 2006. This process of concentration further has nurtured concerns about a dominant market position and the assumed mark-up pricing by Russian exporters.

The emergence of Russia in international wheat markets has encouraged research regarding Russia's pricing behavior. Please see Chapter 3.5.1.3 for more details on the PTM studies described in the next paragraphs and Chapter 3.5.2 for details on the respective RDE studies on Russian market power in international wheat trade.

Pall et al. (2013) are the first to conduct a study in this field. They analyze the Russian pricing behavior in international wheat trade with a PTM study considering 25 destination countries and estimate the model for three different periods, namely the entire data period from January 2002 to February 2010, the time before the imposition of Russia's export tax on wheat exports (January 2002 to March 2007) and the time period after the export tax imposition (March 2008 to February 2010). According to their results, Russia behaves less competitively after the export tax than before. The estimation results indicate price discrimination by Russia in five to seven out of 25 export markets for the entire period in dependence on the econometric specification. More precisely, based on a model specification considering nominal exchange rate shocks, evidence for Russian price discrimination is found in Algeria, Azerbaijan, Cyprus, India and Mongolia.[8]

8 The PTM approach infers market imperfections from price discrimination. See McAfee et al. (2006) and Levine (2002) for a discussion about the relationship between price discrimination and market power.

A more recent PTM study by Gafarova et al. (2015) on Kazakh, Russian and Ukrainian pricing behavior is based on aggregated data covering the period 1996–2012. Their results provide evidence for Russian pricing-to-market behavior in 20 out of 71 destination markets. Pall et al. (2014) apply the RDE approach to Russian wheat exports. Please see Chapters 3.4 and 3.5 for more information on the RDE method. Pall et al. (2014) estimate Russia's inverse residual demand elasticity for eight export markets for the period 2002 to 2009 and find support for Russian market power in Albania, Georgia and Greece. Moreover, applying an IVP-PML estimator, their estimation results suggest a perfectly competitive behavior in Azerbaijan, Egypt, Lebanon, Mongolia and Syria.

In her doctoral thesis, Gafarova (2018) provides a RDE study on Russian market power in wheat exports to the Caucasian states. Her estimation results suggest Russian market power in Armenia and Georgia while estimation results are insignificant for Azerbaijan.

To sum up, previous research targeting the Russian pricing behavior in international wheat trade confirms the presence of price discrimination and market power in several destination markets. Yet, these different econometric studies find evidence for market imperfections for distinct export markets. Hence, the question whether Russia possesses market power in its main export markets remains open and deserves further analysis and discussion. Generally, information about the competitive situation in the world wheat market is useful for policy makers in countries which are heavily depending on wheat imports, possibly inducing a strategic realignment of national food policies. Information about the pricing behavior of wheat exporters is particularly relevant for an importing country that heavily depends on one supplier. Therefore, the aim of this chapter is firstly to test for and secondly to quantify the exertion of market power by Russia in Egypt and Turkey, the two most important Russian export markets for wheat. Russia is the most important trading partner for wheat for Egypt and Turkey with a market share of about 34 percent in Egypt and about 52 percent in Turkey (average 2006–14). To arrive at these aims, we apply the RDE approach to Russian wheat export data covering the time period January 1, 2006 to December 31, 2014. As compared to the RDE study of Pall et al. (2014), the main advantage of our study is the application of weekly data while the estimates of Pall et al. (2014) rely on quarterly data. In doing so, our estimation results are based on 363 observations for Egypt and 342 observations for Turkey in contrast to only 29 observations for Egypt in the study by Pall et al. (2014). Consequently, we expect more precise estimation results. Furthermore, our data period covers both wheat price spikes in 2007/08 and 2010/11. Moreover, to our knowledge, we provide the first empirical evidence on Russian market power in wheat exports to Turkey.

The rest of this chapter is organized as follows. In the next subchapter, we present a rough outline of the Russian wheat export market to better understand the choice of the export markets considered in our estimation. Subchapters 6.3 and 6.4 describe the RDE approach and our data set, respectively. In Section 6.5, we present the econometric model and discuss our estimation results. Finally, Subchapter 6.6 provides concluding remarks.

6.2 RUSSIAN WHEAT EXPORTS

This subsection provides relevant information on Russian wheat exports for the period 2006–14 which is the data period in this econometric study. In particular, we describe export restrictions applying to Russia's wheat export sector as the instrument applied in the econometric estimation of this chapter are based on Russian wheat export restrictions in our data period.

Russia is one of the top wheat exporters worldwide. Expressed in figures, Russia's average annual export volume amounted to 14.9 MMT (average of the marketing years 2005/06 to 2014/15) or contributed to 10.7% of global wheat exports; a market share, however, that varied between 3.0% in 2010/11 and 14.1% in 2014/15 (according to USDA data). Russia's export volume is strongly affected by trade policy. During our data period, Russian wheat exports were subject to several restrictions of which Table 6.1 gives a detailed overview.

Table 6.1: Restrictions of Russian wheat export activities, 2006–14

Type of export restriction	Period of restriction	Tax rate
Export tax [a)]	12.11.2007–28.01.2008	10% from the customs value but not less than 22 euro per t
Export tax [b)]	29.01.2008–30.06.2008	40% from the customs value but not less than 105 euro per t
Export ban [c)]	15.03.2008–30.04.2008	–
Export ban [d)]	15.08.2010–31.12.2010	–
Export ban [e)]	02.01.2011–10.06.2011	–

Note: The export ban established by resolution № 74 bans wheat exports to members of the Customs Union while the export bans established by resolution № 559 and resolution № 853 apply to exports to all countries.

Source: **a)** The Resolution of the Government of the Russian Federation dated October 10, 2007 № 660 "On Approval of Export Custom Tariffs on Wheat, Meslin, and Barley exported from the Territories of the Russian Federation and Members of the Custom's Union Agreement"; **b)** The Resolution of the Government of the Russian Federation dated October 28, 2007 № 934 "On amendments to the resolution of the government of the Russian Federation № 660 of October 10, 2007 concerning approval of export customs tariff on wheat and meslin" and the Resolution of the Government of the Russian Federation dated March 3, 2008 № 225 "On the extension of the export duties on wheat, barley and meslin". **c)** The Resolution of the Government of the Russian Federation dated February 10, 2008 № 74 "On the introduction of a temporary ban on the export of wheat and meslin, exported from the territory of the Russian Federation in the state – participants of the Customs Union"; **d)** The Resolution of the Government of the Russian Federation dated August 5, 2010 № 559 "On the introduction of a temporary ban on the export of wheat and meslin, exported from the territory of the Russian Federation"; **e)** The Resolution of the Government of the Russian Federation dated June 10, 2011 № 853 "On the introduction of a temporary ban on the export of certain types of agricultural products from the territory of the Russian Federation". Taken from Uhl et al. (2019).

The Government of the Russian Federation implemented a tax on wheat exports at the end of 2007. From November 12, 2007 until June 30, 2008, the export tax rate was set at 10% from the customs value but not less than 22 euro per ton. However, on January 29, 2008, the Russian government adopted a new resolution of approval of export duty rates for wheat and meslin. According to this resolution, the export tax rate was raised to 40% from the customs value but should not be less than 105 euro per ton. This implies that the export tax is a quantity tax if and only if the export price is not higher than 220 euro per ton in the first period of restriction and 265.5 euro per ton in the second period of restriction, respectively. Otherwise, the tax is an ad valorem tax with a tax rate of 10% or 40%, respectively. Moreover, the Government of the Russian Federation banned wheat exports three times between 2008 and 2011, namely in 2008, 2010 and 2011.

Table 6.2: Russia's market share in selected import markets

Destination country	Market share (average 2006–14, in %)
Armenia	87.24
Azerbaijan	42.12
Egypt	34.13
Georgia	65.56
Jordan	34.83
Lebanon	43.88
Turkey	52.40
Yemen	20.23

Source: Taken from Uhl et al. (2019). Table is based on import data provided by UN Comtrade.

In total, Russia exported wheat to 109 different countries in the period 2006 to 2014.[9] Besides Russia's relevance in global wheat trade, the interest in Russian wheat export pricing is due to its regional importance in the MENA region as well as in the Caucasus. Russia accounts for a large portion of total wheat imports of several MENA and Caucasian countries. Russia's market share in the period 2006–2014 is documented in Table 6.2 for selected destination markets. Table 6.2 indicates the high dependency of several destination countries on Russian wheat exports.

Due to this dependency the analysis of the pricing behavior of Russia is of major interest for these countries. Among Russia's export destinations, trade statistics report that wheat exports to Egypt and Turkey take an outstanding position in terms of export quantity. Figure 6.1 depicts the share of wheat exports to Egypt and Turkey between 2006 and 2014, and shows that exports to Egypt and Turkey accounted for up to half of total Russian wheat exports.

Table 6.3 illustrates the importance of the Egyptian and Turkish market for Russian exporters. 40% of Russian wheat exports in 2006–14 were destined for Egypt and Turkey, while the third important export destination, Yemen, imported less than 4% of Russian wheat exports. Against the

9 The regions Abkhazia and South Ossetia are recognized as independent countries by Russia.

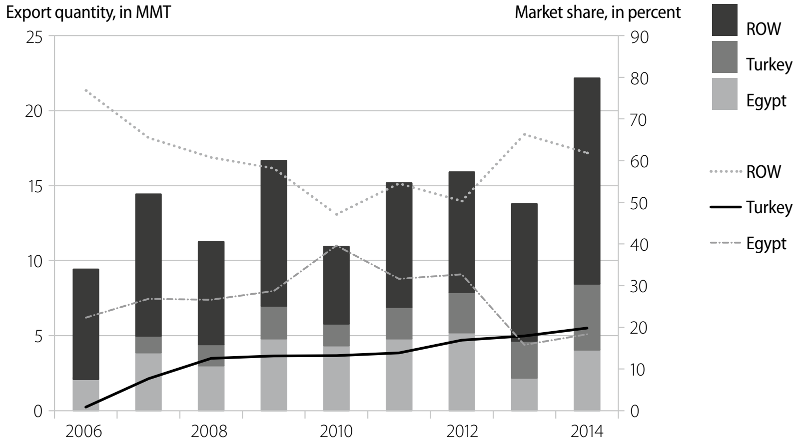

Figure 6.1: Russian wheat export destinations, 2006–14

Note: ROW abbreviates Rest of the World. Lines reflect market shares and bars export quantities.

Source: Taken from Uhl et al. (2019). Figure is based on data provided by APK-Inform.

Table 6.3: Russia's top five export destinations

Destination country	Share in Russian wheat exports (average 2006–14, in %)
Egypt	26.47
Turkey	13.80
Yemen	3.91
Azerbaijan	3.55
Iran	3.51

Source: Taken from Uhl et al. (2019). Table is based on data provided by APK-Inform.

background of this ranking and the fact that both countries depend on wheat imports from Russia, we focus our analysis on Egypt and Turkey.

Figures 6.2 and 6.3 demonstrate the development of total wheat exports to Egypt and Turkey, respectively, as well as the market share of the source countries. Figure 6.4, depicting the trends of Russian wheat exports to Egypt and Turkey over the investigation period, reveal that

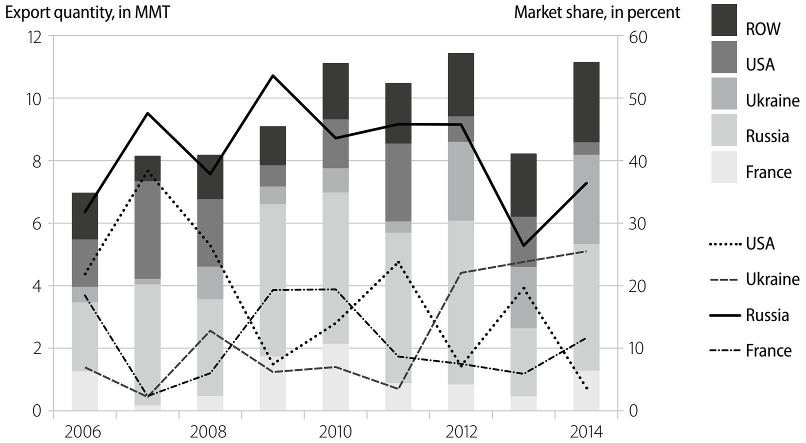

Figure 6.2: Total wheat exports to Egypt, 2006–14

Notes: ROW abbreviates Rest of the World. Lines reflect market shares and bars export quantities.

Source: Taken from Uhl et al. (2019). Figure is based on data provided by UN Comtrade.

both trends are positive, yet, Turkish wheat imports from Russia have been increasing more sharply. However, there is no clear trend regarding Russian wheat exports to Egypt within our data period. Figure 6.2 shows that Russia's share in Egyptian wheat imports varied between about 30% and 50% in our data period. Note that while Russia is the top exporter of wheat to Egypt; France, Ukraine and the US have substantial market shares as well. In contrast to Egypt, wheat exports to Turkey have been increasing sharply in recent years. A fact that resulted from Turkey's soaring wheat import demand which could be satisfied by Russian wheat as the wheat quantity imported from other countries remained stable. Two numbers may round off this picture: in 2006, Russia exported 81,133 metric tons of wheat to Turkey, as compared to 4,387,749 metric tons in 2014. Indeed, a tremendous rise in Russian wheat exports to Turkey by more than 5,000%. Owing to this development, today, the Turkish market is as important as the Egyptian market for Russian wheat exporters in terms of wheat export volume (see Figure 6.4).

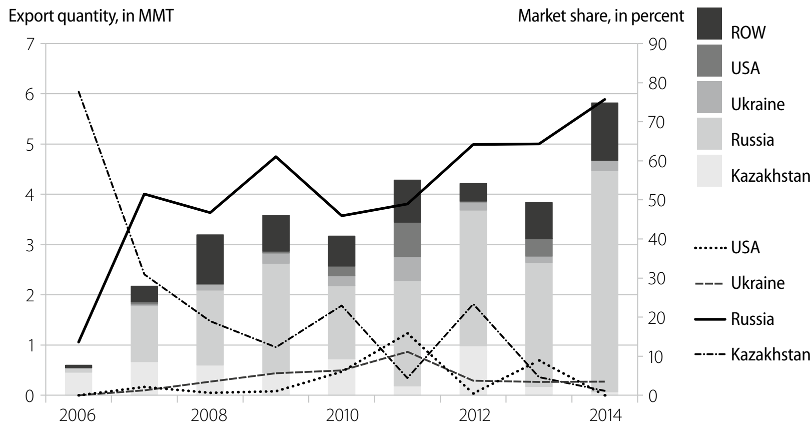

Figure 6.3: Total wheat export to Turkey, 2006–14

Notes: ROW abbreviates Rest of the World. Lines reflect market shares and bars export quantities.

Source: Taken from Uhl et al. (2019). Figure is based on data provided by UN Comtrade.

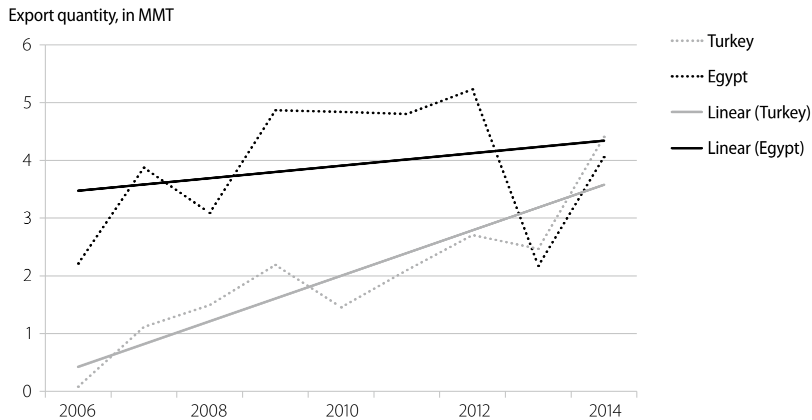

Figure 6.4: Russian wheat exports to Egypt and Turkey, 2006–14

Note: The two lines are linear trends.

Source: Taken from Uhl et al. (2019). Figure is based on data published by UN Comtrade.

6.3 THE THEORETICAL FRAMEWORK

Our analysis is based on the RDE approach which was first introduced by Baker and Bresnahan (1988) and then popularized by Goldberg and Knetter (1999) with a prominent empirical application to international markets. Since then, there have been several agricultural market applications of the RDE model (see Chapter 3.5.2).

The chief advantage of the RDE method lies in its ability to disclose a seller's degree of market power by estimating a single equation, namely its residual demand curve. In this context, the term 'residual demand' means the demand a seller is facing taking into account the supply responses of all competitors. If a seller's residual demand curve is downward sloping, then the seller is not a price taker but can influence the price by choosing its quantity. Thus, the seller faces an imperfectly elastic residual demand and, consequently, possesses market power. Since the RDE methodology does not require the estimation of own- and cross-price elasticities of demand, the extent of market power can therefore be estimated with moderate data requirements. Another advantage of this approach as compared to the widely applied PTM approach is that the RDE method is based on an oligopoly model considering competitors' costs while the PTM model only assumes a simple monopoly model ignoring strategic interactions. In the following, we provide a formalization of the RDE method for the case of two exporting firms competing in the same export destination. The theoretical model is based on Baker and Bresnahan (1988).

Consider two exporting countries ($k = 1, 2$) that compete in a destination market. Exporter 1 is Russia, our exporter of interest, and exporter 2 is a competitor of Russia, for instance the US. Let P_k and Q_k be the export price and export quantity of competitor k, and Z be a vector of demand shifters in the destination market, for example income. The export price is expressed in the importing country's currency. Both exporters face inverse residual demand curves:

$$P_1 = P^1(Q_1, Q_2, Z) \tag{6.1}$$

and

$$P_2 = P^2(Q_2, Q_1, Z) \tag{6.2}$$

Let e_k be the exchange rate between the importing country and exporter k. C^k is competitor k's cost function, W_k a vector of k's cost shifters and W is a vector of cost shifters relevant for all exporters. Both exporters seek to maximize their profit and they face the profit maximization problem as formalized in equation (6.3) exemplary for exporter 1 with the corresponding first-order condition of the profit maximization problem for exporter 1 in (6.4).

$$max_{Q_1} \Pi_1 = Q_1 * P^1(Q_1, Q_2, Z) - e_1 * C^1(Q_1, W_1, W) \tag{6.3}$$

$$P_1 + Q_1 * [\partial P^1/\partial Q_1 + (\partial P^1/\partial Q_2) * (\partial Q^2/\partial Q_1)] - e_1 * MC^1 = 0 \tag{6.4}$$

The term in square brackets is the conduct parameter and represents exporter 1's conjectures about the change in P_1 induced by a change in Q_1, and therefore comprises exporter 1's conjectural variation about exporter 2's response to changes in Q_1. The value of the conduct parameter consists of two effects: a price change induced by a change in the exporter's own quantity as well as the quantity adjustment of the competitor, exporter 2. The profit maximization problem results in the optimality condition stating that marginal revenue (MR) equals marginal cost (MC), thereby determining the supply of the two exporters.

$$MR^1(Q_1, Q_2, Z) = e_1 * MC^1(Q_1, W_1, W) \tag{6.5}$$

$$MR^2(Q_2, Q_1, Z) = e_2 * MC^2(Q_2, W_2, W) \tag{6.6}$$

To derive Russia's RD function, we have to solve the demand function in (6.2) and the expression of (6.6) determining the exporter's supply simultaneously in the next step. In doing so, we receive $Q_2 = Q^2(Q_1, Z, e_2, W_2)$. Substituting this expression in (6.1) yields (6.7), and, after dropping out redundancies, the term of (6.8) with R terming the inverse residual demand.

$$P_1 = P^1(Q_1, Q^2(Q_1, Z, e_2, W_2, W), Z) \tag{6.7}$$

$$P_1 = R(Q_1, e_2, W_2, W, Z) \tag{6.8}$$

The inverse residual demand of Russia in the export market is a function of the following arguments: Russia's wheat export quantity, cost shifters of Russia's competitor in the competitor's currency, cost shifters relevant for all exporters and demand shifters in the destination country. In order to be able to estimate (6.8) we rewrite the equation in its log-linear form, see (6.11) for the estimation equation. The coefficients in the log-linear form are interpreted as elasticities. Our parameter of interest is the inverse RDE in (6.9).

$$\propto_1 = \frac{\partial \ln R}{\partial \ln Q_1} = \frac{\partial R}{\partial Q_1} * \frac{Q_1}{R} \tag{6.9}$$

By estimating the inverse RDE, we determine the joint impact of the change in wheat price induced by Russia's own change in quantity and the quantity adjustment of its rival exporter to Russia's quantity change. This becomes apparent by rewriting (6.9) considering the correspondence between (6.7) and (6.8):

$$\propto_1 = \frac{\partial \ln R}{\partial \ln Q_1} = \frac{\partial R}{\partial Q_1} * \frac{Q_1}{R} = \frac{\partial P^1}{\partial Q_1} * \frac{Q_1}{P_1} + \frac{\partial P^1}{\partial Q_2} * \frac{\partial Q^2}{\partial Q_1} * \frac{Q_1}{P_1} \tag{6.10}$$

6.4 DATA SET DESCRIPTION

To estimate our econometric model, we applied data provided by APK-Inform (2015). The data set comprised daily firm-level data on export quantities and statistical values of Russian wheat exporters for the period from January 2006 to December 2014.

Table 6.4 presents the descriptive statistics of the variables included in our econometric model. Please note that the descriptive statistics are based on weekly data.

Since the data set however did not contain information about costs of Russia's wheat exporters, we were not able to estimate the RDEs of single wheat-exporting firms. Therefore, we had to aggregate our firm-level data to a weekly frequency. Before doing so, we eliminated seed exports because seed is typically higher-priced than non-seed wheat exports. In this step, we deleted 40 firm-level observations in case of Egypt and 46 firm-level observations in case of Turkey. Additionally, we also dropped exports of other grains than wheat from our data set.

The cost shifters included exchange rates, wheat producer or export prices of rival exporting countries as well as the oil price. The choice of exchange rates as cost shifters in international trade applications was first proposed by Goldberg and Knetter (1999) and is now standard in RDE applications to agricultural export markets (see Glauben and Loy, 2003; Pall et al., 2014 and Reed and Saghaian, 2004). Weekly exchange rate data was extracted from OANDA Forex Trading and Exchange Rates Services, and the euro-dollar weekly exchange rate data was retrieved from the website of the Federal Reserve Bank of St. Louis (see Board of Governors of the Federal Reserve System (US), 2017). US and French wheat FOB prices in USD and euro per ton, respectively, were collected from the Agriculture & Horticulture Development Board (AHDB) website.

Ukrainian wheat producer prices (EXW, UAH per ton) were provided by APK-Inform (see APK-Inform, 2015). The Kazakh wheat producer price (average selling price in Kazakhstani tenge per ton) was extracted from statistical yearbooks published by the Agency of Statistics of the Republic Kazakhstan (see ASRK). Regional wheat producer prices, which we used as an instrumental variable, covered each Russian federal district, and were provided by the Russian Grain Union. Furthermore, we used weekly oil prices (Europe Brent spot price FOB, USD per barrel) that were published by the US Energy Information Administration (EIA).

Demand shifters of our econometric model included the Consumer Price Indices (CPI) for food items and real GDP per capita of the importing

Table 6.4: Descriptive statistics of variables

Variable	Egypt			Turkey		
	Mean	Min	Max	Mean	Min	Max
EUV	1,318.3	601.5	2,273.0	390.1	204.2	633.2
EQ	92,129.9	2,389.5	460,732.5	51,815.9	998.0	210,335.5
Real GDP	70.1	55.7	82.7	15.7	12.8	19.3
CPI food	101.1	96.5	106.4	100.9	95.6	105.2
ER EUR	8.0	6.8	9.7			
ER USD	6.0	5.3	7.1	1.7	1.2	2.3
ER UAH	0.8	0.4	1.1	0.2	0.1	0.3
ER KZT				0.011	0.009	0.015
EP FRA	183.9	104.8	301.8			
EP USA	241.7	134.2	433.5	251.4	160.5	424.3
PP UKR	1,517.8	690.0	3,300.0	1,645.6	815.0	3,300.0
PP KAZ				24,403.3	11,868.4	34,326.0
Oil price	99.9	84.8	122.2	99.9	84.8	122.2
Ban KAZ				0.02	0	1

Notes: **EUV** abbreviates export unit value, expressed in the importing country's currency. **EQ** terms export quantity, expressed in metric tons. **ER EUR**, **ER USD**, **ER UAH** and **ER KZT** are destination-specific exchange rates per euro, United States dollar, Ukrainian hryvna, and Kazakhstani tenge, respectively. **EP FRA** and **EP USA** denote French and US wheat export prices, respectively. **PP UKR** and **PP KAZ** are Ukrainian and Kazakh wheat producer prices. **Real GDP** is the real Gross Domestic Product per capita of the destination country, expressed in the importing country's currency, and **CPI food** denotes the Consumer Price Index for food items of the importer. The **oil price** is expressed as an index. **Ban KAZ** is a dummy variable capturing the Kazakh wheat export ban that was in force between April 27, 2008 and September 1, 2008.

Source: Taken from Uhl et al. (2019)

countries Egypt and Turkey. The selection of the demand shifters was similar to that of Pall et al. (2014). We applied the CPIs for food data published by FAOSTAT. Since information on the real GDPs per capita was not available, we generated the necessary data from downloadable records of nominal GDPs, GDP deflators and population data from the World Development Indicators Database from the World Bank. Data on GDPs and CPIs for food products were not available at weekly frequency. Therefore, we had to interpolate real GDPs per capita as well as the CPIs for food items.

6.5 THE ECONOMETRIC MODEL AND ESTIMATION RESULTS

The RDE model was estimated in its log-linear form on the basis of the theoretical equation in (6.8).

$$\ln P_t^{RUS} = Cons + \alpha \ln Q_t^{RUS} + \beta \ln Z_t^{IMP} + \gamma \ln e_t^{COM} + \delta \ln PP_t^{COM} + \vartheta BAN_t^{COM} + \varphi \ln OIL_t + \omega\, MONTH_t + \varepsilon_t \tag{6.11}$$

P_t^{RUS} and Q_t^{RUS} are the Russian wheat export price and export quantity in period t, respectively, Z_t^{IMP} is a vector of demand shifters in the importing country (CPI for food items and the real GDP per capita), and $Cons$ abbreviates the constant term. e_t^{COM} is a vector of exchange rates of Russia's competitors in Egypt and Turkey, i.e. France, Ukraine and the United States in the Egyptian market and Kazakhstan, Ukraine and the USA in Turkey. The competing wheat-exporting countries were selected on the basis of their market shares in Egypt and Turkey. Table 6.5 gives an overview of the main wheat exporters to Egypt and Turkey over the period 2006 to 2014.

PP_t^{COM} is a vector of producer and export prices of the set of rival exporting countries, OIL_t denotes the oil price, $MONTH_t$ is a vector of

Table 6.5: Exporters' (Competitors') market share, 2006–14

Destination country	Exporter/Competitor	Market share (in %)
Egypt	Russia	34.13
	United States	19.70
	France	11.36
	Ukraine	7.90
Turkey	Russia	52.40
	Kazakhstan	19.04
	United States	5.54
	Ukraine	3.95

Source: Taken from Uhl et al. (2019). Table is based on import data provided by UN Comtrade.

dummy variables for the months February to December, and BAN_t^{COM} is a dummy variable capturing Kazakh export restrictions. ε_t is the error term and α, ϑ and φ are parameters, and β, γ, δ are vectors of parameters to be estimated. As we seek to determine the inverse RDE, our parameter of interest is α.

Russia's wheat export quantity and export price were determined simultaneously. Therefore, the export quantity needed to be instrumented. The instrument has to satisfy two properties. Firstly, it has to be relevant, that is, sufficiently correlated with the instrument, here Russia's export quantity. Secondly, it has to be valid, i.e., orthogonal to the error term. Consequently, a valid instrument for Russia's wheat export quantity should not have a direct impact on the export price, but an indirect by affecting the export quantity. Goldberg and Knetter (1999) propose cost shifters of the exporter of interest that are irrelevant for other suppliers as instrument for the quantity variable. W_1, the vector of Russia's cost shifters, does not appear in (6.8), the theoretical equation, and are therefore valid instruments for Russia's export quantity. Russia's export tax is a valid and relevant instrument for Russia's export quantity for both, ad valorem tax and quantity tax. As a quantity tax shifts marginal cost, the export tax is a valid instrument. The validity of an ad valorem tax can be justified in a very similar way. The key point is that the introduction of the ad valorem export tax results in a shift of the supply curve of Russian wheat exporters to the left as output of Russian exporters are shrinking while demand for Russian wheat remains unaffected. These cost shifters are also relevant instruments because they affect Russia's export quantity by the FOC in (6.5). Consequently, cost shifters that are relevant exclusively for Russian exporters are theory-consistent instruments for Russia's export quantity. Therefore, we selected Russian cost shifters as instruments in our model.

Russian wheat export restrictions were specified as an instrumental variable for Egypt and Turkey. See Table 6.1 in Section 6.2 for an overview of all Russian restrictions on wheat exports. In the analysis, these restrictions were captured by a variable that was equal to the export tax, i.e. the export price multiplied by 0.10 (0.40) in the first (second) period of restriction or 22 (105) euro converted to the USD if the export price is not

Table 6.6: Validity and relevance of the excluded instruments

	Egypt	Turkey
Excluded instruments	Russian wheat export tax	Russian wheat export tax Russian wheat producer price (Central Federal District)
F-test	11.04 [0.0000]	14.32 [0.0000]
Hansen's J statistic	–	0.095416 [0.7574]

Notes: Numbers in square brackets are p-values. As we applied only one instrument in case of Egypt, Hansen's J statistic could not be calculated.

Source: Taken from Uhl et al. (2019)

more than 220 (265.5) euro per ton, and 0 if no tax is imposed. The export ban was not reflected in the instrumental variable since there were no observations for the time of the export ban. The instrumental variable specifying Russia's wheat export tax is a relevant instrument for Egypt as proved by the results of the F-test of the joint significance in the first-stage regression (see Table 6.6). For Turkey, we additionally selected a second instrument, namely the Russian wheat producer price for one of the main wheat-producing areas of Russia for the export market, the Central Federal District. The selection of the instrumental variables for Turkey is in line with the F-test result of the joint significance in the first-stage regression and Hansen's J statistic. Please note that Hansen's J statistic could not be calculated for Egypt as there were no overidentifying restrictions.

We applied a GMM estimator to estimate the econometric model of (6.11) because of the endogeneity problem described above and since we were suspicious of heteroscedastic error terms.

The estimation results for Egypt and Turkey are listed in Table 6.8. Theory predicts a negative sign of the export quantity coefficient, implying a negative slope of the residual demand curve. For both export destinations, the estimated coefficient is negative, more precisely significant for Turkey, but insignificantly negative and small for Egypt. Thus, the estimation result indicates that Russia exhibits market power in Turkey but not in Egypt. This finding is consistent with our a priori expectations for the following reason: In Section 6.2 we discuss trends in the Egyptian and Turkish wheat import market. Russia has been dominating Turkish imports in recent years with other exporting countries accounting only for minor market shares. In contrast, the Egyptian wheat import market is not characterized by one dominant exporter. This fact has two important implications for the interpretation of our estimation results. First, in an oligopolistic market, a measure for the exertion of market power is the Lerner index for an entire industry that is equal to

$$L = \frac{P - MC}{P} = \frac{HHI}{|\varepsilon|} \tag{6.12}$$

ε is the industry's price elasticity of demand and HHI is the Herfindahl-Hirschman index, a measure of market concentration. The HHI is defined as the sum of squared market shares of all sellers in the market. Consequently, the monopoly case corresponds to the HHI of 10,000 points while the HHI of a perfectly competitive market is close to zero. The Lerner index is defined as the mark-up over marginal cost and tells us that industry-wide market power increases with increasing market concentration. In the Appendix A.6.1 we show that the Lerner index for an entire industry, as expressed in (6.12), is a special case of our RDE model. Table 6.7 displays the HHI for Egypt and Turkey based on state-level export data. The United States Department of Justice defines the following ranges of market concentration: a market with the HHI between 1,500 and 2,500 points is moderately concentrated while a highly concentrated market is characterized by the HHI above 2,500 points. We expected a higher degree of market power in Turkey than in Egypt. Indeed, the calculated HHI indicates the wheat import market of Egypt to be moderately concentrated but a high degree of market concentration for Turkey. Consequently, our results are in line with theoretical expectations.

Table 6.7: Herfindahl-Hirschman index

	2006	2007	2008	2009	2010	2011	2012	2013	2014	Ø
Egypt	1,992	3,780	2,435	3,381	2,579	2,833	2,753	1,954	2,403	2,343
Turkey	6,256	3,654	2,746	4,026	2,765	2,842	4,690	4,305	5,807	3,675

Source: Taken from Uhl et al. (2019). Calculations are based on state-level export data provided by UN Comtrade.

Second, for a single seller, there is a direct relationship between the inverse RDE and the Lerner index, which is expressed in a Consistent Conjectures Equilibrium (CCE), as outlined by Baker and Bresnahan (1988). CCE means that each seller has correct conjectures about all competitors' responses to its actions (Bresnahan, 1981). In a CCE, the Lerner index is equal to the inverse RDE of seller k, $-\alpha_k$, as can be shown by rearranging (6.4).

$$L = \frac{P_k - e_k * MC^k}{P_k} = -\alpha_k \tag{6.13}$$

One might argue that exporters with minor market shares in the Turkish market would follow the Russian price-setting behavior, so that Russia has consistent conjectures about the behavior of its competitors. Consequently, there is a direct relationship between the estimated inverse RDE and the Lerner index, which is revealed by the estimated mark-up over marginal cost of 13.5%.

Turning to the competitors' cost shifter variables including exchange rates as well as wheat producer and export prices. The sign of these coefficients gives insight into the degree of competition with Russian wheat. However, the exchange rate variables are likely to be correlated as shocks to the Egyptian/Turkish economy affect the exchange rates of the Egyptian pound/Turkish lira against all other currencies. Therefore, we should be careful with the interpretation of the coefficients of the exchange rate variables as standard errors of collinear variables are increased.

Positive coefficients mean that Russia charges higher prices after a cost shock that reduces the competitiveness of other suppliers. This implies that Russian price setting was more restricted before the cost shock. Thus, the positive sign of the estimated coefficient suggests that Russia's price-setting scope is indeed bounded. The positive ERT elasticity implies that Russia sets higher export prices after an appreciation in the competitor's currency. We see that all ERT elasticities reveal a positive sign and, apart from Kazakhstan, are significantly different from zero. This finding suggests that the competitors sell a close substitute to Russian wheat, thereby restricting Russian market power. Furthermore, all producer and export price coefficients have a significantly positive sign with the exception of the US wheat export price in case of Egypt. A positive producer or export price indicates that Russia is able to charge higher prices when costs of the competing country are rising. The coefficient of the oil price variable, a cost shifter that applies to all exporters, is insignificantly different from zero. To conduct a robustness check, we re-estimated our econometric model without the oil price variable. As a result, our estimations are robust to the exclusion of the oil price variable.

As demand shifters of the importing country, we included the real GDP per capita as well as the CPI for food items. The coefficient for real GDP per capita exhibits a significantly positive sign in both importing countries, suggesting that an increase in income boosts demand in wheat. The CPI for food items is negative in both countries. This implies that inflation in food prices leads to a lower demand for wheat, a result that is completely consistent with economic theory. The effect is significant in case of Egypt but insignificant in case of Turkey. Egypt imports wheat for domestic consumption while Turkey uses a substantial share of its wheat imports for processing wheat and exporting the processed products. Therefore, demand for wheat is less sensitive to domestic food price inflation in Turkey.

Table 6.8: Estimation results

Variable	Egypt		Turkey	
EQ	−0.0009	[−0.032]	−0.1350***	[−6.341]
Real GDP	0.2548**	[2.499]	0.3424**	[2.103]
CPI food	−1.0827***	[−3.222]	−0.1385	[−0.227]
ER EUR	0.5867***	[7.020]		
ER USD	0.4835***	[3.461]	0.5680***	[4.118]
ER UAH	0.3767***	[6.859]	0.3693***	[4.001]
ER KZT			0.0456	[0.209]
EP FRA	0.5443***	[9.076]		
EP USA	0.0105	[0.205]	0.4541***	[7.665]
PP UKR	0.4304***	[8.994]	0.4793***	[7.596]
PP KAZ			0.1029**	[2.329]
Oil price	−0.1333	[−1.183]	−0.3361	[−1.502]
Ban KAZ			0.0072	[0.162]
February	0.0014	[0.049]	0.0144	[0.324]
March	−0.0188	[−0.680]	0.0373	[0.801]
April	−0.0694***	[−3.256]	0.0491	[1.087]
May	−0.0700**	[−2.462]	0.0355	[0.692]
June	−0.0676***	[−2.728]	−0.0208	[−0.479]
July	−0.0908***	[−3.962]	0.0780	[1.618]
August	−0.0710*	[−1.801]	0.1522***	[3.105]
September	−0.0444	[−1.165]	0.1427***	[3.068]
October	−0.0236	[−0.774]	0.0876**	[2.106]
November	−0.0228	[−0.770]	0.0782*	[1.942]
December	−0.0122	[−0.448]	0.0806*	[1.872]
Constant	3.7141**	[2.388]	1.9306	[0.641]
Number of observations	363		342	
R-sq.	0.9554		0.8601	
Adj. R-sq.	0.9526		0.8504	

Notes: See Table 6.4 for a detailed description of the model variables. Numbers in brackets are t-statistics.

Source: Taken from Uhl et al. (2019). Estimation results are generated using the statistical software Stata version 14.1 (StataCorp, 2015).

6.6 CONCLUSION

Russia has emerged as a major wheat exporter since the turn of the millennium, and today holds significant market shares in several wheat-importing countries in the MENA region as well as in the Caucasus. Russia's dominance in some wheat import-dependent countries raises the question whether Russia exploits its dominant market position. This concern is particularly relevant in times of high world wheat market prices as market power may contribute to high and volatile prices.

We apply Baker and Bresnahan's (1988) RDE method to Russian wheat exports to Russia's two main destination markets Egypt and Turkey. The RDE approach allows estimating the extent of market power of an exporter by estimating a single equation, the residual demand curve. Moreover, the approach considers cost shifts of all competing exporters as well as demand shifts in the importing country. According to our estimation results, Russia behaves competitively in Egypt and there is Russian mark-up pricing in Turkey with an estimated mark-up of 13.5%. The results conform to our a priori expectations since Russia has been dominating the Turkish wheat import market for the last years. The situation is different with Egypt where there are also other exporting countries with significant market shares in the Egyptian wheat import market, thus limiting Russian market power. The estimation results of this RDE study conform to our findings of our PTM study of Chapter 4. In our PTM study relying on annual data for the years 2002–11, we find evidence for Russian price discrimination in Turkey but none for Russian wheat exports to Egypt.

We want to point out that the presence of Russian market power in Turkey does not necessarily have negative implications for food security in Turkey. While Egypt imports wheat mainly for domestic consumption, Turkish wheat imports are further processed and then re-exported. Therefore, higher wheat export prices for Turkey do not directly affect Turkish consumers.

7 GENERAL CONCLUDING REMARKS AND PERSPECTIVES FOR FUTURE RESEARCH

7.1 SUMMARY OF MAIN FINDINGS

The supply structure of the world wheat market has changed over the last two decades. While the traditional wheat exporters, especially the US, used to dominate world wheat exports, former Soviet Union members, particularly Russia and Ukraine, emerged as significant exporters in the 2000s. In 2016, Russia accounted for a market share in world wheat exports of 13.8% while in the year 2000 Russia had a negligible market share of only 0.4%. In contrast, the share of traditional wheat exporters declined substantially over the same time period.

These statistics suggest that the world wheat market is today more competitive than some decades ago. Early PTM studies examining world wheat trade presume a duopolistic supply structure with the US and Canada as leading exporting nations, and findings suggest that the US and Canada were discriminating wheat export prices in about half of the considered destination markets (see Pick and Carter, 1994). Recent PTM and RDE studies on wheat exports consider these shifts on the supply side, and investigate the pricing behavior of the EU as well as Black Sea wheat-exporting nations. These studies tend to find less evidence for market power than early studies (see Dawson et al. (2017) for a PTM study on EU wheat exports and Pall et al. (2013, 2014) examining Russian wheat exports). Dawson et al. (2017) conclude that PTM behavior by the EU is constrained by competition from the Black Sea wheat exporters.

This doctoral thesis seeks to examine Russian pricing behavior based on firm-level data. To this aim, this thesis entails a descriptive analysis of Russia's wheat export industry. Statistics on Russia's wheat export industry point out high CR of Russian wheat exports to several major export markets. For example, up to 60% of the annual Russian wheat exports to Armenia in 2006–14 were sold by one exporting company. Up to 23% of the annual Russian wheat exports to Egypt, Russia's top export market, were exported by one firm in the same time period. High CR in some of Russia's important wheat export markets suggest that Russian firms might be able to exert market power. As a major wheat supplier to developing and emerging economies, Russia plays today a significant role for regional and global food security. The analysis of Russian pricing behavior in international wheat trade is motivated by Russia's new position in the world wheat market and the high relevance of wheat trade for regional and global food security.

The empirical analyses of this thesis are based on two different approaches: Krugman's PTM approach to identify third-degree price discrimination in international trade and the RDE method to measure market power. This doctoral thesis comprises two PTM studies and one RDE study targeting Russian pricing behavior in world wheat trade. Table 7.1 provides a summary of the estimation results of both PTM studies and the RDE study. PTM results hinge on confidential firm-level data sets provided by APK-Inform for the years 2002–11 and 2006–14, respectively. Beside estimation results aggregated over firms, I provide firm-group-level evidence for the top 5 and top 6–10 exporting firms by destination country. The results of the RDE study are based on aggregated weekly data for the years 2006–14. Thereby, I apply a new instrumental variable based on Russia's export restrictions for wheat.

The estimation results for my PTM studies confirm that Russia behaves competitively in most of its export markets. There is no evidence of PTM behavior in 36 out of 61 Russian wheat export markets for the period 2002–11 relying on annual firm-level data. To ensure parameter stability despite soaring wheat prices during the data period, I estimate the PTM model for two different time periods, for the entire period as well as separately for the period of high world wheat market prices from 2006. The estimation results suggest that Russia amplifies the effect of the exchange rate shock in times of high prices, and thereby contributes to price volatility. Applying daily firm-level data for the years 2006–14, findings suggest competitive pricing behavior in 32 out of 49 destination markets. Furthermore, the estimation results suggest that larger firms exert more PTM than firms with a smaller market share in a particular market. This finding is particularly evident for Russia's main export markets in North Africa and Western Asia as well as for Sub-Saharan African states.

However, the estimation results of this doctoral thesis point out that some countries could not benefit from the more diverse supply structure

Table 7.1: Comparison of my empirical studies

	PTM1	PTM2	RDE
Data period	2002–11	2006–14	2006–14
Data frequency	annual	daily	weekly
No of countries	TP1: 61 TP2: 49	FG1:49 FG2:48 FG3: 20	2
…with evidence of PD/MP	TP1: 25, TP2:14	FG1: 15 FG2: 14 FG3: 6	1
…with evidence of AEE/LCPS	TP1: 12/13 TP2: 9/5	FG1:1/14 FG2: 0/14 FG3: 1/5	–
Implementation of firm-specific behavior	Firm FE	Firm-group specific ERT elasticities	–

Notes: **PTM1** refers to my PTM study of Chapter 4, and **PTM2** is my PTM study presented in Chapter 5.**TP1** is the time period 2002–11, and **TP2** covers the years 2006–11. **FG1** includes all firms, **FG2** comprises the top 5 firms per export market, and **FG2** the corresponding top 10 firms.

of the world wheat market, likely due to their unfavorable geographical location. There is robust evidence of Russian market power in Turkey which is heavily relying on Russian wheat exports. Both PTM studies suggest Russian price discrimination in wheat exports to Turkey. Furthermore, I estimate the mark-up of Russian wheat exports to Turkey by means of the RDE method, and the estimated mark-up over MC is equal to 13.5%. While there is evidence for Russian market power in Turkey, findings for Egypt, Russia's top export destination over the data period 2002–14, are mixed. The estimated ERT elasticity is insignificant applying annual export data while it is significantly negative using daily export data. The estimated mark-up applying the RDE approach is insignificant for Egypt, suggesting competitive pricing behavior by Russia. Russia has been dominating the Turkish wheat import market for the last years. The situation is different with Egypt where there are also other exporting countries with significant market shares in the Egyptian wheat import market, thus limiting Russian market power.

The Caucasian states, particularly Armenia, are heavily dependent on Russian wheat exports. The PTM study relying on daily data provides strong evidence for Russian price discrimination in Armenia. The estimation results for the ERT elasticity are significantly negative for all firm groups. Thereby, the ERT elasticity is largest in absolute values for the top 5 exporters as compared with all exporters and the top 6-10 exporting firms. Moreover, Armenia's country fixed effects are significantly positive, implying higher wheat export prices as compared with the reference country Israel. Overall, the estimation results conducted within this doctoral thesis indicate competitive pricing behavior in most of Russia's export market but suggest the exertion of Russian market power in some destinations that are less integrated into the world wheat market.

Albeit the two PTM studies produce similar empirical findings for most export markets, Table 7.1 points to some differences in the empirical findings. Most strikingly, there are differences regarding the direction of the exchange rate effect. While the PTM study based on daily data for the years 2006–14 finds that Russian firms tend to stabilize the local currency price following an exchange rate shock, findings of the PTM study based on annual data indicate that Russian wheat exporters amplify the exchange rate shock for a substantial fraction of the export markets.

It is to be assumed that these differences can at least be partly attributed to the application of distinct data periods. The PTM study relying on annual data is based on the period 2002–11 and 2006–11, respectively; while the other PTM study relies on data for the period 2006–14. During the years 2002–14, Russia's wheat export market experienced substantial changes. Hence, exporting firms were facing different market conditions.

Figure 4.1 demonstrates the dynamics in Russia's wheat export market for the years 1998–2011. In the beginning of the 21st century, Russia's wheat export market was characterized by numerous firm entries and exits, accompanied by a remarkable concentration process. The continuous concentration process reversed after 2011, yet, market concentration remained above the concentration level of 2006. The number of exporting firms was highest in 2003 with more than 500 Russian wheat-exporting companies, and was tremendously declining after 2003. Between 2006 and 2014, the number of firms varied between 159 firms in 2013 and 259 in 2007.

As the ability to exert market power is clearly related to market concentration, Russian wheat exporters should face tougher competition from other Russian wheat sellers in the period 2006–14 than in the period 2002–11. Knetter (1993) argues that the likelihood to observe LCPS increases with competition. Therefore, the finding of LCPS behavior rather than an amplification of the exchange rate effect for the period 2006–14 is likely related to tougher competition during these years as compared with the years 2002–11.

Apart from estimating the PTM model for different time periods, the data frequency likely results in different findings. Accuracy of the estimation results critically depends on the choice of the exchange rate that was relevant during the point of time of the transaction. This exchange rate can only be determined by knowing the terms of each single transaction.

7.2 DISCUSSION ON THE APPLIED APPROACHES

International wheat markets are subject to some particularities. These are annual and seasonal price variations, as well as quality differences related to the source country. In this section, I discuss whether the PTM and RDE methods address these particularities, and, hence, are appropriate approaches to study market imperfections in international wheat trade.

Wheat markets are, such as other agricultural markets, characterized by seasonal as well as annual price oscillations. Wheat supply is affected by weather conditions, and therefore varies from marketing year to marketing year. Supply variations combined with a highly inelastic demand for wheat result in substantial price oscillations.

The RDE approach explicitly incorporates cost shifters of the competitors. In my empirical specification I include producer prices of Russia's rivals. These producer prices should reflect supply variations of Russia's competitors. Hence, the RDE method is a suitable approach to study a market with supply variations due to external shocks. The PTM method, in contrast, does not consider competitors' cost changes. However, in my econometric model a time dummy captures price variations that affect all export countries in a similar way. Thereby, price variations induced by supply fluctuations are well addressed in the empirical model.

Seasonal price oscillations are, in contrast to annual variations, related to storage costs of wheat. With the end of the harvest time wheat prices should increase continuously to compensate the seller for costs involved for storage, such as rental, insurance, loss or investment return (Koester, 2016). My empirical specification of the PTM and RDE approaches allow for seasonal price patterns. The time effects in the PTM model capture these seasonal patterns. To allow for seasonal effects in the RDE model, I include a vector of dummy variables for the months February to December.

Another particularity of the world wheat market is related to quality. Wheat is not a homogeneous product but quality varies, as outlined in Section 3.1, among wheat-producing countries. Beside quality differences among source countries, wheat quality also varies, albeit probably to a smaller extent, among Russian wheat suppliers.

The RDE approach explicitly allows for product differentiation among competitors (see Perloff et al., 2007). In the RDE approach the coefficients of the rivals' cost shifters reflect the degree of product differentiation and hence the intensity of competition. Thereby, I account for quality differences among source countries in an appropriate way. However, my econometric model does not consider quality differences among different Russian suppliers. This is only feasible with cost shifters for each single firm. However, my dataset does not comprise firm-specific cost variables. Hence, the estimation results of my RDE model reflect average affects.

In the PTM model, differences among Russian exporting firms in terms of offered wheat quality are captured by firm fixed effects. Furthermore, the country fixed effects capture quality differences related to country-specific quality preferences. In a market of a homogeneous product, the country effects are interpreted as evidence for third-degree price discrimination. As wheat, as included in my model, is not a homogeneous product, the interpretation of the country effects is not straightforward. Significant country fixed effects might be a sign of price discrimination or heterogeneous quality preferences. However, the ERT elasticity, the key parameter in the PTM model, should not be affected by heterogeneous quality preferences.

To conclude, both, the PTM and the RDE approach, are well suited methods to study pricing behavior in international wheat trade. Both approaches account for price fluctuations in an appropriate way. Moreover, both methods allow for product differentiation. However, the RDE method, derived from an oligopolistic market model, better accounts for quality difference among source countries, while the PTM approach, including firm fixed effects, controls for quality differences between Russian wheat traders.

7.3 POLICY IMPLICATIONS

Theory predicts that a high dependency on one supplier results in market power and higher prices if demand is not perfectly elastic. My empirical findings confirm these theoretical predictions. I find strong evidence for Russian market power in Turkey, as well as evidence for price discrimination in the Caucasus. These countries highly depend on Russian wheat exports. In contrast, for export markets importing wheat from different source countries, I do not tend to find evidence for price discrimination or market power. Moreover, my research findings indicate that firms with a larger market share in a country possess a larger price-setting scope than firms with a small market share. Therefore, to reduce Russian market power, I recommend a strategy of diversification in terms of source country as well as exporting firms.

7.4 SUGGESTIONS ABOUT FUTURE RESEARCH

In this doctoral thesis, the focus is set on the ability of exporters to exert market power. Higher import prices and price volatility due to exporters' market power might jeopardize food availability in import-dependent developing countries. In this doctoral thesis, however, I do not examine market imperfections by actors further downstream along the value chain. These might also impinge on food security. Future research could study the transmission of exchange rate shocks to consumer prices to better assess the consequences of market power on food security along the entire wheat supply chain.

Future research on price discrimination in world wheat trade could also account for differences in wheat quality. Doing so, the issue of pseudo-PTM, described by Lavoie and Liu (2007), could be solved. Lavoie and Liu (2007) show that a false detection of PTM can arise from product differentiation. They argue that exchange rate shocks might produce a shift in the product-quality mix, hence changing unit values. Testing for PTM based on these unit values can produce biased estimation results. Estimating the model for single classes of wheat separately would solve this problem.

Another suggestion about future research is to draw on the determinants of PTM behavior in international wheat trade. The Corsetti and Dedola (2005) model predicts that PTM rises with local distribution costs. Future research could investigate whether quality of the wheat import infrastructure in the destination markets is related to third-degree price discrimination.

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APPENDIX

Table A.2.1: FAO's food security indicators

Food security dimension	Indicator
Availability	Average dietary energy supply adequacy
	Average value of food production
	Share of dietary energy supply derived from cereals, roots and tubers
	Average protein supply
	Average supply of protein of animal origin
Access	Rail lines density
	Gross domestic product per capita (in purchasing power equivalent)
	Prevalence of undernourishment
	Prevalence of severe food insecurity in the total population
Utilization	Percentage of population using at least basic drinking water services
	Percentage of population using at least basic sanitation services
	Percentage of population using safely managed drinking water services
	Percentage of population using safely managed sanitation services
	Percentage of children under 5 years of age affected by wasting
	Percentage of children under 5 years of age who are stunted
	Percentage of children under 5 years of age who are overweight
	Prevalence of obesity in the adult population (18 years and older)
	Prevalence of anemia among women of reproductive age (15–49 years)
	Prevalence of exclusive breastfeeding among infants 0–5 months of age
Stability	Cereal import dependency ratio
	Percent of arable land equipped for irrigation
	Value of food imports over total merchandise exports
	Political stability and absence of violence/terrorism
	Per capita food production variability
	Per capita food supply variability

Source: FAO (2018)

Table A.4.1: Descriptive statistics of Sample A (2002–11)

		Exchange rate				Wheat export price			
Destination	N	Mean	CV	Min	Max	Mean	CV	Min	Max
Afghanistan	16	1.83	0.1264	1.51	2.02	6,681.1	0.29	2,812.7	9,139.4
Albania	237	3.59	0.0972	2.99	4.47	4,379.6	0.35	1,837.6	8,109.2
Algeria	195	2.56	0.0227	2.29	2.71	2,793.9	0.23	1,377.8	5,260.0
Armenia	128	13.41	0.1420	11.45	18.86	5,770.7	0.43	1,880.9	28,561.1
Austria	35	0.03	0.1138	0.02	0.03	4,688.9	0.39	1,841.5	7,553.4
Azerbaijan	429	0.03	0.0931	0.03	0.03	4,322.5	0.40	1,446.7	14,112.3
Bangladesh	124	2.49	0.0798	2.18	2.76	4,313.0	0.33	2,432.4	8,897.4
Congo Republic	7	16.68	0.1719	14.88	22.23	4,858.9	0.27	3,191.2	7,374.9
Cyprus	67	0.03	0.0939	0.02	0.03	3,767.7	0.42	1,253.9	7,679.6
Denmark	38	0.24	0.0864	0.18	0.25	2,468.0	0.70	1,316.6	8,079.5
Egypt	628	0.20	0.1205	0.14	0.22	4,504.7	0.37	1,924.4	8,450.0
Eritrea	7	0.54	0.1109	0.45	0.62	5,271.8	0.25	3,406.8	6,719.6
Ethiopia	12	0.50	0.1911	0.35	0.58	6,083.5	0.19	4,284.9	7,786.2
Georgia	428	0.06	0.0752	0.05	0.07	4,437.7	0.38	1,088.4	12,512.7
Germany	29	0.03	0.1200	0.02	0.03	3,562.7	0.59	1,624.9	7,421.5
Greece	266	0.03	0.0966	0.02	0.03	4,013.1	0.44	1,238.2	8,185.9
India	45	1.64	0.0271	1.51	1.75	4,571.0	0.28	3,083.6	7,964.4
Indonesia	40	338.09	0.1010	279.46	390.26	4,652.0	0.31	2,436.0	6,688.2
Iran	148	312.47	0.1408	220.33	379.37	4,230.3	0.38	1,680.8	7,529.4
Iraq	15	42.72	0.4058	0.01	69.52	5,551.1	0.28	3,314.7	8,211.2
Israel	268	0.15	0.1058	0.12	0.16	4,106.6	0.42	1,692.8	8,462.4
Italy	358	0.03	0.1096	0.02	0.03	3,726.1	0.52	1,191.2	9,549.2
Jordan	72	0.03	0.0934	0.02	0.03	5,101.8	0.36	2,435.5	8,799.9

Table A.4.1: Descriptive statistics of Sample A (2002–11) (continued)

		Exchange rate				Wheat export price			
Destination	N	Mean	CV	Min	Max	Mean	CV	Min	Max
Kazakhstan	80	4.75	0.0199	4.64	4.89	8,594.1	0.65	1,299.2	25,325.2
Kenya	54	2.70	0.0682	2.44	3.02	5,375.8	0.37	2,931.1	14,434.3
Kyrgyzstan	10	1.43	0.0462	1.35	1.51	5,811.9	0.58	3,977.8	15,216.1
Latvia	23	0.02	0.0617	0.02	0.02	3,456.4	0.80	1,128.5	10,136.8
Lebanon	261	52.24	0.0824	47.49	60.66	4,448.0	0.35	2,116.0	8,390.6
Libya	146	0.04	0.0893	0.04	0.05	4,975.7	0.33	1,758.2	8,185.9
Lithuania	31	0.10	0.1091	0.08	0.12	3,915.2	1.07	1,413.8	23,527.1
Malaysia	10	0.12	0.1163	0.10	0.13	5,329.5	0.33	2,862.3	7,778.0
Mauritania	7	9.48	0.0618	8.27	10.11	5,942.3	0.33	3,132.8	7,952.4
Moldova	61	0.45	0.0203	0.42	0.47	4,871.0	0.29	2,150.4	9,207.4
Mongolia	98	42.42	0.0964	35.42	46.91	5,211.3	0.43	1,359.6	13,292.1
Morocco	170	0.32	0.0761	0.25	0.35	3,667.6	0.52	1,567.4	7,987.1
Mozam-bique	19	0.94	0.0747	0.87	1.12	5,672.7	0.20	4,296.2	7,908.3
Nigeria	15	4.40	0.1281	3.85	5.24	3,620.7	0.40	2,481.5	7,225.9
North Korea	6	4.08	0.4945	0.07	5.65	7,487.1	0.55	1,872.2	12,664.2
Norway	13	0.22	0.0834	0.19	0.24	4,129.6	0.44	2,301.9	7,903.8
Oman	10	0.01	0.0827	0.01	0.02	6,224.0	0.24	3,274.5	7,694.5
Pakistan	95	2.43	0.1319	2.02	2.83	4,918.4	0.39	2,489.0	8,441.7
Peru	10	0.11	0.0948	0.09	0.12	4,883.6	0.39	2,918.8	7,951.2
Poland	8	0.12	0.0828	0.10	0.13	5,645.3	0.34	1,851.6	8,195.9
Romania	72	0.11	0.0308	0.10	0.11	3,985.0	0.26	2,068.4	7,751.0
Rwanda	10	20.12	0.0877	17.90	22.00	5,987.3	0.13	5,253.0	7,712.8

Destination	N	Exchange rate Mean	CV	Min	Max	Wheat export price Mean	CV	Min	Max
Saudi Arabia	43	0.13	0.0709	0.12	0.15	3,206.7	0.65	1,413.8	8,799.9
South Korea	39	39.16	0.0354	35.11	44.34	3,741.9	0.84	1,536.1	17,613.4
Spain	127	0.03	0.1156	0.02	0.03	2,933.2	0.61	1,065.8	8,922.7
Sudan	34	0.08	0.0714	0.07	0.09	4,824.0	0.34	2,435.7	7,712.2
Switzerland	9	0.04	0.1600	0.03	0.05	3,455.9	0.52	1,573.3	6,434.7
Syria	169	0.39	0.0941	0.35	0.45	4,602.3	0.31	2,173.1	7,930.1
Tajikistan	43	0.13	0.1395	0.09	0.16	4,815.0	0.68	868.1	21,622.1
Tanzania	58	46.37	0.0993	39.91	53.51	5,539.4	0.25	3,171.8	7,715.7
Tunisia	118	0.05	0.0577	0.04	0.05	4,112.7	0.39	1,642.6	7,674.3
Turkey	493	0.05	0.0539	0.05	0.06	5,215.3	0.29	2,125.6	8,474.6
Uganda	31	70.76	0.1104	63.97	85.86	5,880.6	0.20	4,067.4	8,080.1
Ukraine	344	0.18	0.0928	0.17	0.27	4,395.5	0.48	1,179.2	15,814.8
U. Arab Emirates	19	0.13	0.0894	0.12	0.15	5,771.7	0.27	2,819.1	7,878.0
Uzbekistan	24	51.58	0.1230	24.67	58.54	7,002.8	0.77	3,106.1	25,078.4
Vietnam	22	583.70	0.0986	487.41	698.04	4,435.5	0.35	2,030.9	8,138.8
Yemen	97	7.06	0.0746	6.39	8.04	4,441.9	0.38	2,460.7	8,519.6
Total	**6,471**					**4,461.4**	**0.46**	**868.1**	**28,561.1**

Notes: N shows the number of observations, Mean, CV, Min and Max show mean value, coefficient of variation, minimal and maximal values of the model variables. The wheat export price is denoted in Russian ruble.

Source: Taken from Uhl et al. (2016)

Table A.4.2: Descriptive statistics of Sample B (2006–11)

		Exchange rate				Wheat export price			
Destination	N	Mean	CV	Min	Max	Mean	CV	Min	Max
Albania	140	3.41	0.0624	2.99	3.61	5,251.0	0.25	2,719.1	8,109.2
Algeria	27	2.64	0.0398	2.29	2.71	3,711.0	0.16	2,827.9	4,948.8
Armenia	111	12.80	0.0851	11.45	15.30	6,025.1	0.41	2,882.2	28,561.1
Austria	26	0.03	0.0940	0.02	0.03	5,464.6	0.26	3,052.1	7,553.4
Azerbaijan	218	0.03	0.1175	0.03	0.03	5,470.4	0.28	1,651.5	14,112.3
Bangladesh	96	2.55	0.0714	2.18	2.76	4,730.4	0.28	2,534.1	8,897.4
Cyprus	29	0.03	0.0861	0.02	0.03	5,110.6	0.26	2,965.2	7,679.6
Egypt	384	0.20	0.0853	0.17	0.22	5,497.7	0.25	2,447.2	8,450.0
Ethiopia	12	0.50	0.1911	0.35	0.58	6,083.5	0.19	4,284.9	7,786.2
Georgia	208	0.06	0.0742	0.05	0.07	5,538.6	0.25	2,105.6	9,533.4
Greece	123	0.03	0.0734	0.02	0.03	5,552.4	0.25	2,474.4	8,185.9
India	45	1.64	0.0271	1.51	1.75	4,571.0	0.28	3,083.6	7,964.4
Indonesia	26	347.63	0.0923	299.34	390.26	5,500.5	0.18	3,159.3	6,688.2
Iran	99	334.61	0.0820	310.78	379.37	5,183.8	0.19	1,689.1	7,529.4
Iraq	11	39.29	0.0792	36.86	48.01	6,298.0	0.17	5,248.8	8,211.2
Israel	149	0.14	0.1318	0.12	0.16	5,289.9	0.27	2,460.8	8,462.4
Italy	156	0.03	0.0834	0.02	0.03	5,396.8	0.32	2,474.4	9,549.2
Jordan	53	0.03	0.0980	0.02	0.03	5,850.1	0.26	2,697.2	8,799.9
Kazakhstan	55	4.74	0.0193	4.64	4.85	9,007.6	0.67	1,611.0	25,325.2
Kenya	44	2.72	0.0702	2.44	3.02	5,849.3	0.32	2,991.0	14,434.3
Kyrgyzstan	10	1.43	0.0462	1.35	1.51	5,811.9	0.58	3,977.8	15,216.1
Lebanon	156	53.21	0.0947	47.49	60.66	5,482.8	0.21	3,262.9	8,390.6
Libya	117	0.04	0.0965	0.04	0.05	5,564.8	0.22	2,474.4	8,185.9
Lithuania	10	0.09	0.0958	0.08	0.10	7,815.6	0.74	3,319.6	23,527.1
Malaysia	7	0.12	0.1146	0.10	0.13	6,331.2	0.14	4,964.3	7,778.0
Mauritania	6	9.49	0.0674	8.27	10.11	6,410.5	0.26	3,229.0	7,952.4
Mongolia	63	45.06	0.0270	43.07	46.91	6,065.3	0.37	1,359.6	13,292.1

		Exchange rate				Wheat export price			
Destination	N	Mean	CV	Min	Max	Mean	CV	Min	Max
Morocco	40	0.30	0.0868	0.25	0.32	6,800.9	0.18	3,953.6	7,987.1
Mozam-bique	19	0.94	0.0747	0.87	1.12	5,672.7	0.20	4,296.2	7,908.3
Nigeria	8	4.89	0.0481	4.69	5.24	4,487.0	0.34	2,719.1	7,225.9
Norway	9	0.21	0.0880	0.19	0.24	4,863.5	0.35	2,616.2	7,903.8
Oman	9	0.01	0.0875	0.01	0.02	6,551.7	0.17	4,434.9	7,694.5
Pakistan	64	2.59	0.0984	2.22	2.83	5,825.7	0.29	2,792.5	8,441.7
Rwanda	10	20.12	0.0877	17.90	22.00	5,987.3	0.13	5,253.0	7,712.8
Saudi Arabia	12	0.14	0.0790	0.13	0.15	6,278.3	0.20	3,167.8	8,799.9
South Korea	15	38.89	0.0551	35.11	44.34	6,833.6	0.46	4,475.3	17,613.4
Spain	26	0.03	0.0810	0.02	0.03	6,040.1	0.25	2,392.8	8,922.7
Sudan	20	0.08	0.0824	0.07	0.09	5,951.7	0.19	4,169.7	7,712.2
Syria	114	0.40	0.1052	0.35	0.45	5,435.6	0.16	3,067.7	7,930.1
Tajikistan	35	0.14	0.0442	0.13	0.16	5,244.5	0.63	2,007.6	21,622.1
Tanzania	48	47.72	0.0811	41.60	53.51	5,988.5	0.18	3,394.9	7,715.7
Tunisia	55	0.05	0.0525	0.04	0.05	5,464.3	0.24	3,015.3	7,674.3
Turkey	389	0.05	0.0540	0.05	0.06	5,789.6	0.18	3,369.2	8,474.6
Uganda	31	70.76	0.1104	63.97	85.86	5,880.6	0.20	4,067.4	8,080.1
Ukraine	62	0.21	0.1081	0.19	0.27	7,221.2	0.28	3,406.2	15,814.8
United Arab Emir	17	0.13	0.0943	0.12	0.15	6,106.7	0.21	3,318.4	7,878.0
Uzbekistan	23	52.75	0.0528	46.52	58.54	6,216.9	0.62	3,106.1	22,218.0
Vietnam	15	606.70	0.0858	537.65	698.04	5,124.8	0.27	3,262.9	8,138.8
Yemen	53	7.38	0.0704	6.39	8.04	5,610.7	0.26	2,779.3	8,519.6
Total	**3,455**					**5,641.5**	**0.32**	**1,359.6**	**28,561.1**

Notes: See Table A.4.1

Source: Taken from Uhl et al. (2016)

Table A.4.3: Market characteristics

Destination	Number of firms 2002–2011	Number of firms 2006–2011	CR 4	CR 10	RIS	WIDR
Afghanistan	13	11	77	99	*	*
Albania	122	82	20	39	60.12	51.94
Algeria	124	24	20	41	4.03	70.30
Argentina	1	0	100	100	0.00	-0.02
Armenia	70	61	63	79	62.95	60.43
Austria	22	16	56	80	0.00	26.83
Azerbaijan	204	105	37	50	44.19	40.94
Bahrain	2	2	100	100	3.72	*
Bangladesh	81	73	42	63	25.45	68.48
Belgium	5	0	94	100	0.56	77.82
Benin	2	0	100	100	6.62	*
Bosnia and Herzegovina	9	0	77	100	*	60.60
Brazil	3	1	100	100	0.06	59.13
Bulgaria	13	7	54	93	17.77	1.67
Canada	1	0	100	100	0.01	0.65
Chad	1	1	100	100	*	*
Chile	1	0	100	100	0.00	28.31
Colombia	1	0	100	100	0.00	97.41
Congo	6	5	97	100	0.00	*
Croatia	5	1	84	100	0.01	2.45
Cuba	2	2	100	100	0.00	*
Cyprus	49	23	34	56	14.19	89.49
Czech Republic	1	1	100	100	0.02	0.94

Destination	Number of firms		CR 4	CR 10	RIS	WIDR
	2002–2011	2006–2011				
Denmark	34	3	46	73	6.07	7.94
Djibouti	8	8	87	100	0.00	*
Ecuador	1	1	100	100	0.21	98.12
Egypt	272	185	38	61	32.52	48.01
Equatorial Guinea	1	0	100	100	*	*
Eritrea	4	3	100	100	9.54	*
Estonia	21	0	49	66	6.73	14.01
Ethiopia	10	9	90	100	7.65	31.62
Finland	10	0	62	79	10.42	6.51
France	9	1	79	100	0.76	1.79
Georgia	244	121	38	52	63.12	90.01
Germany	26	9	34	72	0.54	12.44
Gibraltar	1	0	100	100	*	*
Greece	134	70	25	42	26.12	40.06
Guinea	1	0	100	100	0.00	*
Hong Kong	1	0	100	100	*	*
Hungary	4	1	93	93	0.00	1.65
Iceland	1	1	100	100	0.37	*
India	34	34	68	87	38.25	1.22
Indonesia	30	20	62	80	1.35	*
Iran	104	77	37	61	7.42	11.51
Iraq	11	8	76	95	*	53.49
Ireland	5	0	72	73	0.39	33.11

Table A.4.3: Market characteristics (continued)

Destination	Number of firms 2002–2011	Number of firms 2006–2011	CR 4	CR 10	RIS	WIDR
Israel	130	73	30	48	4.03	91.21
Italy	183	82	24	43	7.40	49.12
Japan	1	1	100	100	0.11	87.21
Jordan	46	34	45	72	29.65	96.55
Kazakhstan	55	43	56	80	96.16	0.15
Kenya	37	31	56	77	21.37	65.55
Korea (DPRK)	7	5	45	47	*	*
Kuwait	1	1	100	100	0.51	99.75
Kyrgyzstan	9	9	89	95	1.33	21.53
Latvia	21	6	77	89	0.50	34.35
Lebanon	150	96	26	44	51.50	78.88
Libya	94	72	45	65	26.98	83.51
Lithuania	22	6	63	90	12.71	8.32
Malawi	3	3	100	100	54.58	89.43
Malaysia	9	7	91	100	0.75	*
Malta	5	1	60	72	6.83	69.23
Mauritania	6	6	89	100	6.73	*
Mexico	1	0	100	100	0.13	55.96
Moldova	58	5	43	63	51.08	7.04
Monaco	2	0	100	100	*	*
Mongolia	57	38	52	76	28.12	36.63
Montenegro	1	1	100	100	14.76	89.86
Morocco	119	36	29	46	6.58	42.75

Destination	Number of firms 2002–2011	2006–2011	CR 4	CR 10	RIS	WIDR
Mozambique	18	18	65	87	4.26	*
Myanmar	1	1	100	100	*	35.03
Netherlands	10	1	77	99	0.18	83.97
New Zealand	1	0	100	100	0.00	48.47
Nicaragua	1	1	100	100	2.20	*
Nigeria	15	8	56	88	0.78	97.72
Norway	11	8	66	100	3.58	44.92
Oman	5	5	99	100	4.57	105.08
Pakistan	56	42	36	63	28.71	3.33
Peru	8	3	93	100	3.08	88.53
Philippines	7	7	87	100	0.72	*
Poland	5	1	36	37	1.10	6.51
Portugal	7	2	86	100	0.62	94.03
Qatar	1	1	100	100	0.00	100.12
Romania	68	5	23	45	7.39	12.75
Rwanda	7	7	76	100	16.18	18.23
Saudi Arabia	35	9	63	85	4.02	18.29
Senegal	1	1	100	100	0.00	*
Serbia and Montenegro	7	1	82	100	22.53	2.23
Sierra Leone	1	1	100	100	0.00	*
Singapore	1	1	100	100	0.00	*
South Africa	6	4	90	100	1.22	38.61
South Korea	33	11	43	55	0.67	99.65

Table A.4.3: Market characteristics (continued)

Destination	Number of firms 2002–2011	2006–2011	CR 4	CR 10	RIS	WIDR
Spain	94	22	26	48	2.92	47.85
Sri Lanka	2	2	100	100	0.15	*
Sudan	25	14	59	84	2.56	74.28
Sweden	5	1	89	93	3.97	6.05
Switzerland	9	3	52	65	0.00	37.79
Syria	97	67	40	59	50.22	10.19
Taiwan	4	4	100	100	*	99.91
Tajikistan	37	30	44	69	*	28.61
Tanzania	39	31	59	83	21.69	95.27
Thailand	5	5	100	100	1.43	99.98
The Bahamas	1	0	100	100	0.00	*
Tunisia	75	37	57	75	14.06	54.64
Turkey	226	183	22	38	43.82	9.36
Turkmenistan	3	2	37	37	*	*
USA	4	1	100	100	0.00	6.45
Uganda	21	21	68	90	18.79	94.67
Ukraine	285	53	25	38	27.81	5.73
United Arab Emirates	14	11	68	98	3.95	120.75
United Kingdom	4	2	90	90	0.65	8.23
Uruguay	1	0	100	100	0.00	20.38
Uzbekistan	22	21	8	13	*	2.45
Venezuela	1	0	100	100	0.00	99.98
Vietnam	17	11	63	95	1.56	*

Destination	Number of firms 2002–2011	Number of firms 2006–2011	CR 4	CR 10	RIS	WIDR
Virgin Islands (British)	2	0	54	54	*	*
Yemen	58	31	57	76	18.68	93.33
Zaire	3	3	100	100	*	97.16
Zimbabwe	2	2	100	100	1.94	45.61

Notes: **CR 4** and **CR 10** are the concentration ratios of the four and ten largest exporters over 2002–2011 in each country. **RIS** denotes the share of wheat imports originated from Russia in total wheat imports (2002–2011). **WIDR** abbreviates wheat import dependency ratio and is expressed in percent. The WIDR gives the share of imports in wheat consumption. Wheat consumption is computed the following way: domestic wheat production plus wheat imports minus exports. The WIDR is calculated for the years 2002–2011. **Asterisk** * indicates that not all information needed to compute the RIS/WIDR, i.e., data on wheat production (in t), exports (in t) or imports (in t), is available. Further note that data on production, import and export quantities is not available for all countries for all years. Hence, the RIS and WIDR are calculated including only all complete years.

Source: Taken from Uhl et al. (2016). The number of observations and the concentration ratios are based on data provided by APK-Inform. The WIDR is computed based on data published by FAOSTAT. RIS is calculated based on data released by UN Comtrade.

Table A.5.1: Concentration of Russian wheat exports, 2006–14 (in %)

Destination	CR 5	CR 10
Afghanistan	88.2	99.7
Albania	55.9	77.8
Armenia	76.5	90.5
Austria	96.5	100.0
Azerbaijan	63.7	79.9
Bangladesh	74.4	91.1
Cyprus	92.0	100.0
Egypt	52.0	74.9
Ethiopia	97.9	100.0
Georgia	62.9	76.9
Germany	100.0	100.0
Greece	60.2	79.8
India	72.2	88.0
Indonesia	90.3	98.9
Iran	68.6	85.0
Iraq	100.0	100.0
Israel	68.2	87.5
Italy	61.9	79.8
Jordan	88.8	98.9
Kazakhstan	80.5	94.5
Kenya	80.4	97.3
North Korea	100.0	100.0
South Korea	98.2	100.0
Latvia	93.3	100.0
Lebanon	53.8	74.3
Libya	70.4	87.1
Lithuania	100.0	100.0
Mongolia	69.7	89.6
Morocco	89.3	96.6
Mozambique	82.1	96.8
Nigeria	95.3	100.0

Destination	CR 5	CR 10
Norway	98.7	100.0
Oman	99.5	100.0
Pakistan	68.1	86.7
Saudi Arabia	96.3	100.0
South Africa	73.0	91.9
Spain	78.5	91.9
Sudan	97.9	100.0
Syria	63.2	83.0
Tajikistan	81.2	98.1
Tanzania	85.3	99.7
Tunisia	88.1	98.2
Turkey	41.2	59.6
Uganda	92.6	100.0
Ukraine	61.5	76.6
United Arab Emirates	94.4	99.6
Uzbekistan	74.4	92.5
Vietnam	99.4	100.0
Yemen	86.2	99.6

Notes: **CR 5** and **CR 10** are concentration ratios of the top 5 and top 10 Russian exporters. Firms are ranked according to wheat export volume, and the order of the firms varies by export market and export year.

Source: Own compilation based on our firm-level data set provided by APK-Inform

Table A.5.2: Descriptive statistics of variables used in estimations

Destination	All firms: Exchange rate Mean	CV	Export price Mean	CV	Top 5: Exchange rate Mean	CV
Afghanistan	1.80	0.1080	6,870.94	0.2177	1.77	0.1203
Albania	3.27	0.0758	6,321.77	0.3060	3.25	0.0813
Armenia	12.52	0.0924	6,603.84	0.2830	12.51	0.0951
Austria	0.03	0.0834	5,733.38	0.2449	0.03	0.0837
Azerbaijan	0.03	0.1926	6,399.36	0.3582	0.03	0.1928
Bangladesh	2.44	0.0706	5,194.66	0.3126	2.42	0.0759
Cyprus	0.01	0.1540	6,353.58	0.3956	0.01	0.1466
Egypt	0.20	0.0907	6,043.13	0.2807	0.20	0.0918
Ethiopia	0.50	0.1806	6,267.65	0.1764	0.50	0.1825
Georgia	0.06	0.1577	6,194.89	0.2870	0.06	0.1464
Germany	0.03	0.0737	6,342.25	0.1534	0.03	0.0737
Greece	0.03	0.1048	6,493.96	0.3224	0.03	0.1000
India	1.65	0.0346	5,664.79	0.3380	1.66	0.0364
Indonesia	336.50	0.0742	6,729.18	0.1924	332.35	0.0699
Iran	461.63	0.3983	6,790.84	0.3330	459.49	0.3985
Iraq	36.40	0.0607	8,015.20	0.2033	36.40	0.0607
Israel	0.13	0.1572	6,083.61	0.2831	0.13	0.1561
Italy	0.03	0.1138	6,147.28	0.4652	0.03	0.1100
Jordan	0.02	0.1173	6,343.77	0.2906	0.02	0.1197
Kazakhstan	4.30	0.0966	5,193.76	0.5979	4.33	0.0930
Kenya	2.74	0.1068	7,301.99	0.2212	2.76	0.1034
North Korea	4.78	0.1029	11,268.77	0.1541	4.78	0.1029
South Korea	35.38	0.1489	7,292.63	0.3045	35.42	0.1515
Latvia	0.02	0.1444	9,176.74	0.3499	0.02	0.1333
Lebanon	50.23	0.1107	6,198.76	0.2715	50.31	0.1145
Libya	0.04	0.1081	6,605.29	0.2148	0.05	0.1067
Lithuania	0.09	0.0820	7,740.33	0.2647	0.09	0.0820
Mongolia	46.67	0.0580	7,288.85	0.2814	46.34	0.0581
Morocco	0.30	0.0976	7,377.51	0.1539	0.30	0.1069

	Top 5		Top 6–10			
	Export price		Exchange rate		Export price	
	Mean	CV	Mean	CV	Mean	CV
	6,738.46	0.2336				
	6,397.53	0.3004	3.27	0.0762	6,369.80	0.3128
	6,544.10	0.2533	12.57	0.1005	6,253.05	0.2758
	5,703.19	0.2489				
	6,483.45	0.3367	0.03	0.1802	5,906.59	0.3662
	5,489.78	0.2897	2.49	0.0559	5,092.40	0.2795
	6,260.97	0.3898				
	6,158.29	0.2901	0.20	0.0932	5,952.84	0.2921
	6,265.05	0.1795				
	6,248.21	0.2546	0.06	0.1582	6,249.88	0.3326
	6,342.25	0.1534				
	6,314.11	0.3323	0.03	0.1260	6,974.36	0.3465
	5,514.18	0.3459	1.62	0.0263	6,893.04	0.2212
	6,546.37	0.2099				
	6,389.04	0.3096	483.26	0.3818	7,543.40	0.2755
	8,015.20	0.2033				
	6,020.67	0.2972	0.14	0.1593	6,356.98	0.2446
	5,726.96	0.4419	0.03	0.1042	6,201.25	0.4035
	6,327.94	0.3258				
	4,555.78	0.3636				
	7,237.92	0.1985				
	11,268.77	0.1541				
	7,249.31	0.3059				
	8,562.41	0.1593	0.01	0.1727	13,110.82	0.5244
	6,206.02	0.2878	49.83	0.1221	6,472.54	0.2568
	6,647.67	0.2005	0.04	0.1110	6,819.88	0.1992
	7,740.33	0.2647				
	7,264.42	0.2933	47.55	0.0473	7,763.49	0.2145
	7,299.00	0.1617				

Table A.5.2: Descriptive statistics of variables used in estimations (continued)

Destination	All firms				Top 5	
	Exchange rate		Export price		Exchange rate	
	Mean	CV	Mean	CV	Mean	CV
Mozambique	0.90	0.0841	7,528.51	0.2314	0.90	0.0943
Nigeria	4.70	0.1023	8,229.81	0.2904	4.73	0.0950
Norway	0.19	0.1019	7,263.88	0.2927	0.19	0.1028
Oman	0.02	0.0762	6,913.53	0.1083	0.02	0.0769
Pakistan	2.54	0.1525	5,562.32	0.3356	2.47	0.1512
Saudi Arabia	0.13	0.0788	5,185.06	0.3674	0.13	0.0780
South Africa	0.29	0.0844	8,066.31	0.1479	0.28	0.1040
Spain	0.03	0.1041	6,970.27	0.2787	0.03	0.1174
Sudan	10.89	0.3334	7,873.40	0.3176	10.77	0.3376
Syria	1.65	0.1881	5,377.40	0.1973	1.64	0.2176
Tajikistan	0.13	0.1482	5,610.53	0.3020	0.12	0.1582
Tanzania	47.11	0.0840	7,167.27	0.2435	46.75	0.0796
Tunisia	0.05	0.0307	7,399.34	0.2154	0.05	0.0260
Turkey	0.06	0.0976	7,068.89	0.2592	0.06	0.0949
Uganda	71.37	0.1268	7,499.21	0.2776	72.06	0.1174
Ukraine	0.20	0.0780	7,068.22	0.1763	0.20	0.1104
United Arab Emirates	0.11	0.1333	7,398.66	0.2140	0.11	0.1360
Uzbekistan	52.32	0.0783	5,636.77	0.2260		
Vietnam	602.85	0.0682	5,557.33	0.3128	602.58	0.0702
Yemen	6.88	0.0959	6,761.83	0.2940	6.81	0.0925
Total	17.57	4.9035	6,531.82	0.3167	15.19	5.1086

Notes: CV abbreviates coefficient of variation. Export price is denoted in Russian ruble per metric ton.

	Top 5		Top 6–10			
	Export price		Exchange rate		Export price	
	Mean	CV	Mean	CV	Mean	CV
	7,544.64	0.2581				
	8,113.30	0.2910				
	7,231.88	0.2945				
	6,928.07	0.1077				
	5,263.22	0.3566				
	4,916.13	0.3851				
	8,385.54	0.1813				
	6,869.78	0.2929				
	7,608.86	0.2950				
	5,193.08	0.2297	1.65	0.1271	5,407.63	0.1662
	5,630.72	0.3346				
	7,123.92	0.2530				
	7,431.84	0.2016	0.05	0.0499	7,262.69	0.2907
	7,103.73	0.2601	0.05	0.0999	7,086.46	0.2745
	7,385.69	0.2573				
	6,979.93	0.2386	0.20	0.0490	6,909.27	0.0894
	7,200.82	0.2087				
	5,637.09	0.3134				
	7,198.32	0.2733	6.88	0.0978	5,880.20	0.3234
	6,560.80	0.3051				

A.6.1: Derivation of the industry Lerner index

In the following, we show that the Lerner index for an entire industry, as expressed in (6.12), is a special case of the RDE model from Section 6.3. For this purpose, we need the following assumptions:

(I) There is one single market price, thus $P_1 = P^1(Q_1, Q_2, Z) = P^2(Q_2, Q_1, Z) = P(Q_2, Q_1, Z)$.

(II) The products are perfect substitutes. Therefore, the inverse demand function can be rewritten the following way: $P(Q_2, Q_1, Z) = P(Q_2 + Q_1, Z) = P(Q, Z)$.

(III) We assume zero conjectural variations in quantity. Thus, $\frac{\partial Q^2}{\partial Q_1} = 0$.

(IV) Demand functions are linear.

The profit maximization problem for exporter 1 is then equal to $max_{Q_1} \Pi_1 = Q_1 * P^1(Q_1 + Q_2, Z) - e_1 * C^1(Q_1, W_1, W)$. Since $\frac{\partial Q}{\partial Q_1} = \frac{\partial Q}{\partial Q_2} = 1$ due to assumption (III) we can rearrange the FOC to the following expression: $\frac{P - e_1 * MC^1}{P} = -\frac{Q_1}{P} * \frac{\partial P}{\partial Q}$ that is equal to the Lerner index for a single seller. The industry Lerner index is computed as the sum of the market share-weighted Lerner indices for all sellers. In our two-exporter example, the industry Lerner measure is equal to:

$L = s_1 * \frac{P - e_1 * MC^1}{P} + s_2 * \frac{P - e_2 * MC^2}{P}$ with $s_1 = \frac{Q_1}{Q}$ and $s_2 = \frac{Q_2}{Q}$. Inserting the expression for the FOC yields $= s_1 * [-\frac{Q_1}{P} * \frac{\partial P}{\partial Q}] + s_2 * [-\frac{Q_2}{P} * \frac{\partial P}{\partial Q}]$. We multiply this expression by $\frac{Q}{Q}$ and thereby we obtain

$$= s_1 * \frac{Q_1}{Q} * [-\frac{Q}{P} * \frac{\partial P}{\partial Q}] + s_2 * \frac{Q_2}{Q} * [-\frac{Q}{P} * \frac{\partial P}{\partial Q}] = \sum_{i=1}^{2} s_i^2 * (-\frac{Q}{P} * \frac{\partial P}{\partial Q}) = HHI * |\frac{Q}{P} * \frac{\partial P}{\partial Q}|.$$

As we assume linear demand functions it is $|\frac{\partial P}{\partial Q}| = |\frac{1}{\partial Q / \partial P}|$ and we can retype the expression for the Lerner measure as expressed in (6.12):

$L = HHI * \frac{1}{|\frac{\partial Q}{\partial P} * \frac{P}{Q}|} = HHI * \frac{1}{|\varepsilon|}$ with ε abbreviating the price elasticity of demand.

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