
# Market power in the international fertiliser market: empirical evidence for exports from Russia

Philipp Goretzki[1], Oleksandr Perekhozhuk[2], Thomas Glauben[2], Jens-Peter Loy[3]

[1] Rentenbank, Germany (goretzki@rentenbank.de)

[2] Leibniz Institute of Agricultural Development in Transition Economies (IAMO), Halle (Saale), Germany (perekhozhuk@iamo.de, glauben@iamo.de)

[3] University of Kiel, Germany (jploy@ae.uni-kiel.de)

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## Abstract

This study presents empirical evidence for the behaviour of Russian exporters in the international fertiliser market. Russia is in the spotlight since the potash cartel has collapsed. In 2012, Russia became the world's second-largest exporter increasing its potash exports from 1996 to 2012 more than two times. PTM approach developed by Krugman (1986, 1987) is chosen to test the market behaviour. Imperfect competition in the Russian export market for nitrogen fertilisers is revealed in two-thirds of the destination countries under study. In the export market for potash, a sufficiently perfect market is found in only one out of 9 countries.



**JEL Codes:** D43, F12, F14, L11, L13

**Keywords: Pricing-to-market (PTM), market power, price discrimination, international market, international fertiliser market, Russia**

## 1. Introduction

The international fertiliser market has been growing steadily, up by 1.9 % per year over 2012-2016, and it is estimated to reach 194.1 million tonnes by the end of 2016 (FAO, 2016, p. 12). Among other things, this means that the demand for the three nutrients nitrogen, phosphate and potash along with the supply has been growing steadily in recent years. According to predictions of the International Fertilizer Association (IFA), this growth is expected to continue in the future. The demand for nitrogen is going to increase by 1.8% p.a. between 2011/12 and 2018/19 (IMF, 2015). Global aggregate demand will then reach a historic high. According to the forecast, the demand for potash will grow at the highest rate (2.8% p.a.) followed by phosphate (1.9% p.a.) and nitrogen (1.5% p.a.). The IFA predicts a similar development for the fertiliser supply. Nearly 200 growth projects are planned in the fertiliser industry, slated for implementation in the next five years (Heffer & Prud'homme, 2014: 2 f.). Another 30 projects focus on the extraction of phosphate rock in the mining industry.

The dynamic development of the international fertiliser market is mainly caused by the expansion of global agricultural production. Asia as the largest fertiliser market is the major driving force behind the steady increase in fertiliser consumption. Regions such as Latin America and Africa are contributing to the rising demand as well. Both regions are defined by recovering agriculture and great potential for the expansion of agricultural production. Both regions have the highest growth rates for demand p.a. at 3.7 % and 3.4 % (Heffer & Prud'homme, 2014: 3).

The production capacity of the international fertiliser industry is highly concentrated and located in very few countries. In the countries dominating the market often just a few companies make most of the production and exports. Concentration in the production and trade of potash fertilisers is particularly striking. Essentially there are only two major players worldwide, the potash distribution cartels that jointly control more than 70 percent of worlds total potash sales. The Russian/Belarus potash cartel consisting of the Russian “Uralkali” group and the Belarus “Belaruskali” group controls 43 % of worldwide potash fertiliser exports through the Belarus potash distribution company (BKK). The three corporate groups Potash Corp (Canada), Agrium (Canada) and Mosaic (USA) forming the North American Canpotex cartel control 30 % of the world market (Karbalewitsch, 2013). The German fertiliser and salt producer K+S and the Israeli

chemical company and fertiliser manufacturer ICL are also significant players in the world market, but they do not belong to any potash cartel. The oligopolistic market structure in the international fertiliser market and the highly concentrated supply suggest the hypothesis market power. This speculation is fuelled by the collapse of the potash cartel in 2013 that kept the prices for potash artificially high before.

The objective of this article is to describe the market structure and market concentration of the Russian export company in the international fertiliser market, and to develop hypotheses about the oligopolistic market behaviour. Furthermore, we test the hypotheses by employing econometric models to provide evidence for market power and price discrimination in the international fertiliser market. The article focuses on Russia because the country was very much in the spotlight of the international public and politics when the potash cartel collapsed. Furthermore, the termination of the cartel by the Russian company Uralkali sent shock waves through the fertiliser industry. The news agencies of the international exchanges reported plunging share prices for the largest potash producers and negative economic projections for the development of fertiliser prices in the international markets.

Primarily against the background of increased market concentration by the companies in the fertiliser markets and regarding the aforementioned cartel dispute, this study constitutes a first attempt to close the research gap in the empirical literature and to promote empirical research on the market behaviour of export companies in the international markets.

The paper is structured as follows. In the second section we describe the market structure and the concentration of the Russian export market for fertilisers. The theoretical foundation of the PTM approach and the empirical model specifications are discussed in section three. Section four summarises the base data and descriptive statistics of the model variables. In section five we present and discuss the empirical estimation results of the panel model analysis. Finally, we summarise the paper and draw some conclusions.

## 2. Russian export markets for fertilisers

Russia is one of the leading suppliers of nitrogen and potash fertilisers in the world market. Today one-fifth of worldwide nitrogen and potash fertiliser exports come from Russia (COMTRADE, 2015). From 1996 to 2012 Russia accounts for an average share of nearly 20 %

of the global nitrogen and potash fertiliser exports. Russia's exports of phosphate fertilisers are of minor importance, its share of world exports is only less than 1 %. Therefore, in this study we focus on the Russian nitrogen and potash fertiliser exports. Table 1 shows that more than half of Russian exports of nitrogen fertilisers are destined to five countries, namely Brazil, China, Mexico, Turkey and USA . The share of Russian exports of the destination market's total imports is very high (above 65 %) for 7 out of 28 destination countries such as China, Estonia, Latvia, Lithuania, Moldavia, Mongolia and Ukraine. In Argentina, Brazil, Finland, Georgia, Honduras, Kyrgyzstan, Morocco, Mexico, Poland and Turkey the share of Russian imports is between 20 and 50 %. The remaining countries (France, India, Italy, Malaysia, Norway, Slovakia, Spain, Hungary, the USA, the UK and Vietnam) show shares of less than 20 % of their imports. The calculations of the Herfindahl-Hirschman index *(HHI)*[1] results for six out of 28 destination countries a highly concentrated market structure[2]. In fact there is a Russian monopoly in Mongolia according to the *HHI* (see Table 1).

We find moderate market concentration for Finland, Georgia, Honduras, Lithuania, Morocco, Mexico, Poland and Hungary. In half the listed countries such as Argentina, Brazil, China, France, India, Italy, Malaysia, Norway, Slovakia, Spain, Turkey, the USA, the UK and Vietnam, Russia faces low market concentrations. Russia's export competitors in these markets and the share of Russian nitrogen exports into these destination countries underscore the dominant market position of the Russian exporters of nitrogen fertilisers in those destination countries.

[1] Assume that there is an equivalent number of equally sized competitors that supplied nitrogen fertiliser to the countries listed above between 1996 and 2012 in addition to Russia.

[2] The United States Department of Justice (US DOJ) and the Federal Trade Commission (FTC) classify the markets into three types by the size of the $HHI$: (1) high market concentration $(HHI > 0{,}25)$, (2) moderate market concentration $(0{,}15 < HHI < 0{,}25)$, and (3) low market concentration $(HHI < 0.15)$ (Rogoff, 1996; U.S.DOJ-FTC, 2010).

**Table 1: Market structure of the Russian export market for nitrogen fertilisers in 1996-2012**

| Destinations | Share of Russian exports (%)[1)] | Russian's market share (%)[2)] | Number of competitors [3)] | $HHI^{*}$ [4)] | Market concentration |
|---|---|---|---|---|---|
| Argentina | 1.4 | 29.1 | 9 | 0.11 | low |
| Brazil | **18.6** | 32.3 | 11 | 0.09 | low |
| China | **4.9** | 58.5 | 7 | 0.14 | low |
| **Estonia** | 0.7 | **83.2** | **2** | **0.50** | **high** |
| Finland | 0.3 | 46.9 | 6 | 0.17 | moderate |
| France | 2.5 | 7.3 | 8 | 0.13 | low |
| Georgia | 0.0 | 22.8 | 6 | 0.17 | moderate |
| Honduras | 1.2 | 37.3 | 5 | 0.20 | moderate |
| India | 1.5 | 5.4 | 8 | 0.13 | low |
| Italy | 1.1 | 13.1 | 10 | 0.10 | low |
| **Kyrgyzstan** | 0.2 | **27.3** | **3** | **0.33** | **high** |
| **Latvia** | 1.6 | **66.0** | **2** | **0.50** | **high** |
| Lithuania | 1.5 | **68.7** | 4 | 0.25 | moderate |
| Malaysia | 1.2 | 12.9 | 7 | 0.14 | low |
| Morocco | 0.9 | 37.0 | 6 | 0.17 | moderate |
| Mexico | **6.7** | 31.2 | 6 | 0.17 | moderate |
| **Moldovia** | 0.4 | **72.7** | **3** | **0.33** | **high** |
| **Mongolia** | 0.2 | **96.8** | **1** | **1.00** | **high** |
| Norway | 0.2 | 7.6 | 7 | 0.14 | low |
| Poland | 1.6 | 30.3 | 5 | 0.20 | moderate |
| Slovakia | 0.2 | 13.3 | 8 | 0.13 | low |
| Spain | 0.5 | 9.2 | 11 | 0.09 | low |
| Turkey | **12.3** | 29.8 | 9 | 0.11 | low |
| **Ukraine** | 2.2 | **92.7** | **2** | **0.50** | **high** |
| Hungary | 0.9 | 14.1 | 5 | 0.20 | moderate |
| USA | **7.9** | 7.2 | 15 | 0.07 | low |
| United Kingdom | 2.4 | 13.3 | 8 | 0.13 | low |
| Vietnam | 1.8 | 5.6 | 7 | 0.14 | low |

Note: [1)] Share of Russian export to destination of total Russian exports. [2)] Russian's market share in the total imports of the destination market [3)] A country is considered as a competitor of Russia if its share is >3% in 1996-2012. [4)] $HHI^{*}$ ranges from 0 to 1 and was calculated by assuming an equivalent number of equally sized competitors ($HHI = 1/n^{*}$).
Source: Authors' own calculations based on COMTRADE database of the UN Statistics Division **(**COMTRADE, 2015**)**.

Potash fertiliser is Russia's leading export product among the industrial minerals. Russia extracted 8.4 million tons of potash in 2014[3]. This puts Russia in second place for global potash production behind Canada with 15.7 million tons.[4] In contrast to nitrogen fertilisers, Russian potash fertilisers in the period under review were purchased regularly by only nine countries, as shown in Table 2 by the number of countries listed.

[3] Vgl. ROSSTAT (2015: 377).

[4] Vgl. CanStat (2016).

**Table 2: Market structure of the Russian export market for potash fertiliser in 1996-2012**

| Destination country | Share of Russian exports (%)[1)] | Russian's market share (%)[2)] | Number of competitors [3)] | ***HHI**** [4)] | Market concentration |
|---|---|---|---|---|---|
| Brazil | **8.2** | 16.3 | 5 | 0.20 | moderate |
| China | **34.3** | **48.6** | 6 | 0.17 | moderate |
| Finland | 2.2 | **45.0** | **3** | **0.33** | **high** |
| India | **14.4** | 24.4 | 8 | 0.13 | low |
| Malaysia | 3.3 | 22.1 | 5 | 0.20 | moderate |
| Poland | 2.2 | 21.7 | **3** | **0.33** | **high** |
| Ukraine | 0.9 | 11.8 | **2** | **0.50** | **high** |
| Hungary | 1.2 | **72.1** | 4 | 0.25 | moderate |
| USA | **5.4** | 4.3 | **2** | **0.50** | **high** |

Notes: For footnotes [1), 2), 3)] and [4)] see Table 1.
Source: see Table 1.

From 1996 to 2012 these destinations accounted on average for 72 % of Russian potash fertiliser exports. China and Finland are the most important destinations for Russian potash fertiliser exports. On these import markets Russian exports account for 50 % of total imports. In four of nine destination countries (Brazil, India, Malaysia and Poland) Russia holds a share between 15 and 25 %. Russia's share is less than 15 % in the two remaining countries (Ukraine and the USA). Only in Hungary Russia holds a large share of the potash imports (corresponding to more than 70 %.) But examining the *HHI* shows that the destination with the highest import ratios, Hungary, exhibits only a moderate market concentration. According to the *HHI*, the destination countries of China, Finland, Poland, Ukraine and the USA have highly concentrated markets. The *HHI* is highest for Ukraine and USA (about 50 %).

The data in Table 1 and 2 indicates a high concentration and dominant market position of the Russian exporters in many destination countries. This definitely strengthens Russia's market position in its export markets and can lead to price discrimination and/or the use of market power by Russian exporters in the international markets for nitrogen and potash fertilisers.

## 3. Literature review

In the last few years, numerous agricultural and general economists have undertaken empirical studies analysing imperfect competition, market power and price discrimination in international agricultural and food markets in order to examine the issues of market functioning, pricing and

competition with the help of econometric methods and approaches.[5] The empirical studies are mostly based on econometric model analyses, which have to be viewed in the context of trade theory approaches and assume that international trade is defined by imperfect competition, oligopolistic market structures, cartel agreements and price fixing. The pricing to market (PTM) model has been broadly applied in empirical research to identify market power and oligopolistic behaviour of the exporter through the effects of exchange rate changes between the currencies of the trading partners on export prices with the help of panel data.[6]

Pall et al. (2013) investigate the behaviour of Russian grain exporters based on quarterly data for the period from 2002 to 2010. They find indications of market power in the highly import-dependent countries in North Africa (Lebanon, Pakistan and Syria), the southern Caucasus (Azerbaijan, Armenia, Georgia) and Central Asia (Mongolia). Gafarova et al. (2015) use annual data for the period from 1996 to 2012 to analyse wheat export markets in the KRU countries. They find market power in seven out of 48 Kazakh, in twenty out of 71 Russian and in seventeen out of 65 Ukrainian wheat export markets. Uhl et al. (2016) analyse Russian wheat exports on the basis of annual export data for individual companies, finding empirical evidence of price discrimination behaviour by Russian exporters in 25 out of 61 destination countries in the period from 2002 to 2011.

In addition to numerous descriptive market research studies and market reports[7] indicating a high concentration of the fertiliser industry in the national and international fertiliser markets, there are only a few empirical studies to our knowledge that investigated the market and export structures, market behaviour and pricing in national and international fertiliser markets applying modern econometric approaches and methods. According to a description of the current market situation in the fertiliser industry and the production, consumption, trade and price development

[5] An overview of the extensive literature on the identification and measurement of market power in the international export markets is provided by the studies of Gafarova, Perekhozhuk, and Glauben (2015); Glauben and Loy (2001, 2003); Pall, Perekhozhuk, Glauben, Prehn, and Teuber (2014); Pall, Perekhozhuk, Teuber, and Glauben (2013); Uhl, Perekhozhuk, and Glauben (2016).

[6] See Glauben and Loy (2003) for a comparison and interpretation of the PTM approach.

[7] See market research studies by Janze, Schmidt, and Theuvsen (2011, pp. 30-34).

trends in view of the high concentration of the industry in international and especially national markets, Hernandez and Torero (2011) examine the effect of market concentration (number of companies, the concentration rate of the four largest companies ($CR_4$) under consideration of the production capacities and the value shares as well as the Herfindahl-Hirschman index ($HHI$) on the price of urea fertiliser. Using a regression analysis on the basis of the country-specific panel dataset for the period from 1961 through 2002, the authors find on the one hand that fertiliser prices are higher in concentrated markets. On the other hand they find that higher prices in the fertiliser market could also be related to exploiting market power. The causes and sources of market power as well as secret cartel agreements cannot be perfectly explained by the high level of market concentration, since high market concentration is affected by economies of scale in production and the demand for cost efficiency.

Besides rising global demand, shortage of supply there are other factors putting pressure on fertilizer prices included market concentration, cartels and commodity agreements. Because of the rising global demand, market fluctuations, price volatility and higher market concentration in the international fertilizer market, there is an urgent need for econometric analysis, in particular market behaviour and pricing of Russian fertilizer exporters, currently one of the world's biggest fertiliser exporters and players in the export market for nitrogen and potash fertilisers.

**4. Theoretical foundations of the PTM approach**

The foundation of the econometric analysis in this study follows the PTM approach developed by Krugman (1986, 1987) and its econometric implementation developed by Knetter (1989). This approach allows the estimation of the behaviour of fertiliser exporters using a fixed effects panel specification regression model of the following form:

$$\ln p_{it} = \theta_t + \lambda_i + \beta_i \ln e_{it} + u_{it}, \forall_i = 1, \dots, N \text{ and } \forall_t = 1, \dots, T, \quad (1)$$

where $p_{it}$ is the Russian fertiliser export price (in logarithm) of destination $i$ in the currency of the export country (FOB price) in the period $t$. The parameters $\theta_t$ and $\lambda_i$ represent time and country fixed effects. The parameter $\beta_i$ is the elasticity of the export price in reference to exchange rate changes. The model variable $e_{it}$ is the bilateral exchange rate measured in units of the importer currency per unit of the exporter currency. $u_{it}$ represents the error term.

A benefit of this approach is that it is easy to obtain public statistical data for the export statistics of the export country with the specification of export quantities and export values to the importing countries; public statistical data about bilateral exchange rates between the currencies of the export and import countries can be used for the empirical analysis. Furthermore, the PTM approach delivers comprehensive results for the econometric study on the basis of panel data that can explain three scenarios for the pricing behaviour of the export country towards the import countries according to Knetter (1989) (see Table 3). In the first market scenario with perfect competition, the export prices are the same for all destinations (prices equal to the marginal costs) since there is no country effect ($\lambda_i = 0$). In such a market form, the bilateral exchange rate is not influenced by the bilateral export prices, which implies ($\beta_i = 0$) (see Table 3: market situation A). The time effect $\theta_t$ determines the common marginal costs (and therefore also the price) for all destinations. The second and third market forms include imperfect competition and price discrimination between destinations.

**Table 3: Relationships between the estimated parameters and the market situation**

| Market situation | Model parameters | | Description of the market situation |
|---|---|---|---|
| | $\lambda_i$ | $\beta_i$ | |
| A | $\lambda_i = 0$ | $\beta_i = 0$ | Perfect competition,<br>Imperfect competition with ordinary price markup |
| B | $\lambda_i \neq 0$ | $\beta_i = 0$ | Constant demand elasticity → constant price markup may differ across destination markets |
| | $\lambda_i = 0$ / $\lambda_i \neq 0$ | $\beta_i \neq 0$: | non-constant demand elasticity → varying price markup |
| C1 | | • $\beta_i < 0$ | Price stabilization in local currency through adjustment of exchange rate effects → PTM |
| C2 | | • $\beta_i > 0$ | Increase the effect of the exchange rate |

Source: Author's own presentation according to Knetter (1993, p. 476), Glauben and Loy (2003), and Pall et al. (2013).

The second market situation assumes constant demand elasticities regarding the respective domestic currency of the destination. Here the marginal costs are the same for all destinations but can vary over time. They are still measured by the time effect $\theta_t$. As given in equation (1), the mark-up is constant but can vary across the destinations, which implies $\lambda_i \neq 0$. Now the

parameter $\lambda_i$ measures the markup relative to the reference country.[8] The markups are constant percentages. The changes in the bilateral exchange rates do not influence the export prices in different destinations, which means $\beta_i = 0$ applies (see Table 3: market situation B).

The third market situation is based on price discrimination with varying demand elasticities. In this market situation, the demand elasticity can vary due to the influence of exchange rate changes. When demand elasticities change, the markup will also change through the marginal costs and the export prices depend on exchange rates. This corresponds with the PTM model of Krugman (1986, 1987), since the optimal markup of a price discriminating monopolist varies between the different destinations and depends on the bilateral exchange rates. In reference to equation (1), this means $\lambda_i \neq 0$ and $\beta_i \neq 0$. Whether the expected leading sign for $\beta_i$ is negative (positive) depends on whether the demand is less (more) convex than in the demand function with constant elasticities. A negative coefficient $\beta_i$ is consistent with the original idea of the PTM according to Krugman (1986, 1987) (see Table 3: market situation $C_1$). In contrast, a positive coefficient implies that the exporter increases the effect of the exchange rate (see Table 3: market situation $C_2$).

This discussion could be extended based on Glauben and Loy (2003). It is in particular interesting, whether panel methods could improve the interpretation (see page 14-15 there).

**5. Data and descriptive statistics**

The data for the empirical analysis are formed by two panel datasets of Russian nitrogen and potash fertiliser exports. The data covers the period from 1996 to 2012 and contain the average annual exchange rates and export unit values $(EUV)$ on an FOB basis for the respective export goods. The two export goods constitute aggregates at the 4-digit level of the harmonised code (HS) for nitrogen HS-3102 "Mineral or Chemical Nitrogen Fertiliser" and potash HS-3104

[8]The reference country is the country with the dummy that was excluded to avoid singularity Fahlbusch (2009, p. 43).

"Mineral or Chemical Potash Fertiliser"[9]. The annual unit values for the two export raw materials being examined were determined from the ratio of the export value $(EV)$ and the export quantity $(EQ)$ for the two export goods: $EUV_{(i,j)} = EV_{(i,j)}/EQ_{(i,j)}$, where $i$ represents the exporting country (Russia) and $j$ the importing destinations. These data were taken from the goods trading statistics of the United Nations (COMTRADE, 2015).

However, the use of unit values or export unit values also has disadvantages. They aggregate data across products for different applications. This assumes that there are no quality differences and that all goods transported to the different destinations are identical (Lavoie & Liu, 2004, p. 2). Knetter (1989) argues that systematic differences in product quality can be accounted for with the help of country dummies. Changes in product qualities that are the same across the countries can be captured the same way with time effects (Lavoie & Liu, 2004, p. 3).

The average annual exchange rates are calculated as the value of a Russian rouble in the currency of the respective destination. Data from the international finance statistics of the International Monetary Fund (IMF, 2015) and Forex trading as well as the foreign exchange services of the OANDA website (OANDA, 2015) are used to calculate the average annual exchange rates. Furthermore, missing exchange rates are obtained from the information of central banks. The OANDA online database lacks the exchange rates for the countries of Georgia, Kyrgyzstan and Moldavia for the years 1996 through 2006 and, for the Ukraine, the exchange rates for the years 1996 and 1997. The missing exchange rates for the countries of Georgia and Kyrgyzstan are calculated indirectly based on the IMF data since the IMF database only offers the exchange rates in US dollars per national currency. For the PTM analysis however, the variable "exchange rate measured in the currency of the import country per currency unit of the export country" is required (here: "national currency per Russian rouble"). Here the variable "US dollar per national (local) currency" was multiplied by the variable (exchange rate) "US dollar per Russian rouble". The result is the variable "Russian rouble per national (local) currency". With the inverse value, one obtains the variable required for the PTM analysis. However, the IMF

[9] Tables A1 and A2 in the appendix to this article show the descriptive statistics for the endogenous and exogenous variables of the individual panel datasets that were compiled for the analysis of Russian fertiliser export markets for nitrogen and potash.

database did not contain the values for the corresponding years for Moldavia. These gaps are filled with data from the Russian and Moldavian central banks. Another problem with using the OANDA online database is that it does not take into account the 1998 currency reform in Russia. Therefore, the exchange rates for the years 1996 and 1997 need to be adjusted by the factor of 1:1,000. The exchange rates for the countries in the Eurozone also required extra treatment: for countries that converted to the Euro in 1998, the exchange rates for the time before the conversion had to be converted to Euros using the officially prescribed exchange rates. Here Finland, France, Italy and Spain are affected. For the Euro countries that adopted the Euro later on (Slovakia – 2008, Estonia – 2010, Latvia – 2013 and Lithuania – 2014), the exchange rates are left in the domestic currency. For Turkey that converted from the "old Turkish lira" to the "new Turkish lira" in 2005, the exchange rates in the currency "new Turkish lira" are used (1,000,000 TRL = 1 TRY).

The countries for the study are selected according to two criteria: for one, those countries importing relatively large quantities of the two goods from Russia and simultaneously buying nitrogen or potash from Russia regularly over the years are selected. Here the datasets in the COMTRADE database are analysed regarding the observations of the trade value. Countries with fewer than 16 observations are excluded. As a result of this analysis, 28 countries are included in this study for Russian nitrogen exports.

Tables A1 and A2 in the appendix show the descriptive statistics of the model variables for the panel dataset used for the econometric analysis of the Russian export market for nitrogen and potash fertilisers. There are relatively large variations in the export unit values (EUV) and nominal exchange rates (NER) between the countries. The EUV ranges from 1.922 roubles (Vietnam) to 5.160 roubles (Mongolia) for nitrogen. The variation coefficient of the exchange rates ranges from 0.702 (Georgia) to 0.953 % (France). The nominal exchange rates (NER) range from 0.032 roubles (Latvia) to 820.392 roubles (Vietnam). Here the variation coefficient ranges from 0.249 (Moldavia) to 1.114 % (Lithuania). For potash fertiliser, the EUV ranges from 4.293 roubles (India) to 8.153 roubles (Ukraine). Here the variation coefficient has a range from 0.845 (China) to 1.459 % (Ukraine). The nominal exchange rates (NER) range from 0.045 roubles (Finland) to 11.555 roubles (Hungary). The variation coefficient ranges from 0.255 (Ukraine) to 0.955 % (USA).

## 6. Estimation results of the panel model analysis

The econometric model analysis of Russian fertiliser export markets for nitrogen and potash fertilisers is conducted in the statistics program STATA (version 13) with the application of several estimation methods (STATA, 2015, pp. 446-481). Initially the least squares dummy variable estimator (LSDV estimator) with dummy variables for cross-section and time series effects with robust standard errors is used. Then the PTM model is estimated as a linear regression with a panel-corrected standard error and application of the panel-specific AR1 autocorrelation structure. Finally, an econometric estimation of the PTM model is performed using the fixed effect model (FE), a panel model with country-specific and time-specific fixed effects. The estimated coefficients of the PTM models are robust and nearly identical, regardless of the estimation method. Tables 4 and 5 show the estimation results for the PTM models using the fixed effect estimates for nitrogen and potash fertilisers.

While the same number of periods is available for the analysis of both export markets (t = 17), the number of destinations differs. There are 28 destination countries for the nitrogen fertiliser market and 9 destination countries for the potash fertiliser market. The descriptive statistics of the panel data used and the number of observations indicate that an unbalanced panel is being used for the analysis of the nitrogen fertiliser market. The analysis of the nitrogen fertiliser market is based on a balanced panel. The number of observations is 474 and 153 accordingly. The determination coefficient of 0.608 for the nitrogen market and 0.511 for the potash fertiliser market exhibits a good fit for the estimated PTM models.

While nearly half at 26 of 56 estimated PTM parameters for the nitrogen fertiliser market are statistically significant with a 10 % significance level, more than two-thirds of the estimated PTM parameters for the potash fertiliser market are statistically significant at the 10 % significance level. As expected, the estimated parameters for the country price effect and the exchange rate elasticity coincide with the theoretical model result. Comparing the results of this study with the results obtained by Pall et al. (2013) and Gafarova et al. (2015) for the Russian wheat export market shows that the estimated parameters are very similar.

### 6.1 Export market for nitrogen fertiliser

A central result of this study is the insight that there is imperfect competition in the Russian export market for nitrogen fertiliser in two-thirds of the destination countries that are studied (17

out of 28 countries). There is imperfect competition due to different markups in Finland, Georgia, Hungary, Mongolia, Moldavia, Norway and Vietnam. The demand elasticity varies and the effect of the exchange rate is significantly different from zero ($\beta_i \neq 0$). Russian nitrogen exports stabilise the price in the domestic currency by adjusting the exchange rates in Mexico and Norway ($\beta_i < 0$) and intensify the effect of exchange rate changes in Finland, Georgia, Hungary, Mongolia and Vietnam ($\beta_i > 0$) (see Table 4, market situation $C_1$ and $C_2$).

**Table 4: Results of the PTM model for nitrogen export**

| Destinations | $\lambda_i$ | *t*-Statistic | $\beta_i$ | *t*-Statistic | Market situation |
|---|---|---|---|---|---|
| Argentina | - | - | 0,160 | [1,67] | A |
| **Brazil** | 0,246 | [0,95] | **0,198**** | **[2,56]** | $C_2$ |
| **China** | 0,030 | [0,12] | **0,290***** | **[5,12]** | $C_2$ |
| Estonia | -0,291 | [-1,34] | 0,048 | [0,75] | A |
| **Finland** | **0,624**** | **[2,75]** | **0,239***** | **[4,10]** | $C_2$ |
| France | -0,246 | [-1,15] | 0,035 | [0,39] | A |
| **Georgia** | **1,187**** | **[2,42]** | **0,525***** | **[4,09]** | $C_2$ |
| Honduras | -0,227 | [-1,11] | 0,089 | [0,45] | A |
| **Hungary** | **-0,924***** | **[-3,02]** | **0,193***** | **[4,53]** | $C_2$ |
| India | -0,431 | [-1,49] | **0,314***** | **[3,40]** | $C_2$ |
| Italy | -0,372 | [-1,40] | -0,048 | [-1,32] | A |
| **Kyrgyzstan** | -0,477 | [-1,58] | **0,577*** | **[1,78]** | $C_2$ |
| **Latvia** | 0,146 | [0,65] | **0,117***** | **[3,07]** | $C_2$ |
| **Lithuania** | -0,199 | [-1,02] | **0,102**** | **[2,56]** | $C_2$ |
| **Malaysia** | -0,136 | [-0,58] | **0,193***** | **[3,83]** | $C_2$ |
| **Mexico** | -0,242 | [-1,09] | **-0,122*** | **[-1,81]** | $C_1$ |
| **Moldova** | **0,485**** | **[2,52]** | **0,970***** | **[9,10]** | $C_2$ |
| **Mongolia** | **-1,375***** | **[-2,99]** | **0,364***** | **[4,64]** | $C_2$ |
| Morocco | -0,198 | [-0,92] | **0,179***** | **[2,98]** | $C_2$ |
| **Norway** | **-1,111***** | **[-4,40]** | **-0,577***** | **[-3,53]** | $C_1$ |
| Poland | -0,156 | [-0,63] | 0,059 | [0,77] | A |
| Slovakia | -0,294 | [-1,17] | 0,033 | [0,92] | A |
| Spain | -0,375 | [-1,49] | -0,038 | [-0,40] | A |
| Turkey | -0,345 | [-1,28] | 0,086 | [1,47] | A |
| **Ukraine** | **-1,754*** | [-1,86] | -0,769 | [-1,68] | B |
| United Kingdom | -0,327 | [-1,61] | -0,039 | [-0,86] | A |
| **USA** | 0,006 | [0,02] | **0,114***** | **[3,66]** | $C_2$ |
| **Vietnam** | **-5,596***** | [-5,05] | **0,718***** | **[5,10]** | $C_2$ |
| Constant | 1,270*** | [5,18] | - | - | |
| Observations | 474 | Groups | 17 | | |
| $R^2$-squared | 0,608 | $R^2$: within | 0,608 | | |
| $R^2$: adjusted | 0,556 | $R^2$: overall | 0,001 | | |
| AIC | -280,509 | $R^2$: between | 0,623 | | |

Notes: The reference country is Argentina. Star symbols ***, ** and * represent the significance levels of 1, 5 and 10 percent.
Source: Author's own estimation.

Countries in which PTM is proven and where Russia also has few competitors and/or a high market share are Moldavia with two competitors and 72.7 % market share, but especially Mongolia with no competitors and 96.8 % market share and Ukraine with one competitor and

92.8 % market share (see Table 1). In addition, the transportation costs are low due to geographical conditions. The adjustment of the mark-up induced by the bilateral exchange rate changes depends on the elasticity of the residual demand. If this is less convex a constant elasticity is set. Then Russian nitrogen exports stabilise the price in the domestic currency (negative exchange rate effect). This is the case in Mexico and Norway. On the other hand, the price in the domestic currency increases when the residual demand becomes inelastic. Then Russian nitrogen exports stabilise the prices in the domestic currency. These results do not harmonise with possible explanations for price stabilisation in the local currency determined by Knetter (1989: 207-208). The market size in both Mexico and Norway is relatively small. Firstly, share of Russian export to destination of total Russian exports correspond to 6.7 and 0.2 % respectively. Secondly, Russian's market share in the total imports of the destination market accounts for 31.2 % in Mexican and 7.6 % in Norwegian markets (see Table 1). A further explanation regarding the number of competitors or competing companies does not confirm the hypothesis. The number of competing countries is relatively small: six for Mexico and seven for Norway (see Table 1).

The estimated parameters of the PTM model for the Russian export market for nitrogen fertilisers indicate that there is a competitive market or perfect competition in only one-third of the destination countries (Estonia, France, Honduras, Italy, Poland, Slovakia, Spain, Turkey and the UK). Here both the price-specific country effect and the effect of the exchange rate are not statistically significant (see Table 3, market situation A). One can assume that the residual demand for Russian nitrogen is elastic and the behaviour is competitive. Another possibility is that Russia has market power but the countries are too well integrated into the world market and arbitrage is possible. This would balance out any price difference so that Russia would not engage in any price discrimination. The law of one price applies in these countries. Russia therefore applies the same markup for these countries. All of the countries exhibiting no indications of price discrimination in the results are well integrated into the world market. With the exception of Slovakia, all of them are coastal states. This means that Russia has many (potential) competitors in these destinations and/or accounts for only a small proportion of the total nitrogen imports. Here Estonia is an exception. With a market share of 83.2 percent, Russia dominates the Estonian fertiliser market and is the leading supplier there (see Table 1). It is

therefore likely that the residual demand for Russian nitrogen is elastic and the behaviour is competitive.

Only for the Ukraine the estimation results indicate the second market situation B with constant demand elasticity with a constant markup (see Table 3). This is indicated by the price effect, which is significantly different from zero and the exchange rate effect that is not significantly different from zero. It is important to note that a statistically significant price effect does not necessarily indicate imperfect competition, since the price effect can also capture constant quality differences here (Falk & Falk, 2000; Knetter, 1989). See the discussion in Glauben and Loy (2003) on the impact of exchange rates on costs p. 14-15.

### 6.2 Export market for potash fertiliser

In contrast to Russian nitrogen exports, eight out of nine countries exhibit an imperfect competitive market with the application of different markups. The analysis finds PTM in four countries – China, Hungary, Malaysia and India. Each of them exhibits imperfect competition with different markups. Following the theory, there are different demand elasticities. In all countries where PTM is found, Russian potash exports stabilise the price in the local currency ($\beta_i < 0$) (see Table 5, market situation $C_1$).

**Table 5: Results of the PTM model for potash export**

| Destinations | $\lambda_i$ | *t*-Statistic | $\beta_i$ | *t*-Statistic | Market situation |
|---|---|---|---|---|---|
| **Brazil** | - | - | **-1,254*** | **[-2,06]** | $C_1$ |
| **China** | **2,369*** | **[2,08]** | **-0,670*** | **[-1,93]** | $C_1$ |
| **Finland** | 0,676 | [1,60] | **-0,717*** | **[-1,83]** | $C_1$ |
| **Hungary** | **4,970*** | **[1,93]** | **-0,868*** | **[-1,78]** | $C_1$ |
| **Indian** | **3,442*** | **[1,88]** | **-0,858*** | **[-1,77]** | $C_1$ |
| **Malaysia** | **1,335*** | **[2,01]** | **-0,848*** | **[-1,78]** | $C_1$ |
| **Poland** | 1,197 | [1,62] | **-0,935**** | **[-2,21]** | $C_1$ |
| Ukraine | 5,659 | [1,70] | 1,471 | [1,14] | A |
| **USA** | 0,659 | [1,65] | **-0,761*** | **[-1,92]** | $C_1$ |
| Constant | **-1,254*** | **[-2,06]** | - | - | |

| | | | |
|---|---|---|---|
| Observations | 153 | Groups | 17 |
| R-squared | 0,511 | R2: within | 0,511 |
| R2: adjusted | 0,449 | R2: overall | 0,658 |
| AIC | 87,612 | R2: between | 0,787 |

Notes: The reference country is Argentina. Star symbols ***, ** and * represent the significance levels of 1%, 5% and 10%.
Source: Author's own estimation.

The analysis of Russian potash exports in the period from 1996 to 2012 shows that only Ukraine exhibits a competitive market out of the countries that are studied (see Table 5, market situation

A). PTM is not found in any of the countries where the price effect is not significant. Otherwise, Russia would apply a markup in those countries when this compensates for the effect of exchange rate changes, since the export price should always be higher than the marginal costs. This indicates that Russia applies a common market on the marginal costs (see Table 3, market situation B).

Russia does not have a dominant market position for potash in any of the countries that are under study here (see Table 2). Only in Hungary with a Russian market share of 72.1 % could such a market scenario be conceivable. Russia has three competitors for this destination. Hungary is also well integrated into the world market.

The results of the PTM model of the Russian potash export market are defined to a great extent by the negative estimated parameters for the elasticity of the export price in reference to exchange rate changes. One can establish the hypothesis that price stabilisation in the local currency can be due to price fixing and cartel agreements by the Russian exporters in the export market for potash fertilisers. These agreements have to be assigned to the international market shares.

## 7. Summary and conclusions

The results of this paper indicate speculation around the collapse of the potash cartel on the use of price discrimination and the exercising of market power in the international fertiliser market by Russia. The descriptive analysis shows that Russia plays an important role in the export of nitrogen and potash on the world market and many importing destinations. Not only the consistently large export quantities are striking, but also the partly high market share in the overall international market and in various importing countries. Often Russia in addition to the high market share also has no or few competitors in the various destinations, which supports speculation of exercising market power.

The empirical model estimates for the nitrogen fertiliser market show that there is evidence of PTM behaviour by the Russian fertiliser exporters in 7 out of 28 destination countries. Out of these countries, Russia has few competitors and/or a high market share only in Moldavia, Mongolia and the Ukraine. The econometric estimation results for the potash fertiliser market indicate price discrimination behaviour of the Russian potash fertiliser exports for 8 out of 9

destination countries. However, Russia does not have a significantly large market share and/or few competitors here. Hungary could be an exception here. A sufficiently perfect market is found in only one of 9 countries under study.

The empirical results for the analysis of the behaviour of Russian exporters in the international markets for nitrogen and potash fertilisers can be summarised as follows: One, based on price fixing and cartel agreements, the hypotheses regarding price discrimination behaviour by the Russian exporters in the export markets can be tested empirically using the pricing-to-market approach. The interpretation of the estimated parameters of the model is economically plausible and corresponds to the stated hypotheses. Two, the estimation results indicate that market power in the export market for nitrogen fertilisers is exercised by Russian exporters in more than two-thirds of the destination countries and in the export market for potash fertilisers in eight out of nine countries. Three, exercising market power in the export market for potash fertilisers is much more pronounced than in the nitrogen fertiliser export market.

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## Appendix

### Table A1: Summary statistics of export unit values and exchange rates on nitrogen data set (HS-3102)

| Destinations | N | Export unit values (EUV) | | | | Nominal exchange rate (NER) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | MEAN | MIN | MAX | CV | MEAN | MIN | MAX | CV |
| Argentina | 17 | 3.711 | 0.452 | 10.990 | 0.893 | 0.114 | 0.034 | 0.200 | 0.417 |
| Brazil | 17 | 4.080 | 0.497 | 10.005 | 0.763 | 0.095 | 0.057 | 0.200 | 0.473 |
| China | 16 | 3.398 | 0.665 | 8.071 | 0.735 | 0.470 | 0.203 | 1.600 | 0.955 |
| Estonia | 17 | 3.994 | 0.484 | 11.186 | 0.860 | 0.765 | 0.355 | 2.400 | 0.892 |
| Finland | 17 | 4.137 | 0.622 | 9.227 | 0.712 | 0.045 | 0.023 | 0.151 | 0.904 |
| France | 17 | 4.181 | 0.433 | 11.548 | 0.953 | 0.045 | 0.023 | 0.154 | 0.915 |
| Georgia | 16 | 3.752 | 0.741 | 10.123 | 0.702 | 0.090 | 0.053 | 0.200 | 0.568 |
| Honduras | 17 | 4.303 | 0.417 | 11.276 | 0.815 | 0.864 | 0.523 | 2.200 | 0.639 |
| Hungary | 17 | 3.184 | 0.470 | 9.492 | 0.830 | 11.555 | 6.360 | 32.300 | 0.749 |
| India | 17 | 4.441 | 0.636 | 11.779 | 0.855 | 2.406 | 1.509 | 6.900 | 0.748 |
| Italy | 17 | 4.408 | 0.447 | 11.885 | 0.804 | 0.045 | 0.023 | 0.155 | 0.919 |
| Kyrgyzstan | 17 | 4.526 | 0.364 | 12.095 | 0.858 | 1.695 | 1.362 | 3.000 | 0.259 |
| Latvia | 17 | 4.025 | 0.531 | 10.696 | 0.856 | 0.032 | 0.016 | 0.100 | 0.900 |
| Lithuania | 17 | 3.557 | 0.465 | 9.503 | 0.832 | 0.205 | 0.078 | 0.800 | 1.114 |
| Malaysia | 17 | 3.109 | 0.486 | 8.161 | 0.789 | 0.191 | 0.100 | 0.500 | 0.772 |
| Mexico | 17 | 4.644 | 0.383 | 11.400 | 0.785 | 0.557 | 0.308 | 1.500 | 0.687 |
| Mongolia | 17 | 5.160 | 0.812 | 12.695 | 0.771 | 50.550 | 35.174 | 102.784 | 0.421 |
| Morocco | 17 | 3.666 | 0.488 | 9.291 | 0.833 | 0.530 | 0.256 | 1.700 | 0.899 |
| Poland | 17 | 4.100 | 0.542 | 10.294 | 0.821 | 0.189 | 0.097 | 0.600 | 0.838 |
| Rep. Moldova | 17 | 3.730 | 0.669 | 9.464 | 0.755 | 0.478 | 0.353 | 0.800 | 0.249 |
| Season | 17 | 4.067 | 0.145 | 11.728 | 0.871 | 0.400 | 0.187 | 1.300 | 0.915 |
| Slovakia | 17 | 4.000 | 0.475 | 10.724 | 0.780 | 1.867 | 0.674 | 6.000 | 0.937 |
| Spain | 17 | 4.198 | 0.367 | 10.005 | 0.788 | 0.045 | 0.023 | 0.152 | 0.902 |
| Turkey | 17 | 2.998 | 0.288 | 7.673 | 0.848 | 0.042 | 0.016 | 0.058 | 0.331 |
| Ukraine | 17 | 3.305 | 0.125 | 8.868 | 0.832 | 0.228 | 0.170 | 0.358 | 0.255 |
| United Kingdom | 17 | 4.471 | 0.460 | 10.947 | 0.786 | 0.034 | 0.019 | 0.100 | 0.842 |
| USA | 17 | 3.673 | 0.512 | 9.490 | 0.790 | 0.060 | 0.032 | 0.200 | 0.955 |
| Vietnam | 17 | 1.922 | 0.478 | 6.002 | 0.808 | 820.392 | 486.419 | 2155.800 | 0.667 |

Source: Author's own calculations based on COMTRADE (2015), OANDA (2015),IMF (2015), the Central Bank of the Russian Federation and the National Bank of Moldova (NBM).

### Table A2: Summary statistics of export unit values and exchange rates on potash data set (HS-3104)

| Destinations | N | Export unit values (EUV) | | | | Nominal exchange rate (NER) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | MEAN | MIN | MAX | CV | MEAN | MIN | MAX | CV |
| Brazil | 17 | 5.555 | 0.344 | 15.663 | 0.917 | 0.095 | 0.057 | 0.200 | 0.473 |
| China | 17 | 5.192 | 0.451 | 14.749 | 0.845 | 0.459 | 0.203 | 1.600 | 0.953 |
| Finland | 17 | 5.533 | 0.468 | 20.583 | 0.998 | 0.045 | 0.023 | 0.151 | 0.904 |
| Hungary | 17 | 5.327 | 0.356 | 18.207 | 0.972 | 11.555 | 6.360 | 32.300 | 0.749 |
| India | 17 | 4.293 | 0.300 | 12.281 | 0.898 | 2.406 | 1.509 | 6.900 | 0.748 |
| Malaysia | 17 | 4.669 | 0.323 | 14.070 | 0.939 | 0.191 | 0.100 | 0.500 | 0.772 |
| Poland | 17 | 5.510 | 0.332 | 20.838 | 1.047 | 0.189 | 0.097 | 0.600 | 0.838 |
| Ukraine | 17 | 8.153 | 0.898 | 52.185 | 1.459 | 0.228 | 0.170 | 0.358 | 0.255 |
| USA | 17 | 5.752 | 0.351 | 18.427 | 1.050 | 0.060 | 0.032 | 0.200 | 0.955 |

Source: see Table A1