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The Effectiveness of EC Policies to Move Freight from Road to Rail: Evidence from CEE Grain Markets

Russell Pittman,¹ Monika Jandová,² Marcin Król,³ Larysa Nekrasenko,⁴ and Tomáš Paleta⁵

Abstract

The European Commission years ago adopted a policy of encouraging the substitution of motor carrier haulage of freight with rail and water carrier haulage, as part of its “green” agenda of reducing fuel consumption, emission of pollutants, carbon intensity, and road congestion. Regarding railway freight in particular, one policy tool that the Commission has emphasized for this purpose is the restructuring of the rail sectors of member countries through the creation of competition for the incumbents by new train-operating companies (TOC’s) – on its face a less obvious policy choice than alternatives such as Pigouvian pricing measures or infrastructure subsidies. This paper focuses on one important commodity group – grain – in three EC member states and one non-member state – Poland, the Czech Republic, Slovakia, and Ukraine – to examine the degree to which increased rail competition has been associated with increases in rail’s modal share, and more broadly to learn what appear to be the binding constraints to increases in rail’s share. Such constraints seem more closely related to shortages in infrastructure capacity than to a lack of competition among TOC’s. This suggests that other “models” of railway restructuring may be more effective in easing this constraint.

Key words: European Commission, railways competition, environmental protection, open access, motor carriers, intermodal competition.

JEL codes: L92, Q58, R11, R41, R42, R48

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The Effectiveness of EC Policies to Move Freight from Road to Rail: Evidence from CEE Grain Markets

1.1 Introduction

The European Commission many years ago adopted a policy of encouraging the substitution of motor carrier haulage of freight with rail and water carrier haulage, as part of its broader “green” agenda of reducing fuel consumption, emission of pollutants, carbon intensity, and road congestion. Regarding railway freight in particular, one policy tool that the Commission has emphasized for this purpose is the restructuring of the freight rail sectors of individual countries through the creation of competition for the incumbents by new train-operating companies (TOC’s).

The fact that the Commission emphasizes the creation of competition as a device for encouraging modal substitution and so reducing environmental externalities – in comparison with an arguably lesser focus on more traditional instruments such as Pigouvian taxation and infrastructure subsidies – has perhaps received less attention by scholars and policy analysts than might have been expected.

In this paper we seek to examine how this policy works in practice in one specific context: the shipment of grains in the countries of the Czech Republic, Poland, Slovakia, and Ukraine. Grain is a commodity cargo that is typically transported in bulk and in large quantities, characteristics generally favorable to transport by rail. On the other hand, as grain production is both variable and difficult to forecast, grain logistical chains must be both reliable and elastic. All this makes grain transport markets an interesting research field for those examining the effectiveness of policy efforts both to create competition in freight rail and to encourage the movement of freight from road to rail (and water).

We find that while competition among freight rail operators has indeed been successfully created in the first three of these countries – reform policies remain a matter of debate in Ukraine – there has been little success in moving the shipment of grains “off the road” and onto the rail or water. Nor – consistent with the evidence of the broader literature on intermodal competition in the hauling of grain – have Pigouvian instruments been effective in this area (though in these countries they have arguably not been much tried).

Rather, it appears that the binding constraint both in the recent past and going forward to moving grain haulage to the rail and water modes has been capacity limitations in infrastructure – in particular bottlenecks in crucial locations that make rail haulage slow, unreliable, and expensive, in addition a frequent poor matching of rail networks with the locations of grain shippers, as well as a lack of attention to conditions necessary to support river haulage, especially in Poland and Ukraine.

We argue that attention to these capacity constraints in the rail sector going forward is likely to be more effective – indeed a necessary condition – for this mode to grow its share of the haulage of grains and thus to reduce the share traveling by road. One important element to consider seems to be rehabilitation or construction of these infrastructure facilities that are required for the operation of single wagonload services (e.g., marshalling yards and private sidings). These facilities are important for enabling rail to compete with road transport on relatively small shipments. In turn, we argue that the specific rail restructuring model chosen for the creation of competition by the Commission – competition among TOC’s operating on monopoly, state-owned infrastructure – may be exactly the

wrong model for addressing what appears to be the binding constraint on rail's share in freight haulage in these countries – rail capacity limitations – because of its lack of focus on attracting investment into infrastructure. As Pittman (2017a) has pointed out, the “horizontal separation” model of railways restructuring has been much more effective than the vertical separation or third-party access models in attracting private investment into the rail infrastructure.

We conclude that a continued focus on creating open access competition in freight railways, while arguably defensible on other grounds such as the protection of shippers from monopoly and improved effectiveness of the targeting of subsidies, does not seem the most promising policy for moving freight traffic off the roads and onto the rails.

2.1 EC Policy: More Freight by Rail

The European Commission has by now a well-established policy of seeking to reduce the share of freight traveling by road while increasing the share traveling by rail, and, with lesser emphasis, water.⁶ This policy direction has as its stated rationale both reducing the road congestion caused by freight haulage by truck and making use of the relative superiority of rail and water over truck in terms of environmental externalities such as fuel consumption, air pollution, and carbon emissions (European Commission, 2001a, 2011). One of the notable aspects of this policy is the focus in its implementation on the creation and encouragement of competition among TOC's over the monopoly infrastructure of each EU country's railway. This is to be accomplished ideally through complete “vertical separation” of train operations from infrastructure management, though in practice the Commission has tolerated less complete forms of separation.

The focus on the creation of open-access competition is perhaps not the most obvious choice for a policy focused on the overcoming or internalization of the externalities associated with road haulage of freight; one might have expected more reliance on Pigouvian measures such as taxes on externalities and congestion charges and/or on increased resources devoted to expanding and improving capacity in the rail and water modes. Nash and Rivera-Trujillo (2004) point out that Pigouvian measures were emphasized both in a “green paper” issued in 1995, “Toward Fair and Efficient Pricing,” as well as in proposals and directives regarding infrastructure charging issued in 1998 and 2001; however, they argue, implementation has been “limited”. Vassallo and Fagan (2007) contend on the other hand that the EC has not really been negligent in this regard, pointing to relatively high fuel taxes, widespread highway tolls, and long-standing subsidies on rail infrastructure in the EU.⁷ DGIP (2015) argues that

A number of initiatives targeted at modal shift from road to rail have been introduced at the EU level.... In parallel, Member States have implemented a range of measures, including direct financial support targeted at rail infrastructure development.... Taken together, however, national measures have not had a major impact on modal shift. This can be attributed to the generally small scale of the investment in rail and intermodal transport relative to investment in

⁶ There is a large literature on this topic. See, for example, Nash and Rivera-Trujillo (2004); Knieps (2013); Zunder, *et al.* (2013); van de Velde (2015); and Fitzová (2017).

⁷ See also Furtado (2013); Casullo (2017); Nash (2017); and Schäfer and Götz (2017).

roads, and to a lack of coordination of rail freight policy initiatives at the EU and national levels. (p. 10)

A Special Report by the European Court of Auditors (ECA, 2016) is unambiguous:

Freight trains are charged for every kilometre of rail infrastructure used; this is not always the case for road transport. Externalities produced by rail and road transport (environmental impacts and pollution, congestion, accidents, etc.) are not taken into account in a comprehensive manner when setting the price to be paid by users for access to infrastructure.

The conclusions of the most recent EC evaluation, *Sustainable Transport Infrastructure Charging and Internalisation of Transport Externalities* (European Commission, 2019a) reaches a similar conclusion:

The results of the project show that the external and infrastructure costs of transport in the EU28 are only partly internalised. For most transport modes, only 15 to 25% of these costs are covered by revenues from current transport taxes and charges. There is also little evidence that marginal social cost pricing principles are applied on a large scale in transport pricing in the EU28. Finally, for most transport modes (except maritime transport and aviation) the infrastructure costs are not covered by infrastructure charges, reflecting that the “users-pays” principle is often not met.

The policy statements putting forth the introduction of competition as the fundamental tool for increasing the share of rail in EU freight transport began with the first “rail package” in 1991, whose top three stated goals were Community integration, railway efficiency, and “to render railway transport efficient and competitive as compared with other modes of transport”, and in which the emphasis was on a requirement for “accounting separation” of train operations from infrastructure management, along with a requirement for the provision of access to domestic infrastructure by international TOC’s (European Commission, 1991). In 2001, Council Directive 2001/14EC declared rail infrastructure a “natural monopoly” and issued more specific principles for the setting of infrastructure charges and the allocation of infrastructure capacity.

Later railway “packages” required member countries to institute “open access” for freight services, both national and international (2nd package, 2004), as well as open access for international passenger services, including cabotage (3rd package, 2007). Regulation 93/2010 encouraged the development of cross-border freight “corridors” for competing freight rail operators, including the coordination of both investment and charging regimes by infrastructure managers in different countries along a corridor (and even, remarkably, across corridors). Finally, the 4th package, issued in 2016, called for the liberalization of domestic passenger services, as well as introducing various measures to enhance safety and interoperability across borders. The 2nd package also created the European Union Agency for Railways, which sets system-wide interoperability standards.

During the same time period the Commission was issuing policy statements and goals that focused on transport more broadly, while including rail. “European transport policy for 2010: time to decide,” a “white paper” issued in 2001, repeated the call for increased rail shares in freight transport in the Union and again chose as its primary tool for this purpose the creation and enhancement of open-

access competition among TOC's -- this was in fact argued to be "the central precondition for revitalising the railways" (European Commission, 2001b, p. 27). In addition, the white paper lamented the persistence of bottlenecks at various points in the European rail network and called for the allocation of "efficient international train paths" to freight rail, "either in the form of infrastructure or as time slots" (pp. 32-33). The document set a target for rail's share of EU freight transport to increase from 8 percent to 15 percent by 2020 (p. 26). It also noted the historically high share of rail in freight transport in Central and Eastern Europe (CEE) and called for this share to remain at least at the 35 percent level through 2010 (p. 93).

A "mid-term review" of the 2001 white paper, titled "Keep Europe moving -- Sustainable mobility for our continent," confirmed the Commission's dedication to the goals of the original document, with a particular emphasis on "action to remove technical barriers to interoperability and mutual recognition of equipment" as well as a program "to promote rail freight corridors" (European Commission, 2006, p. 23). A second white paper, issued in 2011 and titled "Roadmap to a Single European Transport Area -- Towards a competitive and resource efficient transport system," reiterated many of the goals stated by the previous two documents, with a new emphasis on the importance of "effective and non-discriminatory access to rail infrastructure," preferably through "structural separation between infrastructure management and service provision," as a prerequisite for effective open-access competition (p. 18), as well as "considerable investment ... to expand or upgrade the capacity of the rail network" (p. 7).

A Special Report issued by the European Court of Auditors in 2016 (ECA, 2016) summarized the EU strategy as follows:

The EU's policy objectives for shifting goods from road to rail have been translated into a series of EU legislative measures mainly aiming at opening the market, ensuring non-discriminatory access and promoting interoperability and safety. The EU budget also contributed by approximately 28 billion euros to funding rail projects between 2007 and 2013.

Its evaluation of the success of the strategy was unsparing:

Overall, the performance of rail freight transport in the EU remains unsatisfactory, and the position of road transport has grown further since 2000. Despite the EU policy objectives set by the Commission of shifting freight from road to rail and the EU funding available for rail infrastructure, rail freight transport performance in the EU is unsatisfactory in terms of volume transported and modal share. On average, rail freight modal share at the EU level has actually declined slightly since 2011.

Finally, a 2018 report by the Directorate-General for Mobility and Transport, titled "Transport in the European Union: Current Trends and Issues", lamented the "struggles" of the rail sector to "achieve its potential", noting especially the "low quality and reliability" of freight rail, blaming this situation on "the lack of coordination in cross-border capacity offer, traffic management and planning of infrastructure works", as well as the "lack of effective competition" (DGMT, 2018, pp. 5-6). This report also called for more and better implementation of Pigouvian instruments such as road and fuel taxes,

auto registration taxes, and congestion charges, lamenting the lack of “systematic” and “effective” application of these measures across the Union (p. 21).

What has been the impact of more than two decades of policies seeking to move freight and passenger traffic off the roads? We believe that close examination of the evidence in particular countries may be interesting. In this paper we examine the grain and grain transport sectors in four CEE countries – the Czech Republic, Poland, and Slovakia, as well as a non-EU country, Ukraine – with a focus on the existing constraints to increasing the share of rail and water in transporting grain, as well as what appear to be the government policies most likely to be successful in relaxing those constraints and hence supporting the achievement of this EC policy goal.

3.1 Modal Choice: The Literature

On the specific topic of the progress of EC countries and transport sectors in achieving the ambitious modal shifting goals of the Commission as well as the steps necessary to achieve them ultimately, there have been a number of large-scale, sponsored “reports” as well as academic papers. In the former category are the following:

- *Potential of modal shift to rail transport: Study on the projected effects on GHG emissions and transport volumes* (den Boer, *et al.*, 2011, commissioned by the Community of European Railway and Infrastructure Companies);
- *Long-Distance Freight: Roadmap* (Åkerman, *et al.*, 2014, a report of TRANSFORuM, an EU-funded project);
- *Living in a sustainable world focused on electrified rail* (LIVINGRAIL, 2015, an EU-funded project);
- *The Grand Challenge: Pathways Towards Climate Neutral Freight Corridors* (Doll, *et al.*, 2017, a report of the project Low Carbon Rail Freight Corridors for Europe, funded by the private foundations Stiftung Mercator and the European Climate Foundation); and
- *Modal shift in European transport: a way forward* (Pastori, *et al.*, 2018, a report of Research4Committees, a research body serving the European Parliament).

In the latter category are papers by Aditjandra, *et al.* (2012) and Islam, *et al.* (2016).

There is a notable consistency in these studies, with of course some differences in emphases. Most important among the findings and conclusions for our purposes are the following:

- Demand for motor carrier, railway, and water freight transport are all price-inelastic; thus policy measures focused on pricing – for example, Pigouvian taxes – tend to have only minor impacts on overall modal shares and must be of large magnitude to have any impact at all;
- Railway infrastructure capacity is clearly a binding constraint in many countries, a fact that emphasizes the importance of policy measures that result in more efficient usage of that capacity (improvements in signaling, longer trains, more powerful locomotives, better timetabling, smoother cross-border moves); however,
- Improved utilization of existing capacity can only do so much, and if the Commission goals for rail are to be met, very large expenditures on the expansion of rail capacity will be required.

Among the factors missing from these studies, two stand out for our purposes:

- There is virtually no discussion of the further use of rail sector liberalization or on-track competition as a way to achieve the modal share goals (although Åckerman, et al. [2014] note the absence of correlation between liberalization measures taken and increases in rail modal share); and
- There is no discussion at all of possibilities for attracting private investment as one tool for achieving the large-scale increases in infrastructure investment called for.⁸

The decision of the EC to emphasize the creation and furthering of open-access competition as the primary tool aimed at increasing rail's share in freight transport suggests a broader question: What do we know about how freight shippers choose among alternative transport modes? What does the literature tell us about what tools might or might not be most effective in encouraging these choices to move in one way or another?

Two categories of papers seem most relevant for our purposes: the first, presenting econometric analyses based on data for U.S. shipments of grain and coal, and the second, presenting the results of stated preference surveys.

An early paper by Wilson, *et al.* (1988) uses three-stage-least squares to estimate equations for rail demand, truck demand, and truck supply for shippers of wheat from origins in North Dakota to terminals in Minneapolis and Duluth from 1973 to 1983. Findings include the importance of the supply of rail cars for freight demand and the supply of trucking services for rail demand. A more recent paper using a similar data set by Mitra (2013) focuses on the econometric finding of a higher price elasticity of demand for motor carriers than for rail.

Train and Wilson (2004) combine shipments data with survey data to examine the transport choices of US grain shippers among rail, truck, and barge. They find that shippers with easy access to alternatives to their current modal choice exhibit fairly elastic demand with regard to both rates and transit time, but a significant share of shippers are essentially locked in to their current mode: 26 percent of shippers have no economic access to other modes, and an additional 12 percent would not switch in response to a doubling of rates.

Satar and Peoples (2010) estimate a cost function for coal transport in the U.S. for the 1979-1999 period. They determine that the use of motor carriers is higher than what would be efficient because of both capacity constraints in rail and the exercise of market power by the small number of rail operators participating in the market.

Shen and Wang (2012) estimate both linear regressions and binary logit models to examine the choice of rail versus truck for flows of grain in 2002 between U.S. origins and destinations, mostly at the

⁸ By contrast, Simha (2016), discusses the same issues in the context of freight rail transport in India and concludes that attracting private investment into rail infrastructure is the most promising path for increasing rail's share.

level of the Metropolitan Statistical Area (MSA). Their results confirm the importance of shipment weight and value as well as distance, travel time, and fuel cost in the choice of modes.

Finally, Ndembe and Bitzan (2018) examine the increasing consolidation of the U.S. grain elevator sector as elevators large enough to service block trains (often called “shuttle trains” when carrying grain) begin to take business away from the smaller “country elevators”. They find that this development both responds to and eases the constraint of rolling stock supply limitations on grain shipments, and they confirm the importance of both the presence of “a shuttle elevator” and the more traditional factors of distance, rail rate, and truck rate in the modal choices of grain shippers.

The second category of papers analyses modal choices by shippers by asking them: that is, through stated preference surveys. McGinnis (1989) and Meixell (2008) usefully divide this broad literature into four categories:

- Cost models that focus on a distance breakpoint for the relative cost advantage of motor vis-a-vis rail carriage;
- Inventory theoretic models that seek a balance between direct shipping costs and inventory-related costs;
- Broader models that examine the tradeoff between direct shipping costs and all related non-transportation costs; and
- Constrained optimization models that analyze the minimization of transport costs subject to “non-transportation cost” constraints.

Both papers characterize the literature as favoring the constrained optimization models, and both find the availability of modal capacity to be an important constraint in practice, along with related constraints such as reliability and timeliness. A review of the literature by DGIP (2015) also emphasizes reliability and quality of service.

The importance of capacity constraints, broadly defined, in rail is one of the dominant findings of this category of the literature. This large body of literature consistently laments the failure of rail freight to meet the market share expectations presented in the EC papers; currently the average market share of rail freight in EU-28 sits in the 11-12 percent range of ton-kilometres (European Commission, 2019c), and many specialists expect it to fall rather than rise in the near future as motor carrier productivity and capabilities continue to improve.⁹ Another frequent point is the call for government policies directly supporting rail carriage as a modal choice vis-a-vis motor carriage for freight (for example, Helgedal, 2013; Arencibia, *et al.*, 2015).

However, a much smaller group of papers comes to another conclusion of importance to our own study: the use of price and taxation instruments *by themselves* to discourage motor carrier use and encourage rail use may be ineffective if railways are insufficiently flexible or have insufficient capacity to take the market share from the roads (Ribbink, *et al.*, 2005; see also Nash, *et al.*, 2001). This, in turn, is consistent with another set of findings from surveys of firms choosing between motor carrier and

⁹ See, for example, Briginshaw (2018).

intermodal service that factors like reliability, speed, availability, and other dimensions of quality are more important than cost itself as choice factors (Evers, et al., 1996; Ludvigsen, 1999; Grue and Ludvigsen, 2006). In this broader context, Pigouvian taxes raise the cost of transport over the roads without having a significant impact on road/rail substitution, and the more promising policy direction is likely to be to complement such policies with others that address more directly the constraints on rail and water modal shares – as we seek to show in the country sections that follow.

4.1 Background Data

In the country-specific examinations that follow, we will refer frequently to data from the following tables and figure. In some cases we lack data for all four countries discussed in the paper. In some cases we include data on Germany, a neighbour and often an important trade partner to these countries, as a comparator, especially when EU averages are not available; in others we place our countries in the context of the EU-28 countries. In some cases the primary data we find from country-specific sources are not identical to the data presented here, and we will note that when relevant.

Table 1 presents a broad picture of the agricultural sector in these countries, as well as data on farm size and international trade. Note especially the contrast of the persistence of small farms with Poland with the larger average farm sizes in the Czech and Slovak Republics. Note also the higher share of exports and lower share of imports for Ukrainian agriculture as compared to the other countries.

Table 1. Agriculture and Grain Production in Poland, the Czech Republic, Slovakia, and Ukraine: The Setting

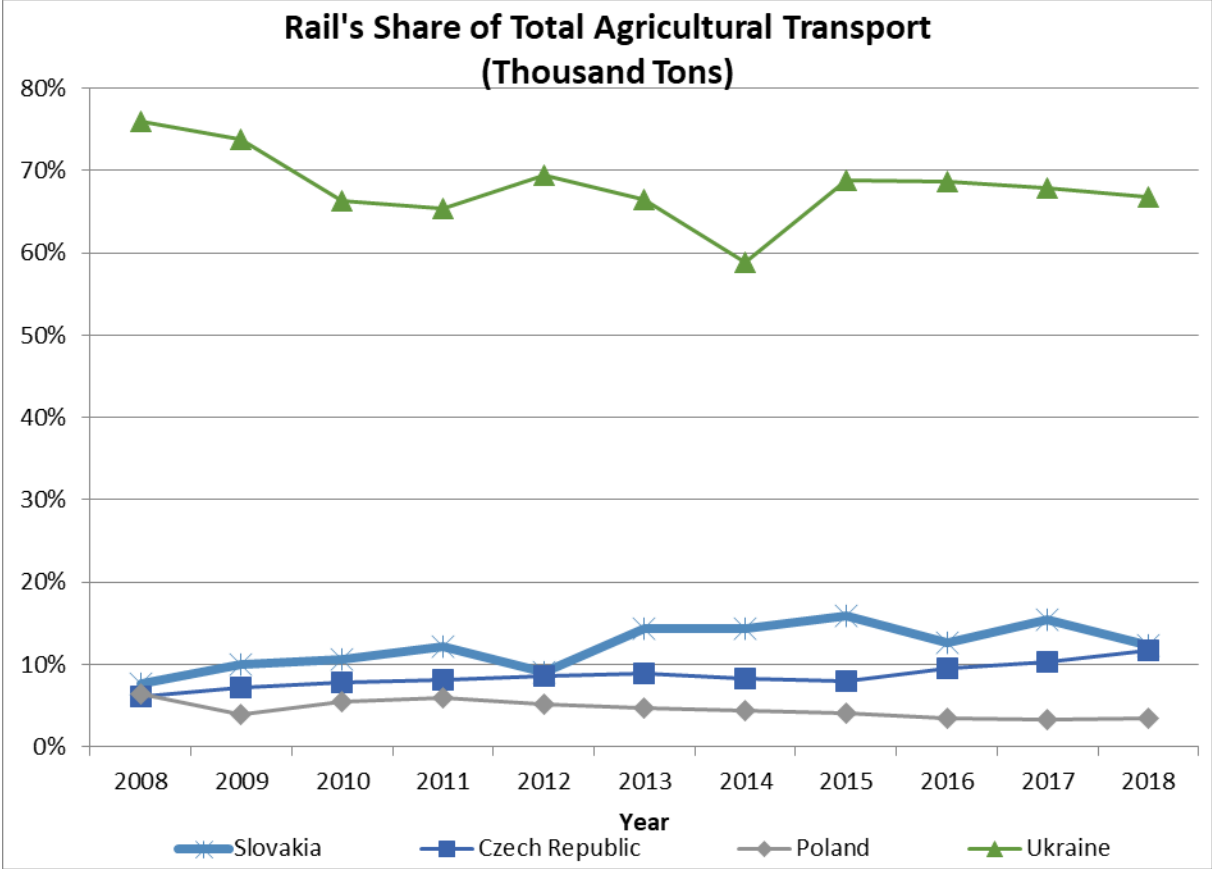
		Poland	Czech Republic	Slovakia	Ukraine	(Germany – a benchmark)
General data						
Area (square kilometres)		312,696	78,865	49,037	603,628 ^{a, b}	357,386
Population (millions)		38.5	10.7	5.6	42 ^c	82
Agriculture – the structure						
Economically active population in agriculture (%)		6.9	2.7	3.3	4.7	0.7
Arable land (% of country area)		36.2	41	28.9	56.1	34.1
Agrarian land in individual (peasant-type) farms (%)		88	29	19	38	
Arable land (in ha) per 1 tractor^d		8	38	65.8	96.9	15.6
Number of crop farms by size intervals (%)	Size intervals:					
	< 5 ha	53.9	18.7	n.a.	n.a.	8.7
	5 – 19.99 ha	37.7	36.4	n.a.	n.a.	36.3
	20 – 50 ha	6.4	17.9	n.a.	n.a.	25
> 50 ha	1.8	27	n.a.	n.a.	30	
Agriculture – grain production (millions of tons)						
Total production		27	7	3	70	
Exports		6.4 ^e	2.5	n.a.	31.2 ^f	
Imports		2.2 ^e	0.4	n.a.	0.1 ^f	

Comments: general data for 2018, agrarian structure data for 2014, grain production for 2018; a – the largest country wholly in Europe; b – including Crimea (annexed by Russia in 2014); c – excluding Crimea; d – data for 2008; e – data for marketing year of 2017/2018; f – data for 2017.

Source: Combined from national statistics, Eurostat, FAOSTAT, CIA World Factbook.

Figure 1 shows rail’s share of agricultural transport by country, by volume. In some cases there is more disaggregated data available for rail’s share of grain shipments, and in those cases we will include that information in the country-specific sections of the paper. The Figure shows the dramatic difference in the importance of rail transport for agriculture between Ukraine and the other three countries that we discuss. In addition, the low rail share for Poland stands out, especially in the context of a commodity and a country size that would in theory be favourable to rail for transport.

Figure 1. Rail’s share of agricultural transport, by country.



Source: EUROSTAT (2018), State Statistics Service of Ukraine (2018)

Table 2 shows the density of coverage of the road and rail networks in these countries. Rail track figures especially are approximate, since it is not always clear in data sources whether what is measured is route-km or track-km (where the latter is higher because of double or triple tracking of particular routes). Poland and the Czech Republic stand out for their relatively dense road networks – the latter comparable to that of Germany – while the Czech Republic stands out for its very dense rail network as well.

Table 2. Road and rail network densities

	Poland	Czech Republic	Slovakia	Ukraine	Germany
Roads (thousand km)	424	131	39	169	644
Road density (km per km ²)	1.36	1.70	0.81	0.29	1.85
Rail track (thousand km)	19	10	4	21	39
Rail track density (km per km ²)	0.06	0.13	0.08	0.04	0.11

Sources: World Bank, CIA World Factbook

Table 3 shows the levels and sources of railways investment by country and by source. Ukraine's is the only railway that receives no state infrastructure funding, and the Czech Republic's the only railway that relies entirely on government and EU funding. Not shown directly in this Table is that state contributions to infrastructure funding in Poland and the Czech Republic are relatively high compared to other CEE countries but not compared to Western European countries. Ukraine's total is especially low when measured on a Euro-per track-km basis.

Table 3. State rail infrastructure funding by source and country, 2016, in million Euro.

	Poland	Czech Republic	Slovakia	Ukraine	Germany
Government funds	756	1,006	68	0	5,686
EU funds	618	339	(2)	0	208
Own funds	456	0	145	305	813
Total funds	1,829	1,345	211	305	6,707
Total funds/track-km	96	135	53	15	172

Sources: European Commission (2019a), Ukrzhaliznytsia website

Table 4 shows the share of ton-km of independent TOC's in total rail freight in all EU countries. Poland and the Czech Republic are squarely in the middle of EC countries in terms of the market share achieved by entrants. Slovakia is lower on this metric, but the *growth* of share by entrants over the 2011-2016 period in Slovakia is one of the highest in Europe. As in Greece, Ireland, Lithuania, and Luxembourg, there are no independent TOC's in Ukraine yet.

Table 4. Competitors in freight, market share and compound average growth rate, 2011-2016.

	Poland	Czech Republic	Slovakia	Germany	EU highest	EU lowest
Share, 2016	57 (UTK)	38 (ČD Cargo)	29 (ZSSK CARGO)	46	63 (Romania)	0.1 (Finland)
Growth rate, 2011-16	6	17	21	11	36 (Italy)	-13 (Estonia)

Sources: European Commission (2019a), other sources cited in text

Table 5 shows average access charges paid by freight TOC's, excluding externality-related mark-ups, by country in 2013 and 2016. Access charges for freight trains are in the middle-to-moderately-high range of EC countries for Poland, the Czech Republic, and Slovakia, and in the high range if Ireland and the Baltic countries are excluded. All three reduced their average charges between 2013 and 2016. Ukraine has not opened its rail infrastructure to independent TOC's, so there are no access charges at this point.

Table 5. Access charges (excluding mark-ups): freight train average by country, 2013 and 2016

	Poland	Czech Republic	Slovakia	Germany	EU high (Latvia)	EU low (Spain)
2013	3.1	3.8	2.8	2.8	10.0	0.1
2016	2.8	2.8	1.5	3.0	10.4	0.1

Source: European Commission (2019a)

Table 6 aggregates all revenues from road taxes and charges paid by heavy goods vehicles in each EU country, and divides that number by total km driven by those vehicles to reach a total revenue per vehicle-km. The Table shows that average road taxes and charges per vehicle-km are relatively high in the Czech Republic but closer to the EU average in Poland and Slovakia. We examine these taxes and charges in their context as Pigouvian policy responses to the presence of externalities.

Table 6. Average revenue from taxes and charges for heavy goods vehicles in 2016 (€/1,000 tkm, PPS adjusted)

	Poland	Czech Republic	Slovakia	Germany	EU28 average	EU high (Switzerland)	EU low (Luxembourg)
	11	27	15.5	16	15	41	6

Source: European Commission (2019b)

5.1 Poland

Poland is an important grain producer. The conditions in Polish agriculture differ observably as compared with other countries in the sample – mostly for historical reasons. Poland was the only country of the ex-Eastern Bloc where, under the Soviet-backed communist government, the private sector played the dominant role in farming. Therefore, while according to Swinnen, *et al.* (2017) large farms play today a key role in grain production in Ukraine, the Czech Republic, and Slovakia, traditional peasant-type family farms still dominate in Poland. The share of agrarian land in possession of individual family farms is strikingly high here; accordingly, farms are small in Poland. This results in a very fragmented structure of grain production and in agrarian overpopulation (Table 1) which, in turn, encourages the high ratio of “labor per land” indicator. Counterintuitively, another feature of Polish farms is that at the same time they are also markedly overcapitalized (Table 1). A few factors contribute to the extensive usage of the capital stock (Latruffe, *et al.*, 2005); however, the small size of farms seems to play a role once again, given that agricultural machinery and equipment are characterized by some indivisibility.

Small size and overcapitalization encourage inefficiency of Polish crop farms. In 2000, 86% of them were operating under increasing returns to scale. Inefficient management practices seem to have played an even more important role than scale inefficiency (Latruffe, *et al.*, 2005). Since Poland joined the European Union in 2004, the sector’s efficiency seems to be increasing. According to the official EU data, farms in Poland have almost doubled in economic size since the accession (DG AGRI, 2014).¹⁰ Also, Polish national statistics show a decreasing number of farms in recent years (by 6.5% in 2010-2016, GUS) which means that tendencies towards consolidation can be observed. However, it seems that so far, this has been rather an adjustment than a structural change in agrarian structures of the country.

Poland’s total grain production is around 30 million tons a year. In 2016, 88% of the output has been produced by private farms (GUS). Characteristically, the proportion of the output that is subsequently traded rarely exceeds 50% (Hamulczuk and Łopaciuk, 2013).¹¹ Domestic annual grain demand amounts to 26-28 million tons (ARR data). A large percentage of grains (around 60% of domestic consumption in recent years, *i.e.*, 15.5-17 million tons) are used in animal (livestock) feed. A majority of these are used on farms, while the rest is supplied to the commercial feed manufacturing industry (this proportion is around 80/20; see ARR). Around 5 million tons a year were used in recent years in the flour milling industry.¹² Around 5-6% of domestic utilization is seed (GUS).

Since Poland joined the EU, agricultural exports have been growing much faster than imports. While grain imports are rather stable, there has been significant growth in exports over the recent period. The most important recipient of Polish grain is Germany (39% of total exports in the marketing year 2016/17); however, non-European export destinations are on the rise recently, the most important being Saudi Arabia, Algeria and Morocco (KOWR, 2018). According to several sources (*e.g.*, USDA, 2017a), the increase of the share of non-EU/non-European export destinations in recent years has been continuous and can be already considered a trend. Poland’s grain suppliers are mostly European countries.

¹⁰ Economic size is measured by the value of standard output (DG AGRI, 2014).

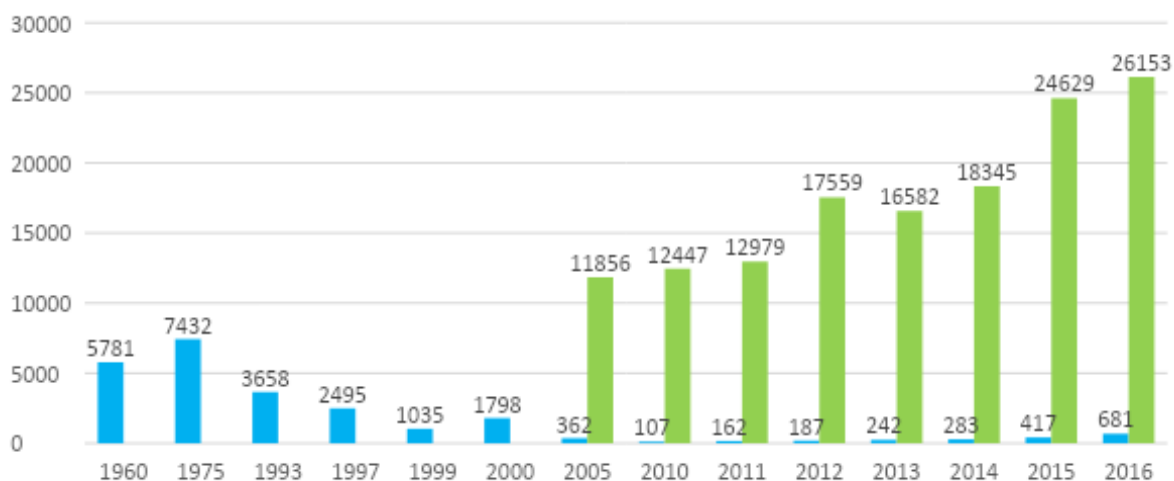
¹¹ For comparison, about $\frac{2}{3}$ to $\frac{3}{4}$ of the production in Germany is traded (Hamulczuk and Łopaciuk, 2013).

¹² European Flour Millers’ Association data, retrieved from www.world-grain.com.

Almost all grain is transported by road transport in Poland. The role of inland waterway transport is negligible,¹³ and there are at least two reasons for this. Firstly, for mostly historical reasons, the spatial extent and capacity of navigable inland waterways is completely unadjusted to the contemporary location of activities and transport needs of economy and trade in Poland. Secondly, as such, this mode of transport has been very neglected and underinvested in Poland¹⁴ and this has further reduced its use. Why, however, the shares of rail are so small in Poland as presented in Fig. 5 is a more complex question.

As is evident from Figure 2, rail has become uncompetitive in grain transportation in Poland as compared to road transport (in 2016 the modal split for road vs. rail was 40:1 – own calculations based on GUS data). A mix of factors seems to be responsible for this. They include (1) the structure of grain production and consumption in Poland, (2) intermodal (*i.e.*, rail vs. road) differences in the development of transport markets and transport infrastructure in Poland, and (3) shippers' experiences.

Figure 2. Cereal grains transported by rail (1960-2016) and road (2005-2016) in Poland (thousands of tons)



Source: GUS; data earlier than for 2005 are not available for road transport

First, large-quantity and long-distance transport is more likely to be operated by rail. However, as noted, grain production is very fragmented in Poland, generating low individual transport flows. Moreover, a large part of production is not traded, resulting in consumption that is carried out locally, with no shipments or shipments at short distances.¹⁵ Grain intended for trade is stored by grain elevators companies. These can potentially generate a flow rate of grain sufficient to make rail a working option, especially in handling exports (and imports). A very important recipient of stored grain

¹³ In connection to this, the Central Statistical Office (GUS) does not collect nor publishes detailed statistics on the activity of this transport mode. Therefore, the exact amount of grain transported by inland waterway transport is not available. However, it can be seen from more general data that the share of this mode in transporting of all products of the 'agriculture, hunting, forestry, fish and fishing products' category has been in recent years 2.5-4 times lower than the share of rail transport.

¹⁴ For instance, GUS data show that the towing fleet in Poland included 5 tugs and 190 pushers (of which only five were constructed after 1990) in 2014 (GUS).

¹⁵ It should be added that farms have a large number of tractors (see Table 1) and use them as a local means of transport.

is also the flour milling industry. However, more than 50% of flour mills in Poland have a capacity of less than 100 tons per day,¹⁶ meaning that both inbound and outbound transport flows may be not of sufficient magnitude to put rail in a favorable position. This is especially the case for block train services which are typically offered to shippers in Poland. As in many other European countries (and the United States), single wagonload services have been downsized in Poland. They are around 17% of rail freight traffic, mostly in international services (% of tkm in 2012; SWT, 2015).

Secondly, grain shippers in Poland benefit from strong intramodal competition among truckers to carry grain. Polish trucker companies have today a very established position not only in Poland, but also in the whole EU.¹⁷ Moreover, until recently, the government's priority was to build a network of highways and roads; rail was so neglected that it ceased to be a potential transport alternative for many shippers. The Polish road network has been significantly extended in two or three last decades (especially after Poland joined the EU in 2004), and it is well-developed. Just between 2011 and 2014 the Polish motorway network grew by 66% (GUS). On the other hand, the rail network has been regressing -- since 1989, the length of railway lines in Poland has decreased by 27%; the number of operated sidings has also dropped significantly; and the general condition of railway infrastructure has deteriorated (especially, the pace of track replacement has been significantly reduced,¹⁸ which has led to drop in average speed of trains; Massel, 2014). Table 2 shows that road density is relatively high in Poland, while rail track density is relatively low.

The government's approach to railway infrastructure has changed in recent years. State contributions have increased noticeably since 2014 (2008 – 2.5 billion zloties that is around 0.6 billion euro; 2015 – 11.1 billion zloties that is around 2.6 billion euro; own calculations), and currently Poland may be unexpectedly ranked in the top 5 European countries by rail infrastructure funding.¹⁹ (See also Table 3, above.) As such, public investments in both main modes of land transport are currently considerably more balanced there. However, paradoxically, large-scale railway modernizations that have been finally made have transformed thousands of kilometers of lines into a construction site, resulting in longer transport times, detours or just cutting shippers off from the railway. This has again negatively affected the reliability and average speeds in railway services in a few last years, though of course the rationale is for improvements in the longer term. The average timetabled speed of freight trains in Poland in 2018 was only 21.5 km/h (UTK) – the lowest in Europe.

A relatively new phenomenon is also that private owners of sidings decide to terminate them due to an increase of formal and legal requirements relating to their functioning (especially in safety certification). This may be a further proof that business in Poland still does not perceive freight railways as a viable alternative (as this form of short-term cost optimization is being chosen rather than maintaining sidings ready for use). In the same time, this makes it more difficult to restore single wagonload services in the future.

¹⁶ European Flour Millers' Association data, retrieved from www.world-grain.com.

¹⁷ They produce more tkm in international transport in the EU-28 than at home (103,789 vs. 96,627 million tkm in 2015, GUS) and are an unquestionable leader in cross-trade and cabotage transport in the EU (what rises many concerns among their competitors across the continent).

¹⁸ In 1989 – 2206 km of tracks were replaced; in 1999 – 132 km; in 2009 – 467 km; 2012 – 1063 km (Massel, 2014).

¹⁹ After the United Kingdom, France, Germany and Italy (data for these countries retrieved from European Commission [2019a]; note that this report underestimates data for Poland).

Rail freight has been liberalized in Poland in the mid-2000s, and there is no doubt that railway undertakings (there were 75 of them active on the market in 2017; see UTK) are performing much better than the former monopolistic Polish State Railways (PKP). Intramodal competition can be described as reasonably intense, with market shares of challengers exceeding 50% both in volume (tons) and performance (tkm). What is more, both of these values are at a similar level (57% for volume, 52% for performance, data for 2018, UTK) which suggests that rail freight competition has become a widespread phenomenon in Poland and not a local one. Market conditions, however, also changed – shippers have become more demanding, and logistical chains have fragmented. This makes intermodal competition with highly competitive and customer-oriented trucker companies more appealing. Evidence can be easily found that, compared to truckers, railways in Poland still show a significant lack of flexibility and they neglect some niche markets – for instance they do not strive for customers in grain transport markets (including grain elevators companies). About 80% of rail grain transport in Poland is still made by the incumbent PKP Cargo (volume, PKP Cargo data).

In particular, railway undertakings do not offer competitive prices in this market segment and they do not offer highly-demanded single wagonload services. For instance, in 2013 a particular grain elevator company (storage capacity of 50,000 tons) located in Koronowo paid 45 zloties for transporting one ton of grain to the Baltic Grain Terminal in the port of Gdynia by truck (truck capacity is 25 tons). In order to reduce the inconvenience of trucks to inhabitants of Koronowo, the company submitted an offer inquiry to PKP Cargo. PKP Cargo offered a price of 57 PLN zloties per ton for transport by bloc trains of 1500 tons. No single wagonload services were offered (Gazeta Pomorska, 2013). Numerous such instances certainly help to explain why rail plays such a small role in grain transport in Poland, while annual transshipments of grain in Polish seaports exceed 6 million tons (in 2016, GUS).²⁰

Thirdly, also experience from the past influences current mode choices. For decades the railway in Poland was emblematic of inadequate service quality and unreliability. This has resulted in a bias against rail. This image may be difficult to change even with the increased flexibility from railway undertakings that is actually presented. Naturally, perceptions would differ among freight market segments. Grain is easy to transport and store; however, the grain logistical chain is complex, and customers value reliability. For instance, flour mills have to ensure their continuous supply, as their transformation process cannot be interrupted (European Flour Millers' Association). Getting new customers who value reliability and who are negatively biased against rail as a mode is difficult. What is more, it has been recognized in literature (*e.g.*, DGIP, 2015) that past mode choices of shippers tend to be reinforced over time. Therefore, even more flexibility and customer-oriented approach is needed to counteract the bias.

Some increase in the transport of grains by rail can be observed in the last few years (Fig. 1). However, the same can be said for road transport. The share of rail is still very small. Yet, the recent increase in the average distance traveled by one ton of grain transported by rail in Poland is noteworthy, which is accompanied by the stabilization of this indicator for road (see Table 7). It seems that some chances for rail transport in Poland may be also seen in the recent increase in grain exports, especially to non-European destinations. Large grain flows from elevator companies to Baltic seaports would put railways into more favorable position as feed service.

²⁰ Loadings (exports) – 4.4 million tons, unloadings (imports) – 1.85 million tons (2016, GUS data). Shares of the Baltic Grain Terminal (BGT) in the port of Gdynia in handling all Polish exports of grain are about 35% (BGT data).

Table 7. The average distance traveled by one ton of grain in 2005 and 2011-2016 (km)

	2005	2011	2012	2013	2014	2015	2016
Rail	264	212	198	256	258	310	407
Road	115	157	154	176	182	177	175

Source: GUS

Interestingly, a measure that can be described as Pigouvian was introduced in Poland in connection to transportation system as early as 2005. All engine fuels that can be used in road transport (gasoline, diesel, natural gas) that are put on the market are subject to so called “fuel charge” (“opłata paliwowa”) paid by the seller. In 2019, the fuel charge ranges from 133 to 297 zloties (32-70 euro) per 1000 liters. The purpose of the charge, that is imposed on fuels in addition to regular taxes (i.e. the value-added-tax and excise), is to collect earmarked money for infrastructure funding. 20% of what is collected (e.g. 1.3 billion zloties that is around 0.3 billion euro in 2015) contributes to the so called “Railway Fund” and has to be spent on rail transport (mostly infrastructure²¹) in order to – as officially stated – “promote sustainable development”. On the other hand, as is clear from Table 6 (above), overall road taxes and charges per vehicle-km for heavy goods vehicles are no more than the EU average.

Discussion. The structure of grain production and consumption in Poland, rather unique compared to other countries in the sample, put railways in unfavorable position in servicing grain markets there. In general, local circumstances are the reason why “one size fits all” policies aimed at changing modal split cannot be effective. This also applies to the European Commissions “pro-competitive” measures. Rail freight competition has become a widespread phenomenon in Poland. However, rail operators have to rival there with road carriers that – in the meantime – have managed to establish their position as ones of the most competitive in Europe’s road transport industry. Contrary to the hopes of EC policy makers, more intramodal competition does not necessarily mean more intermodal competitive advantage.

Polish railways have significantly improved their performance over the past decade or two, but their rivals have achieved even more in this respect. The structure of grain production and consumption in Poland suggests that the rehabilitation of single wagonload services could be an appropriate measure to encourage modal substitution in servicing grain markets there by enabling railway to compete on relatively small shipments. However, capacity constraints, and especially a significant reduction of both public (tracks) and private (sidings) rail infrastructure may prove to be a barrier to achieve this goal. Paradoxically, the disappearance of single wagonload services may be also associated with the intensification of competition in rail transport. These services incur high unit costs but generate low volumes. As intramodal competition keeps profit margins low, cross-subsidizing single wagonloads with bloc trains services becomes therefore uncomfortable. This phenomenon has led to substantial downsizings in single wagonload services across Europe, and as railways withdraw from niche markets (such as wagonload grain in Poland), this may cost railways a few percentage points in terms of modal split. A counter-measure to consider would be cross-subsidizing these services through lowering infrastructure access charges for them.

²¹ According to authors’ calculations, the Fund’s expenses in 2015 broke down as follows: 63% - direct subsidies for the infrastructure manager to be spent on management (46%) and the maintenance work (17%), 28% - rail infrastructure construction. The remaining 9% was spent on passenger rolling stock.

6.1 The Czech Republic

Grain production depends on a suitable climate and warmer soil. The most appropriate areas in the Czech Republic are the lowlands along the Elbe river (Central Bohemia), Southern Moravia, and Haná (Central Moravia). This also corresponds to the actual harvest size. Almost 1.4 million tons of grain (almost 20% of the total Czech production) is harvested by farmers in the Central Bohemian Region, and around 0.9 million tons in South Moravia (13%).

Grains are about one half of the harvest of Czech crops.²² The shares of wheat and barley growing areas in the total arable land exceeds the EU average (AKCR, 2019). A specific feature of the Czech agriculture is the large size of farms, as shown in Table 1. As in Slovakia, this is given partly historical, as collectivization in agriculture began after the Communist takeover in 1948 when agricultural firms were combined into state-owned enterprises. However, the number of farms has then halved in the Czech Republic since joining the EU in 2003, and farms in the Czech Republic are on average almost four times bigger than those in the EU-15 (European Commission, 2014). This low degree of fragmentation should in principle be favorable for rail transport, but other factors have worked in the opposite direction.

Total Czech production of grain is about 7-8 million tons per year. Human consumption of grain in terms of flour weight is around 115 kg per capita annually (CZSO, 2019) which, with a population of 10.7 million in the Czech Republic, means 1.2 million tons per year, which is around 18% of total domestic production of grain.²³ This part of grain production flows therefore through the grain processing industry. This industry is characterized by a high degree of ownership concentration, and specialization has been important since the time of central planning before 1989 (svazmlynucr.cz, 2015). However, the 39 flour mills in the Czech Republic are not suitably located in terms of connection to the rail network and usually do not even have a connection to the railway siding (svazmlynucr.cz, 2015).²⁴ Given the size of mills, they also do not generate sufficiently large flows for economic shipment by rail; the largest mill in the Czech Republic has a maximum capacity of 480 tons per day (MZP, 2019). Thus, the benefits of rail transport resulting from the large size of farms and large volumes of production cannot appear, and domestic grain production is transported by road.

The flour mills have their own warehouses, but their capacity is often limited. This has its historical foundation in the 1960s and 1970s, when large grain warehouses were built in the former Czechoslovakia within the state enterprises of agricultural supply and purchase, and therefore the importance of storage in flour mills decreased (Příhoda, *et al.*, 2004).

Storage capacity is also related to another important aspect of the agricultural market: the existence of intervention purchases.²⁵ There are 86 intervention and storage centers in the Czech Republic (European Commission, 2013). When we look at the geographic distribution of grain elevators, they are spread following the agricultural yield of regions, with a greater concentration of elevators in the Central Bohemian Region and South and Central Moravia, but also in the Pilsen Region (Western

²² The share was between 41% and 51% in 2000-2016.

²³ This value roughly corresponds to the distribution of grain use in the EU, where food consumption accounts for about 21% of grain production (calculation based on data on IGC (2019)).

²⁴ The largest mill in the Czech Republic is situated surprisingly in the Liberec Region (North Bohemia) which is not an agriculturally favorable region. The mill is located by the D10 motorway, but has no connection to the railway siding, and they provide their customers the transport with their own trucks.

²⁵ Grain trade is influenced by the Council Regulation (EC) No 1784/2003 on the common organization of the grain market (SZFI, 2017).

Bohemia). Most elevators (80%) are connected to the railway network. The largest Czech grain elevator in South Moravia has a maximum capacity of 96,000 tons and is among 10 largest in the EU. It is connected to the railway infrastructure and lies next to the 1st transit railway corridor, which is part of the European Orient/East Med corridor.

While for the EU as a whole, exports make up 13% of grain production,²⁶ this share is significantly higher in the Czech Republic (see Table 1), varying between 27 and 47% in recent years. The Czech Republic is a net exporter of grain, with exports flowing almost exclusively into neighboring countries and Germany being the main recipient of Czech grain (almost 70% of exported grain production). Therefore, foreign trade is an important determinant of the modal share of grain transport in the Czech Republic. Given that foreign trade involves medium and long-distance transport flows, the competitive advantage of rail transport may be revealed in this case.

Rail transport in the Czech Republic benefits from a very wide network, because the railway track density is one of the highest in the world here; the road network is also dense (see Table 2, above). The Czech Republic also has good rail connections to neighboring countries and is intersected by European rail freight corridors.

The inland waterway system generates a small share of transport performance in the Czech Republic. Almost a half of the length of waterways is covered by the Elbe (Labe) and Vltava rivers. When water conditions are suitable, these two rivers form a good connection to Germany, the major importer of Czech grain. For instance, in 2009, with stable-to-high water levels in Elbe, the modal share of waterways in transporting grain increased notably (ČD Cargo, 2010). Otherwise, however, rail freight wins and becomes an exclusive carrier of grain to Germany. This is confirmed by Areté (2017), stating that railways play an especially important role in long-distance transport flows of grain from the Czech Republic to the North Sea ports.²⁷

Generally, road, rail and inland waterways play different roles in transportation of grain in the Czech Republic and are often used in combination, with road transport important in the case of short-distance flows, *e.g.* from fields to storage and to crossing points to other transportation modes, but playing only a modest role in long-distance transportation (Areté, 2017). On the other hand, road transport has the advantages of a wider network allowing easier transport, without need of transshipment, which contributes to its relative importance for domestic shipments. Overall modal shares in agricultural products are shown in Figure 1.

Rail freight has been liberalized in the Czech Republic since 2003. The share of newcomers in rail freight has increased gradually to almost 38% in 2019, the rest being provided by the state-owned incumbent company ČD Cargo.²⁸ (See Table 4.) Although the modal share of rail freight transport has been decreasing slightly in favor of road transport, the overall transport performance has been growing – to some extent due to strong international transport flows.²⁹ Several TOC's are specialized in the transport of grain, usually closely tied to important agrarian forwarders and multinational business firms

²⁶ Calculated on the basis of IGC (2019).

²⁷ It has been highlighted as one of the key intra-EU trade flows of cereals (see Areté, 2017).

²⁸ ČD Cargo was established as a subsidiary of the incumbent Czech Railways on 1 December 2007, when there was a separation of passenger and freight transport operated by Czech Railways.

²⁹ Around 2/3 of rail freight performance was dedicated to international transport in 2016 (while it was about 58% in 2005).

(ČD Cargo, 2012).³⁰ Thus there is tough rail intramodal competition in the grain transport market in the Czech Republic, and this competition results in low rates (ČD CARGO, 2010).³¹

TOC's complain of congestion, mainly around large cities and on the main railway corridors, where regional, long-distance and freight transport must share capacity.³² These bottlenecks lead to increasing transport times. As in Poland, the Czech railway infrastructure is being extensively upgraded and repaired, which will help in the long run but for now often leads to higher costs and/or a further significant reduction in transport speed. A "disadvantageous priority order" also plays a role when the infrastructure manager applies a set of priority rules under which international freight transport is given the lowest priority in the Czech Republic (ECA, 2016). Generally, the average transport speed of freight trains is very low in the EU (only around 18 km/h), however, on rail freight corridors, the average speed of trains is relatively comparable to that of trucks (ECA, 2016).

Discussion. As in Poland and Slovakia, the successful introduction of competition among TOC's in the freight rail sector has not been associated with an increase in the share of rail in grain transport. Both rail and water have carried large shares of grain over the longer distances associated with exporting, but domestic shipments remain largely controlled by motor carriers, a result of the small shipment sizes typical of domestic flows as well as the locations of both large farms and flour mills away from the rail network. The location of grain elevators on the rail network, as well as ongoing investments in rail network upgrades that should ease some bottlenecks, may provide some hope for the future.

7.1 Slovakia

Slovakia is a geographically diverse country. Approximately 2/3 of the territory forms a mountain range of the inner and partly outer Carpathians. The southwestern and a bit of the eastern part form the lowland zone of the northern part of the Pannonian lowland. The mountains in the north represent a natural barrier between Slovakia and Poland. The Danube River forms a barrier to land transport on the southern border with Hungary and at the same time is one of the biggest inland waterways in Europe. Geography is reflected in both the concentration of agricultural production, which is concentrated primarily in the lowlands, and the organization of backbone transport routes.

Historically, Slovakia depended very much on agriculture. The situation began to change after the First World War and more significantly after the Second World War, when industrial investment and know-how flowed into the Slovak lands in the context of the development of Czechoslovakia. However, in 2017, agricultural land still occupied 49 % of the country, of which arable land consist of 59 % (SKGeodesy, 2018). The employment in agriculture has dropped to 2.3 % of total employment in 2018 (SSU, 2019).

The highest share of arable land is used by grain, and wheat is the major grain planted. Grain production in Slovakia is about evenly divided between current consumption and a combination of exports and storage (Uhrik, 2018).

³⁰ These agrarian forwarding companies were Agrofret that cooperated with the operator BFL Spedica and RM Lines (TTT, 2017).

³¹ These private rail operators included IDS Cargo and BFL (TTT, 2017). In 2010, some intervention exports of grain from the Czech Republic routed to the Dutch port of Rotterdam were gained by LTE Logistik and Transport (for the section of the Czech Republic) and RAIL4CHEM (abroad) with the organization of transport (Štefek, 2010).

³² The most complicated situation is on all main lines around Prague and Brno, further on the section from Pardubice to Česká Třebová and from Přerov to Ostrava.

The structure of agricultural holdings is likely an important factor in the choice of grain transport mode. The structure of the agricultural holdings in Slovakia is still influenced by the forced collectivization that took place after World War II, when agricultural production became concentrated within the Unified Agricultural Cooperatives. Although privatization in the 1990s brought some deconcentration and fragmentation of agricultural production, after 2000 there was significant reconcentration, and now most of the agricultural land is again held (or rented) by large agricultural holdings (Table 1). Both geographical and organizational concentration should favor the bulk transport of grain by rail, but this has not been the case (Table 1).

Like the Czech Republic, Slovakia is one of few European countries without direct access to the sea. The length of transport infrastructure network has been stable for the last decade, but rail and (especially) road density remain rather low (Table 2). However, infrastructure quality has been slowly improving.

The location of the backbone lines is determined by mountain ranges. One of the backbone lines is located in the west of the country in the north-south direction in the valley of the river Váh between the capital Bratislava and the regional capital Žilina, with connections to Hungary in the south and the Czech Republic and partly Poland in the northwest. Another backbone line runs in the north of the country in the east-west direction between the cities of Žilina and Košice with connections to Ukraine in the east. Importantly, the main railway arteries are largely located outside the main sites of agricultural production. The only significant line that crosses the Danube lowland is the Bratislava - Komárno line and further to Hungary. The access to the railway is still more complicated here and the network is thinner than in the case of road transport.

Rail has never been the dominant transport mode for agricultural production, including grain, in Slovakia. The backbone railway network between Košice and Ostrava (today the Czech Republic) was built with the primary objective of transporting iron ore from Ukraine and heavy industrial production from Košice and North Moravian smelters. This pattern persists to some extent to this day. The data for all goods indicates that the average distance of goods transport by train in the last decade is stable and slightly below 200 km, while the distance of road goods transport varies between 200 to 300 km, and the inland water transport distance varies between 400 to 700 km (AF&partners, 2015).

We have not found data on rail's share in grain transport in Slovakia. Figure 1, above, shows that rail's share in the transport of all agricultural goods is as low in Slovakia as in the Czech Republic, with a small upward trend in recent years. The table shows shares of tons hauled, so since rail generally carries freight shipments over longer distances than trucks, a comparison based on shares of ton-kms would give rail a somewhat higher share.

Since most grain production in Slovakia is used in the domestic economy, given the size of the country, the main advantage of rail transport - long distance transport - does not apply. Moreover, the largest cereal warehouses and processors are located in harvesting areas. The close availability of grain elevators, mills, and other major customers naturally favors road transport in a relatively short distance.

Another problem is connected with freight train access to the infrastructure. The passenger rail traffic in Slovakia is relatively heavy, which results in congestion and low transport speed of freight trains (around 25 km/h: AF&partners, 2015). This, again, favors road transport naturally.

Slovakia has the potential to be a transit country in the east-west direction (railway, partly finished highway) and in the south (lowland, Danube waterway), while in the north, mountains represent a significant natural barrier to Poland. Besides the geographical barriers, there are also bottlenecks of the logistical infrastructure. According to Areté (2017), Slovakia is suffering from a significant number of bottlenecks on the Danube waterway and on the rail infrastructure as well. Moreover, Areté mentions bottlenecks on the cross-border section on Baltic-Adriatic TEN-T corridor resulting from different electrification systems in the national rail networks. This hampers the cross-border interoperability of freight trains.

The entry of new private TOC's in this segment of the market has not done much to increase the share of rail in grain transport, in part because the new operators have concentrated on the most lucrative freight, in particular iron ore and other raw materials or cars. The transport of grain was and still is in the portfolio of railway operators, but it remains marginal.

As for grain exports, the main trading partners within the EU are the Czech Republic, Austria, and Germany, while among the non-EU countries, Ukraine is a stable partner importing grain.

On 1 January 2011, charges for the use of railway infrastructure were reduced by almost 50% for freight operators, with an eye to equalizing the conditions of doing business in road and rail freight, though they remain in the middle to high range for the EU other than Ireland and the Baltic countries (Table 4). This step had a significant impact on the growth of the transport performance of small operators, but not on the performance of the state incumbent ZSSK CARGO. ZSSK CARGO is a part of the former incumbent and still the only network-wide rail operator in Slovakia. It carries approximately 70 % of the total volume of goods shipped by rail annually (in 2014 the share in the volume of transport was 70.6%, which represented approx. 36 million tons of the 51 million tons transported).

The sector of private TOC's is developing dynamically in Slovakia. It responds very flexibly to the needs and challenges of the market, so it is not yet possible to accurately identify its long-term place in the market. In 2018 in Slovakia 36 freight rail operator were registered. It can be stated, however, that the focus of private operators has been mainly on the lines of western and southwestern Slovakia, especially regarding intermodal (container) transport. A typical case is the operator Metrans /Danubia/, with its container terminal in the city of Dunajská Streda, transporting in addition to containers coal, petroleum products, chemical products (from nearby factory Duslo Šaľa), and food. While 30% is not a bad outcome for share of the freight market by independent TOC's in the EU (and the share has been increasing – see Table 4), this level of competition and successful entry has apparently not been associated with an increase in the rail share of freight generally or of grain in particular.

Discussion. Slovakia does not transport much grain by rail, which is due to several complementary factors. The first is the small size of the country, where domestic demand is met more quickly and efficiently by road transport. The second is the relatively small volume to be exported. Although Slovakia is an agricultural country where large farms dominate production, rail transport there is more focused on heavy industry, and transport of grain (and agricultural products in general) has never been a priority for the railway. Neither the successful introduction of competition among freight TOC's nor their encouragement by a dramatic lowering of infrastructure access charges has had an impact on the rail share of grain transport, in part because the new TOC's, like the incumbent, have focused on industrial goods instead. Adding the low transport speed, low priority of infrastructure access for international

freight TOC's, and problems with the capacity of the railway network, it is clear that the possible shift of grain transport to rail in the case of Slovakia does not look too promising.

8.1 Ukraine

Ukraine is one of the world's leading producers and exporters of grain. With the largest endowment of arable land in Europe and one-third of the world's endowment of fertile "black earth" lands, the country is the world's leading exporter of sunflower oil, 2nd leading exporter of maize, 5th leading exporter of wheat, and 3rd to 5th leading exporter in the smaller volumes of oats, rye, and sorghum (World Bank, 2015; USDA, 2017b). More broadly, and with other agricultural sectors like dairy farming included, agriculture accounts for 12 percent of Ukrainian GDP, almost 16 percent of employment, and 42 percent of exports (FAO, 2012; Ministry of Infrastructure, 2017) -- considerably more important to the overall economy in Ukraine than in neighboring countries.

The importance of agriculture, and agricultural exports, to the Ukrainian economy seems only likely to increase with increasing global food requirements and with the hoped-for increasing integration of Ukrainian agricultural products into the EU economy; the Ukrainian government has forecast a near doubling of grain exports by 2020 (Ministry of Infrastructure, 2015, 2017). As US ambassador to Ukraine Geoffrey Pyatt has remarked concerning the current situation, "Those numbers could easily be doubled.... Ukraine is already one of the world's great agricultural producers. But it should be an agricultural superpower."

Transport data sufficiently disaggregated by mode and by commodity for our purposes is not available for Ukraine. According to Ukrstat, motor carriers haul 70.9 percent of all freight tons in Ukraine and 76.5 percent of all non-pipeline freight tons, while rail hauls 21.3 percent (23.1 percent non-pipeline) and river and sea together haul less than 1 percent. These figures may understate the share of motor carriers, as the data are designed to include "shipment of cargo for servicing the needs of one's own production" -- which must be especially important in the agricultural sector -- but likely miss the smallest of such operations. On the other hand, on a ton-km rather than a ton basis, it is rail that is dominant, with 56.1 percent of all freight and 80.1 percent of non-pipeline freight; the motor carriage share is only 12.8 (18.2) percent, with all water at 1 (1.5) percent.

Consistent with this broader pattern, Figure 1 shows the modal share, by volume, of all agricultural products transported in recent years; the share of rail hovers in the range of 60 to 70 percent. Again, two missing sets of data very likely bias this Figure in opposite directions. First, the motor carrier share is certainly understated because it does not include own-haulage by farmers. On the other hand, if we move from tons to the arguably more appropriate ton-kilometers, the motor carrier share would almost certainly drop, reflecting the relatively short distance of many of the truck hauls. A third factor may also be relevant: since grains are such an important export crop, they may be also likely to travel longer distances, and so by rail, than other products in the "all agriculture" category.

Like many other post-Soviet and post-socialist countries, Ukraine began a program of agricultural land reform in the early 1990's (Csaki and Lerman, 1997). However, the process has been widely considered unsuccessful; in particular, a moratorium on agricultural land sales imposed in 2002 in the face of fears of domination of the market by large and/or foreign enterprises has been renewed repeatedly. There have been widespread calls from economists and reformers for a renewed dedication to markets and reform, and as we write, such legislation has been introduced in the Verkhovna Rada

(parliament) and finally approved: the agricultural land market is to be substantially freed on October 1, 2020 (Nizalov, *et al.*, 2015; Kvartiuk and Herzfeld, 2019; Nizalov, 2019).

However, even once this barrier is removed, a significant increase in grain production – most of which would be destined for export -- seems unlikely without actions to address what is arguably the real binding constraint on the market, which is the poor state of the transport capacity available. In particular, with an unstructured, government-owned monopoly in control of the railways, that sector continues to exhibit deteriorated infrastructure, bottlenecks at crucial junctions, and antiquated locomotives and rolling stock. In addition, the inland waterway sector is woefully underutilized compared to its performance in the past. Other problems such as shortages of capacity at seaports and poorly maintained roads probably pale in comparison to these two main issues, so that these are arguably the factors that need to be addressed if there is to be a significant increase in rail (and water) grain haulage.

We consider these two crucial sectors in turn.

Ukraine's railway infrastructure is generally old and in poor repair, and capacity bottlenecks act to slow and disrupt agricultural and other freight shipments in multiple locations, including to and from the crucial Black Sea ports (Pittman, 2015, 2017b).³³ There is legislation before the Verkhovna Rada to restructure the rail sector according to the EU-friendly model of third-party access to the system, but such reforms seem unlikely to make much near-term progress in increasing rail's transport share in the face of more pressing problems. In the case of Ukraine, these are the state of the infrastructure and the rolling stock.³⁴

Most countries in Europe provide government subsidies to their railways (ECMT, 2005; Arrigo and Di Foggia, 2014; and Table 3). Generally these subsidies are provided to infrastructure construction, infrastructure maintenance, and passenger operations, and may originate with a variety of levels of government. Ukraine, like many countries, both provides government subsidies to passenger operations and requires the freight operations of the national railway company Ukrzhaliznytsia to cross-subsidize the passenger operations. However, almost uniquely in Europe, the Ukrainian government provides no infrastructure subsidies to Ukrzhaliznytsia, requiring the company to fund capital improvements from current operations and borrowing.

Few would dispute the statement that there are disadvantages and costs to government subsidization of railways, including reduced incentives for efficient operations, difficulty of segregating subsidies to infrastructure from subsidies to operations, controversies over the optimal level of government to provide different subsidies, welfare losses and economic distortions from taxes and fees, and the opportunity cost of government funds. Still, as a step short of more serious and difficult rail reorganization initiatives, the provision of some government subsidization in order for the worst rail

³³ See Bukovskiy and Kvartal'na (2012): "The priority of 'Ukrzhaliznytsya' should become the liquidation of 2300 km of bottlenecks on the most heavy traffic lines." The EBRD has recently announced a EUR 150 million loan to support electrification and modernization of a 253-km stretch of the railway between Dolynska, Mykolaiv, and Kolosivka (UNIAN, 2018).

³⁴ Allowing entry by third-party train operating companies would, however, work to address a third problem affecting the system, which is the depreciated state of the locomotive fleet.

infrastructure bottlenecks to be addressed would seem a pro-export and pro-farmer policy well worth considering.³⁵

In addition to serious problems with the rail infrastructure, a widely noted problem regarding Ukrainian grain transport is the poor condition of the specialized rolling stock used for this purpose. Four-fifths of the rolling stock used to carry grain is owned by the government-owned monopoly railway company Ukrzhaliznytsia, and most of this is either fully depreciated (30+ years old, about one-third of the fleet) or will be within the next ten years (21-30 years old, over half the fleet) (Tovstopyat, 2013; Maslak, 2016).

Partly this is the result of the continued resistance to reform and restructuring of the railway, so that there is no competition within the railway sector. Partly it is a result of charges imposed by Ukrzhaliznytsia on the empty return trips of privately owned rolling stock that are not imposed on its own rolling stock, as well as alleged corruption in the allocation of Ukrzhaliznytsia-controlled rolling stock during periods of high demand. But even the Russian Federation, which has also resisted the restructuring of its government-owned monopoly railway company Rossiyskie Zheleznye Dorogi (RZhD), has allowed and encouraged private investment into rolling stock in response to widespread shortages of capacity regarding a variety of commodities (Pittman, 2013; Martsenyuk, 2014), first by unbundling the wagon fee from the tariff in 2003, later by spinning off RZhD subsidiaries that owned rolling stock. Thus by 2017, according to the RZhD website, 80 percent of rolling stock is now owned by firms unrelated to RZhD.

An additional problem that compounds the overall shortage of rolling stock in Ukraine is the lack of price flexibility for use of the existing inventory in response to variations in demand (World Bank, 2015). Demand for grain hoppers is of course seasonal, and the absence of seasonal pricing means that marginal users have little incentive to moderate or reschedule their usage in periods of peak overall demand.

The government estimates that the replacement of aging freight cars and locomotives will require a total of USD 2-4 billion over the next few years (Ministry of Infrastructure, 2015, 2017), while the World Bank (2015) estimates that investments of USD 640 million would be required for the 8500 new grain hoppers required to relieve the current and forthcoming shortages of rolling stock for agricultural transport in Ukraine – though all three numbers could be reduced by improvements in incentives for allocating scarce cars during periods of peak demand. The Ministry of Infrastructure's (2017) *National Transport Strategy of Ukraine 2030* argues that Ukrzhaliznytsya requires USD 6-7B for infrastructure repair and improvement.

A good deal of the grain shipments that crowd Ukraine's railways and roads could be transported instead along the country's extensive river system, including not only the Dnieper and Southern Bug but also the Danube and Dniester. Remarkably, a domestic river system that carried almost 66 million tons of freight in 1990 carried just a little over 3 million in 2014. Pidlisny (2016) notes that the inland waterways' share of freight transport in Ukraine is miniscule at 0.25% and compares unfavorably not only with Russia (1.4%) but also with the EU (3.5%), the US (7.7%), and China (15.4%). The proximate cause of the sudden drop after 1990 in Ukraine was the closure of gateways following the

³⁵ See also the discussions of rail investment and financing in Lomtyeva, et al. (2012), Martsenyuk (2012), and Petrenko (2012).

Chernobyl disaster, but there seems to have been no obvious reason beyond bureaucratic neglect, along with decisions to allot scarce investment resources to other uses, for the gradual deterioration since then of the conditions of commerce-supporting infrastructure such as locks and bridges as well as the failure to maintain the regular dredging operations required to restore and maintain navigability, especially along the length of the Dnieper that bisects the country.

The low-hanging fruit with regard to restoring the role of the inland waterways in Ukrainian grain logistics is probably the decision to reverse these decades of official fiscal neglect and devote significant resources to the restoration and improvement of the waterways, including but not limited to the repair and maintenance of locks and significant dredging operations, and the recent commitment of multimillion Euros to these projects by the European Bank for Reconstruction and Development and the European Investment Bank is good news in this regard.³⁶ With such improvements, the government may be willing and able to follow the advice of the World Bank and accept the urging of companies in this sector to extend the navigation period of the Dnieper into the early winter months, a time of peak demand for grain transport (World Bank, 2015). Similarly, although there have been concerns expressed regarding the deterioration of the barge fleet, companies like Nibulon and Ukrrihflot can be expected to expand their capacities significantly once the river conditions are supportive.

However, there is broad agreement among analysts and reformers that the inland waterways will achieve their potential in grain (and other freight) transport only with the implementation by the Verkhovna Rada of the laws “On Inland Waterway Transport” and “On the International Register of Ships in Ukraine” (World Bank, 2015; Pidlisny, 2016; Ilchenko and Oneshko, 2017). The first would both a) drastically reduce the number and the level of fees that must be paid by shippers and vessel operators to make use of the inland waterways and their related facilities and b) remove fee-related penalties for the use of specialized “river-sea” vessels; the latter would eliminate the requirement that foreign vessels go through the expensive and time-consuming process of applying for a permit each time they wish to access the Ukrainian inland waterways.³⁷

The World Bank (2015) estimates that the improvements required to achieve fully operational inland waterways transport of grain in Ukraine would require public and private investments totaling USD 580 million: 10 million for river bed dredging, 270 million for improvements in river ports and terminals, and 300 million for new river barges and tugboats. The infrastructure investment estimate of the *National Transport Strategy of Ukraine 2030* is much higher: USD 2B.

Discussion. The volumes of grain carried by both rail and water are at or near capacity given the current state of both infrastructures in Ukraine, and neither the creation of open-access rail competition nor an increase in road charges (or better enforcement of road weight limits) is likely to increase the share of either mode by themselves. The binding constraint on both the shift of grain transport from road to rail and water as well as any other increases in rail and water transport of grain is clearly the poor state of both infrastructures, exemplified by serious congestion at choke points on the rail network and the dramatic deterioration of river loading infrastructure (as well as other unhelpful policies) that has left water transport of all freight a mere shadow of its former importance. Either direct government

³⁶ Kingdom of the Netherlands (2017).

³⁷ Koshiw (2016); EU4Business (2017). “Ukraine: river transport could triple by 2020 if proper regulation in place,” EU4Business, September 15, 2017, <http://www.eu4business.eu/news/ukraine-river-transport-could-triple-2020-if-proper-regulation-place>, accessed 8 December 2017.

subsidies or policies that attract private investment into infrastructure will be necessary to achieve the goals of long-term intermodal substitution.

9.1 Conclusion

In this paper, we have examined the structure and condition of the markets for the transportation of grain in the four CEE economies of the Czech Republic, Poland, Slovakia, and Ukraine. We have focused in particular on the ability of the railways and – to the lesser extent – internal waterways to substitute for motor carrier haulage in the future, as is the explicit goal of European Commission Policy. One of our focuses has been to evaluate the effectiveness of the promotion of competition by itself within the rail sector as a tool for achieving this broader policy goal.

Our conclusions are to some degree negative and pessimistic, but, we would argue, with some basis for optimism hidden within. Despite the overall success of the policy of the creation of freight rail competition in three of the four countries – Ukraine is the exception at this point – neither this policy nor others has been successful in promoting any significant substitution of rail and water for motor carriers in the transport of grain in these countries.

Some of this stability of road share is very likely due to underlying economic, business, and social factors beyond the capacity of transport policy to address – for example, the relatively small size of farms and flour mills in Poland and the small share of grain traded and short transport distances of Slovakia. Some may be due to Pigouvian policies that could be “corrected” if encouraging this substitution were considered important relative to competing policy goals – for example, the moderate-to-high rail infrastructure access charges in Poland and Slovakia that may have discouraged internal rail shipments in both countries as well as transit shipments in Slovakia.

However, we find that the most important reason for this lack of success in moving grain transport shares has had less to do with rail competition or fees and charges for particular modes and more with severe capacity constraints in the rail sector, particularly in Ukraine but in the other countries as well. One policy strategy for increasing the efficiency of use of existing capacity might be the encouragement of wagonload service, for example through targeted subsidization in a form such as lower access charges. More broadly, there are well known, important capacity “bottlenecks” in the rail sector in all four countries, as well as at border points that host import, export, and transit traffic. In Ukraine and Poland especially, the clear potential for moving grain transport to the rivers has been lost due to a neglect of public investments in the relevant infrastructure as well as restrictive legislation.

Still more broadly, as Pittman (2017a) has argued, it was perhaps a miscalculation in the first place for EC policymakers to expect the encouragement of “open access” competition for freight to lead to an increase in rail’s share, since this reform model is not targeted at – and has not been effective at – encouraging investment in rail infrastructure (as opposed to rolling stock and locomotives). Nor do the Pigouvian policies traditionally favored by economists such as the manipulation of taxes and fees seem likely to be successful under current circumstances. Our findings suggest that a policy focused more directly on infrastructure investment – whether an increase in subsidies or alternative strategies for attracting private investments into infrastructure, including alternative reform models – will be required if the current constraints binding rail’s share are to be relaxed.

Sometimes one can “by indirection find directions out”, as Polonius advises his servant Reynaldo in *Hamlet* – but sometimes more direct strategies are more effective.

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