



**AgEcon** SEARCH  
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

*The World's Largest Open Access Agricultural & Applied Economics Digital Library*

**This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.**

**Help ensure our sustainability.**

Give to AgEcon Search

AgEcon Search

<http://ageconsearch.umn.edu>

[aesearch@umn.edu](mailto:aesearch@umn.edu)

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

*No endorsement of AgEcon Search or its fundraising activities by the author(s) of the following work or their employer(s) is intended or implied.*

# **The influence of infrastructure on regional wheat trade in Russia: A gravity model approach**

Swetlana Renner, Linde Götz, Sören Prehn and Thomas Glauben<sup>1</sup>

<sup>1</sup> Leibniz-Institute for Agricultural Development in Transition Economies (IAMO), Theodor-Lieser-Str.2, D-06120 Halle (Saale), Germany; contact: [goetz@iamo.de](mailto:goetz@iamo.de)



**Paper prepared for presentation at the EAAE 2014 Congress  
'Agri-Food and Rural Innovations for Healthier Societies'**

August 26 to 29, 2014  
Ljubljana, Slovenia

The authors gratefully acknowledge financial support by the Federal Ministry of Food and Agriculture and the Federal Office for Agriculture and Food (Germany).



*Copyright 2014 by S. Renner, L. Götz, S. Prehn und T. Glauben. All rights reserved. Readers may make verbatim copies of this document for non-commercial purposes by any means, provided that this copyright notice appears on all such copies.*

# **The influence of infrastructure on regional wheat trade in Russia: A gravity model approach**

Swetlana Renner, Linde Götz, Sören Prehn and Thomas Glauben

## **Abstract**

We investigate the determinants of Russian regional wheat flows focusing on the role played by transport costs and regional infrastructure. We adapt the Anderson & van Wincoop (2003) gravity model to regional trade by considering a regional border effect and by assuming that trade costs are also determined by infrastructure variables. Our model identifies positive effects of the number and the average loading capacity of grain rail terminals in the region. This analysis reveals substantial effects of infrastructure on interregional wheat trade in Russia. Especially, the quality of infrastructure seems to have a strong effect, suggesting that improvements of infrastructure should focus on the improvements of the quality rather than the quantity of infrastructure.

Key words: wheat trade, gravity model, infrastructure, Russia

## **Introduction**

In a large country as Russia with highly heterogeneous geographical landscapes interregional trade integration is essential for balancing supply and demand between surplus and deficit regions. Although wheat production in Russia significantly increased in the last 20 years the agricultural potential is distributed extremely unevenly between regions. While large volumes of wheat produced in the Southern federal district are almost exclusively exported to the world market, domestic wheat demand of the most densely populated regions of the Central federal district (including Moscow) is covered not only by suppliers from the neighbouring but also from the remote regions of Siberia. A well-developed transportation system is required to move grain from production areas to domestic and foreign feed and processing markets.

Both rail and road transportation play significant roles in the domestic grain market in Russia, while only small amount is moved by inland waterway. After harvesting, wheat is usually transported via tracks from fields to the next storage facility belonging to the agricultural producer, processing company or to the agricultural trading company. Major portion of the wheat produced in the region (70-80%) is sold within the same calendar year on the local market. Road transport is generally used for short distances under 300-400 km or where no railway infrastructure exists. Due to the long haulage distances between federal subjects of Russia, the inter-regional grain trade is dominated by railway transport. Moreover, railway transport plays the main role in the deliveries of grain to the export terminals of the Russian Federation. Major volume of the grain exported through the Black Sea ports (over 60%) is delivered to the grain terminals using railways. However, motor roads are widely used for the export shipments from grain storages located in southern regions of Russia (especially in the Krasnodar region). Due to large distances (on average 1,6 thousand km) and poor infrastructure, trade costs in Russia represent a significant share of average on-farm price, reducing competitiveness of grain producers, especially from the remote regions, and hindering interregional trade. This paper analyses the determinants of Russian regional wheat flows focusing on the role played by transport costs and regional infrastructure.

## **Literature review**

From a methodological perspective, our paper most resembles the study by Egger and Larch (2008) which investigate the influence of transport infrastructure endowments for bilateral trade using an Anderson & van Wincoop (2003) (AvW) gravity model. They find that international trade between two countries increases more if the railway infrastructure is enlarged than when the road infrastructure network is strengthened in these countries. Though, the impact of marginal changes in transport infrastructure on trade flows is rather small since the positive direct effects of investments in infrastructure are diminished by indirect effects of infrastructure investments in other countries. Anderson and van Wincoop (2003) investigate the “border puzzle” of McCallum (1995) according to which trade between Canadian provinces is 22 times (2200%) trade between US states and Canadian provinces across the US-Canadian border. They further develop the theoretical gravity model by introducing relative trade barriers. Thus, trade between two regions depends on the bilateral trade barriers relative to average trade barriers of both regions with all their trading partners, i.e. multilateral resistance. Contrasting to McCallum’s (1995) results, they find that the national border reduces trade between the US and Canada only by about 44%. They explain the difference in results by omitted variable bias. Further evidence of the influence of infrastructure on trade is provided by several existing studies. For example, Bougheas et al. 1999 develop a theoretical model of infrastructure, transport costs and trade by introducing transport costs and infrastructure costs as variables in their model. Results suggest that the benefit of infrastructure from a welfare point of view is the reduction in transport costs which leads to the decrease of the import price. Theory further suggests the stock of infrastructure and the volume of trade to be positively related. These theoretical predictions are confirmed by their empirical application to EU countries. The results of Limão and Venables (2001) suggest that infrastructure is a primary determinant of transport costs. They find that poor infrastructure accounts for 40% of transport costs for coastal countries and up to 60% for landlocked countries. Portugal-Perez and Wilson (2012) extend the Helpman et al. (2008) model framework by introducing hard and soft infrastructure of an exporting country as a determinant of trade costs. They find that investments in physical infrastructure and reforms which improve the business environment enhances export performance of developing countries, though the marginal effect of transport efficiency and business environment is decreasing in per capita income. Unlike, the marginal impact of investments in internet and communication technology and physical infrastructure increases with per capita income.

## **Model approach and data**

We analyze the importance of infrastructure for intra-Russian wheat trade based on the Anderson & van Wincoop (2003) (AvW) gravity model which has the advantage that it accounts not only for bilateral trade resistance but also for multilateral resistance, i.e. third country effects of trade costs are explicitly considered. Thus, trade between two regions is determined by the bilateral trade barrier relatively to the average trade barriers of both regions with all their trading partners. The AvW Model is given by

$$X_{ij} = \left(\frac{Y_i Y_j}{Y^w}\right) \left(\frac{\tau_{ij}}{\Pi_i P_j}\right)^{1-\sigma} \quad \text{where} \quad \Pi_i^{1-\sigma} = \sum_j \left(\frac{\tau_{ij}}{P_j}\right)^{1-\sigma} \frac{Y_j}{Y^w} \quad \text{and} \quad P_j^{1-\sigma} = \sum_i \left(\frac{\tau_{ij}}{\Pi_i}\right)^{1-\sigma} \frac{Y_i}{Y^w}$$

with  $X_{ij}$  giving the quantity of wheat traded by the wheat exporting region  $i$  to the wheat importing region  $j$ .  $\tau_{ij}$  are bilateral trade costs between  $i$  and  $j$ , and  $\Pi_i$  and  $P_j$  are outward and inward multilateral resistance, respectively. The outward multilateral resistance indicates the average trade resistance exporting country  $i$  faces with all regions, whereas the inward multilateral resistance refers to the average trade resistance an importing country  $j$  faces vis-à-vis all its trading partners.  $Y_i$  is  $i$ 's wheat production, and  $Y_j$  and  $Y^w$  are  $j$ 's and total Russian wheat consumption.  $\sigma$  indicates the elasticity of substitution. We adapt the AvW model to regional trade by considering a regional instead of an international border effect and assume that the bilateral trade costs  $\tau_{ij}$  between  $i$  and  $j$  are not only determined by bilateral distance  $ij$  and if regions  $i$  and  $j$  share a common border (adjacency), but also by infrastructure. We account for this in our model by introducing additional infrastructure variables as specified below.

Our dependent variable, the inter-regional wheat trade, is defined as an aggregated annual volume of rail freight flows between regions of Russia. Data is based on the rail transportation documents (rail consignment notes) recorded by the JSC Russian Railways (RZD). In the recent empirical analysis we consider domestic transportation of wheat during the marketing year 2011/2012.<sup>1</sup> Russian regions are represented by 83 federal subjects. We exclude regions that neither produce nor consume wheat and include federal cities Moscow and Sankt-Petersburg in the surrounding Moscow and Leningrad Oblast. As a result, we consider domestic wheat transportation between 62 regions (including freight within region), resulting in total of 3844 observations in our model.

We represent bilateral trade costs  $\tau_{ij}$  by distance (in km), the dummy variable adjacency  $ij$ , and by the exporter specific infrastructure variables average number of grain train stations (per km<sup>2</sup>) and average size of grain train stations (t). We indirectly capture grain trade by trucks by including the average density of roads in region  $i$  as an additional infrastructure variable. We choose wheat production of region  $i$  (in t) as an indicator of the region's wheat supply, and  $j$ 's wheat consumption is approximated by  $j$ 's flour production, pig production (head/km<sup>2</sup>) and poultry production (head/km<sup>2</sup>) which we retrieve from Rosstat (2013). In contrast to conventional empirical specification of gravity models, we estimate our model by a random intercept Poisson Pseudo Maximum Likelihood (PPML) approach (Prehn et al. 2014), which takes into account the unobserved regional heterogeneity, which is usually estimated using the fixed effects approach. However, it also allows for the estimation of exporter- and importer-invariant variables such as infrastructure variables.

## Model results

The estimates for our model parameters (Table 1) confirm the negative influence of distance on interregional trade volumes. Also, trade is higher if two regions are adjacent to each other. Both effects are highly statistically significant. Among the multilateral effects of the exporter region our model identifies a positive effect of the number of the grain rail station.

---

<sup>1</sup> Besides the domestic transportation data base contains import, export and transit transportation which were not considered in the calculation of intra-regional trade. Marketing year 2011/2012 is defined from 01.07.2011 to 30.06.2012.

**Table 1: Model estimation results**

	<b>Coefficient</b>	<b>Std. Error</b>	<b>z value</b>	<b>Pr(&gt; z )</b>
Intercept	-1.558	0.793	-2	0.05 *
<b>within fixed effects</b>				
ln distance ij	-1.587	0.001	-1504	< 0.001 ***
adjacency ij	0.217	0.002	97.1	< 0.001 ***
<b>multilateral effects</b>				
number of grain train stations i	0.956	0.639	1.5	0.135
volume per grain rail station i	3.184	0.894	3.6	<0.001 ***
road density i	-1.097	0.465	-2.4	0.018 *
wheat production i	1.091	0.354	3.1	0.002 **
flour production j	0.235	0.447	0.5	0.598
pig production j	1.656	0.770	2.2	0.032 *
poultry production j	-0.452	0.860	-0.5	0.600

Further, parameter estimates suggest the quality of the infrastructure, represented by the size of the grain train stations, to have a strong and highly significant effect on regional trade. If the average volume of the grain rail terminals of an exporting region increases by 1%, regional grain trade raises by over 3%. We also find a statistically significant negative influence of road density in the exporter region on regional trade. This means that regions with a better developed road network transport less by train, probably because train transport is substituted by truck transport. Model results also suggest that a 1% increase in average grain production raises a region's exports by over 1%. Among the importer specific effects we identify trade increasing effects of flour and pig production, though the former are not statistically significant. Also, the negative effect of poultry production is not statistically significant.

## Conclusions

This analysis of regional wheat trade flows within Russia reveals substantial effects of infrastructure on interregional wheat trade flows. Especially, the quality of infrastructure, which is captured by the size of the grain train terminals, seems to have a strong effect, suggesting that the improvement of infrastructure should focus on the improvement of the quality rather than the quantity of infrastructure. Also, the strong negative effect of road

density indicates that rail grain transport and transport by truck are substitutes rather than complements for regional trade.

Our model results have to be seen before the background that we focus on domestic trade flows with domestic destinations and leave out all trade flows for export in our analysis. As pointed out above, wheat grain is primarily exported via the ports of the Black Sea, and large trade flows are observed from wheat grain production regions among Russia to the exporting region. Thus, parameter estimates for trade flows for domestic consumption might be different to those for export to the world market. Also, we might identify strong regional differences. For example, for producing regions which are far away from the export region, wheat grain transport by train might be of higher importance than for regions which are close. In the future we will extend our analysis accordingly.

## References

Anderson, J.E. and van Wincoop, E. (2003). 'Gravity with Gravitas: A Solution to the Border Puzzle.' *American Economic Journal*, 93(1): 170-192.

Bougheas, S. et al. (1999). 'Infrastructure, transport costs and trade.' *Journal of International Economics*, 47: 169-189.

Egger, P. and Larch, M. (2008). 'The Bilateral and Multilateral Trade Effects of Road and Railway Transport Infrastructure.' Munich, Germany: Ifo Institute for Economic Research, Ludwig-Maximilian University of Munich.

Helpman, E. et al. (2008). 'Estimating trade flows: Trading partners and trading volumes.' *The Quarterly Journal of Economics*, 123(2), 441-487.

Limão, N. and Venables, A.J. (2001). 'Infrastructure, Geographical Disadvantage, Transport Costs, and Trade.' *The World Bank Economic Review*, 15(3): 451-479.

McCallum, J. (1995). 'National Borders Matter: Canada-U.S. Regional Trade Patterns.' *The American Economic Review*, 85(3): 615-623.

Portugal-Perez, A. and Wilson, J.S. (2012). 'Export Performance and Trade Facilitation Reform: Hard and Soft Infrastructure.' *World Development*, 40(2): 1295-1307.

Prehn, S., Brümmer, B. and Glauben, T. (2014). 'Gravity Model Estimation: Fixed Effects vs. Random Coefficient Poisson Pseudo Maximum Likelihood.' Working Paper.

Rosstat (2013): Grain rail transport data, unpublished.