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(Többet kereskedünk, ha gyorsan kereskedünk? Az EU-bővítés tapasztalatai)

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Contents

Abstract

Timely deliveries have become more important in international trade in the recent decades, mostly because of the spread of international production fragmentation. This paper provides empirical evidence on the cost of time in trade by looking at how faster trade within the European Union (EU) contributed to the trade expansion with new EU members after the enlargement in 2004. I derive a bilateral trade cost index from trade data of EU countries in 19 manufacturing industries and years 2000-2006 and perform a double difference-in-differences estimation. The results show that the enlargement-induced decline in the trade cost index, and hence trade creation, was more than twice larger in industries, where production fragmentation is typically widespread. I proxy the improvement in timeliness by the decline in the waiting time at land border crossings and estimate that saving one hour at the border is like a 0.9% trade cost decline in ad valorem terms. Robustness checks, which account for the dominant transport mode or experiment with alternative measures of timeliness, confirm the main findings.

JEL: F13, F14, F15.
Keywords: time cost of trade, double difference-in-differences, treatment intensity, EU enlargement.

Összefoglalás

Az utóbbi évtizedekben egyre fontosabbá vált a külkereskedelmi tranzakciók gyors lebonyolíthatósága, ami kapcsolatba hozható az országok közötti vertikális specializáció elterjedésével. Ez a tanulmány egy empirikus vizsgálat az idő mint külkereskedelmi költség jelentőségéről. Arra keresem a választ, hogy az Európai Unión (EU) belüli gyorsabb kereskedelem milyen mértékben járult hozzá a 2004-es EU-bővítés után az új tagállamok külkereskedelmi forgalmának növekedéséhez. EU-tagországok 19 feldolgozóipari ágazatra bontott, 2000 és 2006 közötti bilaterális külkereskedelmi adatai alapján külkereskedelmiköltség-indexet számolok, amin „dupla különbség a különbségben” (double difference-in-differences) becslést alkalmazok. Azokban az iparágakban, ahol jelentős az országok közötti vertikális specializáció, a külkereskedelmiköltség-index EU-bővítés által kiváltott csökkenése több mint kétszer akkora volt, mint más iparágakban. Azt, hogy mennyivel vált gyorsabbá a külkereskedelem az EU-bővítés által, a szárazföldi országhatárokon való várakozás csökkenésével ragadom meg, és azt találom, hogy egy órával rövidebb várakozás 0,9 százalékpontos értékvám-csökkenésnek felel meg. A fő eredmények változatlanok maradnak, ha figyelembe veszem a jellemző szállítási módokat, illetve ha alternatív változókkal ragadom meg a külkereskedelem időigényének csökkenését.

1 Introduction

Time matters in trade and it has been growing in importance in recent decades. Some goods are inherently perishable like fresh food or face quickly varying demand like fashion articles and have always been sensitive to delivery time. Other products require timely trade mainly because of the structure of production. The spread of international production fragmentation or, in other words, cross-border vertical specialization (Feenstra and Hanson, 1996; Hummels et al., 2001; Breda et al., 2008) has multiplied the need for timeliness. For the final product to reach the consumers and match their changing tastes, intermediate production stages at different parts of the world should be synchronized in an especially timely fashion. A delay at any stage can hold up the whole process and holding large inventories at all locations are costly (Hummels, 2007).

This paper provides empirical evidence on the cost of time in international trade. It identifies from an episode of an one-off permanent decline in the trading time: the elimination of border cargo controls and customs procedures for new members with the enlargement of the European Union (EU) in 2004. This episode is especially suitable to study some non-traditional trade barriers, such as time, since early liberalization measures have lifted traditional trade policy barriers (tariffs, quantitative restrictions) for most manufactured products within the enlarged EU several years before the enlargement took place.

On a database of trade among 14 "old" and 8 "new" EU members[1] in 19 manufacturing industries (excluding food and energy) and seven years I calculate an industry-specific index of bilateral trade costs, following Novy (2008) and Jacks et al. (2008). The identification approach I follow is based on the idea of the double difference-in-differences estimator on the trade cost index. The estimate captures how much more the trade cost index fell from the pre-enlargement to the post-enlargement period for country pairs with at least one new member (pairs of old members being the control group) in time sensitive, relative to non-sensitive industries. Time sensitive industries are defined as those with typically high production fragmentation on the basis of the import content of exports.

The estimates reveal that the decline in the trade cost index for country pairs with new members (treated country pairs) is more than twice larger for time sensitive (7%) than for non-sensitive industries (3%). In terms of trade creation these numbers translate into, respectively, 35% and 12% more international than domestic trade. This reflects that the trade expansion of new members, which shortly followed EU enlargement, was considerably more pronounced in industries, which are characterized by strong international production fragmentation.

To associate the change in the trade cost index with the change in trading time, I replace the dummy for treated country pairs in the estimation with a continuous variable that captures variation in the improvement of timeliness. This so-called treatment intensity indicator is the decline in the waiting time at land borders on the route between a country pair. It is based on data on the pre-enlargement waiting time at the borders of new members and on the assumption that border waiting time within the EU is zero. My estimates imply that one hour shorter waiting time is equivalent to a 0.9% decline in ad valorem tariffs and 5% more trade in time sensitive industries. In non-sensitive industries border waiting time is found to have no significant effect on trade.

The few related empirical evidence in the literature are based on fundamentally different identification approaches. Hummels (2001) estimates the cost of time as the premium firms pay for air instead of sea transportation. Djankov et al. (2010) infer the effect of time on trade flows from a country cross section of the *Doing Business* database.[2] In contrast, the iden-

[1] Throughout the paper I use the terms old and new members, which refer to the pre-2004 EU-15 countries and the countries that entered the EU in 2004, respectively.

[2] Hummels (2001) estimates the premium paid for air transportation to be 0.5% of the product value per day. Djankov et al. (2010) find that in country relations, where trading time is one day longer, the volume of trade is 1% smaller.

tification strategy of this paper has four cornerstones. First, it looks at an episode, which is close to a quasi-experiment in the sense that the decline in trading time was an exogenous move to trade, and that changes in traditional trade policies can be ruled out. Second, the use of the trade cost index, instead of estimating a gravity equation, overcomes the problem of controlling for the unobserved multilateral trade resistances (i.e. trade barriers with third countries), which challenges empirical gravity studies since Anderson and Wincoop (2003). Third, the double difference-in-differences estimator controls for most unobserved heterogeneity of the trade cost index in the country, industry and time dimensions and, hence, it ensures that the estimates are not affected by time-constant characteristics or global, purely country-specific or purely industry-specific trends. Finally, the use of the border waiting time as treatment intensity indicator helps narrowing down the estimated effect to the effect of timeliness alone.

The results of this paper support the implications of the theoretical literature on the time cost of trade (Deardorff, 2002; Evans and Harrigan, 2005; Harrigan and Venables, 2006). In theory time costs can hinder the outsourcing of time sensitive production to more distant and/or less developed locations, lead to agglomeration effects, and reduce international trade. This effect is amplified by the uncertainty time delays cause in the whole production and distribution process, the cost of which can be especially high when production is internationally fragmented.[3]

The paper is structured as follows. Section 2 introduces the trade cost index and presents its evolution around EU enlargement. Section 3 builds the empirical framework, discusses time sensitivity of industries and describes the treatment intensity indicator. Section 4 presents the baseline estimation results. Section 5 cross-checks the main results by mode of transport, while Section 6 presents estimates with alternative treatment intensity indicators. Section 7 concludes.

[3] Yi (2003) and Yi (2005) show that the presence of international production fragmentation magnifies the effects of national border barriers.

2 The trade cost index

A theory-consistent measure of bilateral trade barriers can be inferred from trade flows, as it is shown in Novy (2008) and earlier in Head and Ries (2001). In fact, Jacks et al. (2011) argue that a trade cost index of the same form can be derived from several competing trade theories (Eaton and Kortum, 2002; Chaney, 2008; Melitz and Ottaviano, 2008). In this paper, my aim is to infer the importance of time-related costs directly from the trade cost index. The main advantage of this approach over the traditional way of estimating a gravity equation is that the trade cost index is net of the multilateral trade resistances, i.e. the terms in the gravity equation, which capture trade frictions of the exporter and the importer with third countries. Multilateral trade resistances are unobservable and can cause omitted variable biases when not controlled for properly in gravity estimations (Anderson and Wincoop, 2003).

I derive trade costs at the industry level based on the industry-specific gravity equation of Anderson and Wincoop (2004). A similar approach is taken in Chen and Novy (2009) and Jacks et al. (2008). The gravity equation for trade from country *i* to country *j* of products specific to industry *k* is

$$X_{ij}^k = \frac{Y_i^k E_j^k}{Y_W^k} \left(\frac{T_{ij}^k}{\Pi_i^k P_j^k} \right)^{1-\sigma^k}, \tag{1}$$

where Y_i^k is output in the exporting country, E_j^k is expenditure in the importing country, Y_W^k is world output, and T_{ij}^k denote bilateral trade costs, all specific to industry *k*. The terms Π_i^k and P_j^k are the outward- and inward-oriented multilateral trade resistances for *i* and *j*, respectively, in industry *k*. The elasticity of substitution among varieties, σ^k, is also industry-specific.

Notice that the gravity equation also holds for *intra*national trade, i.e. the domestic sale of domestically produced goods,

$$X_{ii}^k = \frac{Y_i^k E_i^k}{Y_W^k} \left(\frac{T_{ii}^k}{\Pi_i^k P_i^k} \right)^{1-\sigma^k}, \tag{2}$$

where T_{ii}^k is the trade cost within country *i*. Express the product $\Pi_i^k P_i^k$ from (2) and $\Pi_j^k P_j^k$ from the similar domestic gravity equation for country *j*. Then, take the product of two international gravity equations, equation (1) and the equation for the reverse flow X_{ji}^k, and substitute back the expressions for $\Pi_i^k P_i^k$ and $\Pi_j^k P_j^k$. Simple manipulations yield the ratio of international to domestic trade costs, expressed as a function of the domestic to foreign trade ratio. Finally, take the square root to get the geometric mean of the two directions of trade.[4] The index of trade costs between *i* and *j* in industry *k* is then

$$\Theta_{ij}^k \equiv \left(\frac{T_{ij}^k T_{ji}^k}{T_{ii}^k T_{jj}^k} \right)^{\frac{1}{2}} = \left(\frac{X_{ii}^k X_{jj}^k}{X_{ij}^k X_{ji}^k} \right)^{\frac{1}{2(\sigma^k - 1)}}. \tag{3}$$

It reflects that trade frictions between two countries are larger the less open the countries are in terms of the ratio of domestic to international trade. Note that Θ is only a relative measure: the level of cross-country barriers is compared to the level of within-country ones. In theory, the lower bound is $\Theta = 1$, when international trade is just as costly as domestic trade. A special case is frictionless trade, when $T_{ij} = T_{ji} = T_{ii} = T_{jj} = 1$. At the other extreme, for a closed economy with zero international trade Θ approaches infinity.

The trade cost index also corrects for the level of the substitution elasticity between home and foreign goods.[5] When σ is high, demand shifts strongly towards domestic goods even in response to a small relative price increase, induced by

[4] Notice that the index is not suitable to capture asymmetries in trade barriers.

[5] This is the point, where the index in Novy (2008) differs from the one proposed by Head and Ries (2001).

increasing international trade costs. Hence, with high σ, an economy with relatively small international trade barriers can be considerably closed. On the contrary, when σ is low, the economy can be considerably open even with large international trade barriers.

I calculate the trade cost index, Θ, as in (3) for country pairs of the enlarged EU, 19 manufacturing industries and years between 2000 and 2006.[6] The set of countries includes 22 EU members (14 old and 8 new), altogether the EU-25 less Greece, Cyprus and Malta.[7,8] Industries are manufactures according to the two-digit NACE classification, excluding food, beverages, tobacco (codes 15 and 16) and energy products (code 23). For the sampled industries trade was free in terms of tariffs and quotas during the whole sample period within the enlarged EU area.

International trade data is bilateral exports in euros from Eurostat.[9] Following the method of Wei (1996), I construct domestic trade as gross output minus exports plus re-exports of a given country in a given industry. These data is sourced from national supply and use tables in the World Input-Output Database (WIOD).[10] Finally, I take the industry-specific elasticities of substitution from Chen and Novy (2009), who transform the σ estimates for product groups in Hummels (1999) to the NACE industry classification.[11]

I create a panel database, which is balanced in time. This means ignoring that 17% of the country pair-industry cells, where data is missing in at least one year.[12] The number of observations in the balanced panel is 25,641 with 3,663 country pair-industry groups. 44% of the observations belongs to country pairs with two old EU members (control pairs in the estimation). Summary statistics are presented in Tables 11 and 12.

The path of the trade cost index (in log) between 2000 and 2006 is plotted on Figure 1. The three lines are averages across the 19 manufacturing industries for country pairs of two old, two new, or a new and an old member. Trade frictions are the lowest among old members and the highest between old and new members. This pattern reflects differences in trade barriers in the broadest possible sense, ranging from distance-related transportation costs to cultural or institutional factors. A value of 1 (end point for new-new pairs) means that the cost of international trade is 2.7 times larger than the cost of domestic trade. A fall in the index from 1.2 to 1, what happened to new-new pairs during the seven years, reflect a 20% decline in costs in ad valorem terms.

As for evolution over time, the trade barriers between old members are remarkably stable. In contrast, trade barriers declined steadily for new-new and old-new country pairs. It suggests that, regardless the one-off event of EU enlargement, an overall trade integration process was present during the sample period. Industry graphs on Figures 4 to 4 in the Appendix (with $\log\Theta$ normalized to year 2000) reveal that, for some industries, the declining trend became more pronounced after 2004. These are mainly the technology intensive industries such as machinery or motor vehicles, but they also include other branches like basic metals.

[6] Naturally, interpreting the annual Θs as trade barriers requires the assumption that the gravity equation holds in each year.

[7] The three countries are excluded because the quasi-experiment argument does not hold for them. Greece entered the euro area in 2001. Cyprus and Malta had different pre-enlargement trade policies with the EU than the 8 Central and Eastern European countries.

[8] Notice the difference between EU and Schengen membership. The EU allows for the free movement of goods, while Schengen for the free movement of persons. During the sample period Ireland, the UK and the 8 new members were not members of the Schengen area. The 8 new members entered Schengen in 2007.

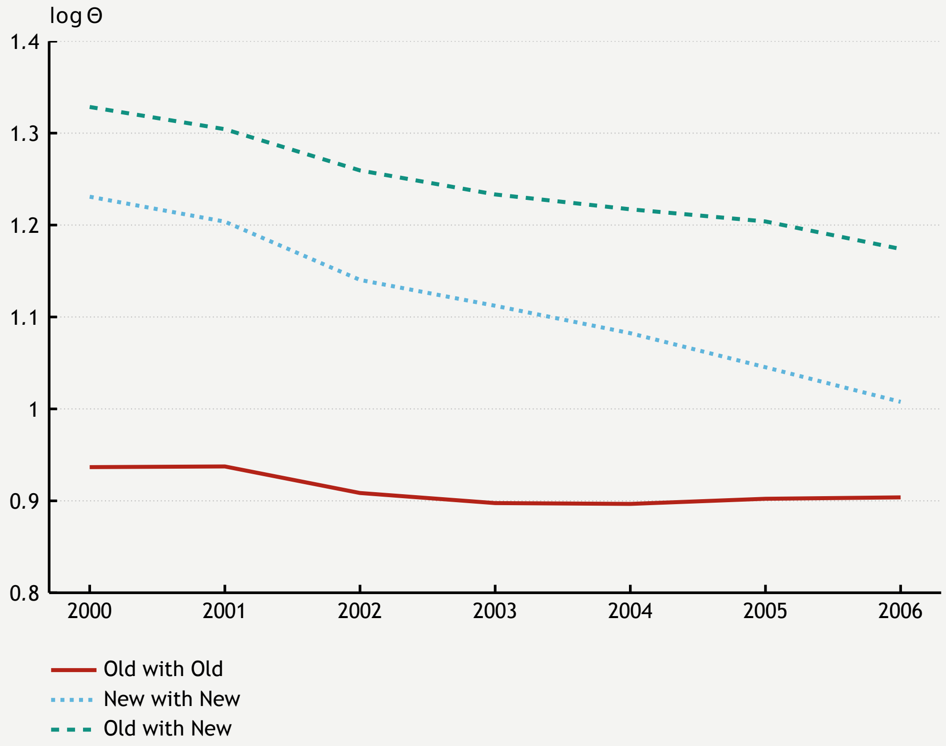
[9] Product-level data in six-digit HS or five-digit SITC breakdown (the latter only for Poland and Slovakia) is classified into two-digit NACE industries using the relevant correspondence tables.

[10] The WIOD make annual national supply and use tables complete and consistent by combining them with time series from the National Accounting Systems. Source: http://www.wiod.org/.

[11] To get the NACE industry σs at the two-digit level, I take the weighted averages of the three-digit σs in Chen and Novy (2009) for each two-digit industry, where the weights are intra-EU trade shares in 2000-2006. The original σ estimates of Hummels (1999) are for 63 two-digit SITC product groups.

[12] Although the source data is complete, the constructed domestic trade variable is not positive for 3% of the observations. These become missing after taking the logarithm of Θ.

Figure 1
Trade cost index within the EU



3 Estimation strategy

I base the estimation strategy on the idea of the double difference-in-differences estimator, which identifies from the country pair, industry and time variation in the trade cost index.[13] Doing that I also exploit the quasi-experiment nature of the episode. Since all the countries considered here traded freely in the sampled industries' products during the whole sample period, there is no need to control for traditional trade policy measures, for which reliable data is often lacking.[14] This section describes the estimation method, presents the division of industries according to their sensitivity to time-related trade barriers and describes the construction and use of the treatment intensity indicator.

3.1 DOUBLE DIFFERENCE-IN-DIFFERENCES

The double difference-in-differences estimator is composed of three differences. The first is a time difference. How much did trade costs decline from the pre-enlargement to the post-enlargement period? This is captured by a dummy variable, d_t, which is 1 for years larger than or equal to 2004 and 0 otherwise.[15]

The second difference is across country pairs. How much larger was the decline in trade costs for country pairs that became intra-EU in 2004 (treated pairs), relative to country pairs already inside the EU (control pairs)? The corresponding dummy is d_{ij}, which equals 1 for the treated pairs and 0 otherwise. Treated country pairs are pairs with either two new members or one new and one old member. This implies that what matters is *joint* membership. The timeliness gain from faster border crossings and less customs administration materializes only when both countries are in. Country pairs of old members are the control group, which is based on the argument that their trade *growth* (and the time change of the trade cost index) is not affected any more by their membership status.

The third difference is across industries. How much larger was the excess decline in trade costs for treated country pairs in industries, which are sensitive to time costs, relative to other industries? Timely deliveries can be very important in some industries and less so in others. If time costs had played an important role in the trade effect of EU enlargement, trade in the former type of industries had to be significantly more affected than trade in the latter type.

I classify industries into a time sensitive and a non-sensitive group according to the import content of export statistics, the widely used measure for international production fragmentation.[16] Since food manufactures are excluded here, I do not need to take into account perishability as another source of time sensitivity. I classify an industry as time sensitive, if the import content of its export is greater than or equal to the median import content of export for the 19 industries. Table 1 shows the import content of export statistics by industry in the EU in the mid-2000s and the resulting classification. Industries that are classified as time sensitive produce textiles, clothing and footwear (codes 17-19), basic metals (27), and non-mechanical machinery and transport equipment (30-35).

[13] Description of the method is provided, among others, in Meyer (1995) and Angrist and Krueger (1999).

[14] Trade in (non-food) manufactures was liberalized by year 2000 within the enlarged EU area. This was ensured by the Europe Agreements between the old EU and the 8 new members, the Central European Free Trade Agreement (CEFTA), the Baltic Free Trade Agreement (BAFTA), and bilateral trade agreements between each pair of CEFTA and BAFTA members. For more details see Hornok (2010).

[15] Although the enlargement took place in May 2004, due to the annual data frequency, I have to put the whole year into the pre-enlargement period. Note that this might cause some downward estimation bias, since four pre-EU months are put in the post-EU part of the sample.

[16] Most previous studies on time sensitivity focused on a narrow subset of products, where defining time sensitivity is relatively straightforward (fresh versus preserved food, or replenishment versus non-replenishment clothing in Evans and Harrigan (2005).) Hummels (2001) provides more comprehensive estimates by SITC product group. How to put his results into the NACE industry classification is however not obvious.

Table 1
Production fragmentation in the EU in the mid-2000s

NACE	Description	Import content of export	1 if sensitive
17-19	Textiles, textile products, leather and footwear	0.12	1
20	Wood and products of wood and cork	0.06	
21-22	Pulp, paper, paper products, printing and publishing	0.05	
24	Chemicals and chemical products	0.09	
25	Rubber and plastics products	0.10	
26	Other non-metallic mineral products	0.04	
27	Basic metals	0.11	1
28	Fabricated metal products	0.08	
29	Machinery and equipment n.e.c	0.09	
30	Office, accounting and computing machinery	0.27	1
31	Electrical machinery and apparatus n.e.c	0.12	1
32	Radio, television and communication equipment	0.22	1
33	Medical, precision and optical instruments	0.11	1
34	Motor vehicles, trailers and semi-trailers	0.11	1
35	Other transport equipment	0.17	1
36	Manufacturing n.e.c	0.09	

Source is OECD STAN Input-Output database.

The double difference-in-differences estimator is the difference of two difference-in-differences estimators. The difference-in-differences estimator,

$$\log\Theta\left[d_t=1,d_{ij}=1\right]-\log\Theta\left[d_t=0,d_{ij}=1\right]-\left(\log\Theta\left[d_t=1,d_{ij}=0\right]-\log\Theta\left[d_t=0,d_{ij}=0\right]\right),$$

tells how much more the log of the trade cost index declined from the pre-enlargement to the post-enlargement period for treated country pairs, relative to control country pairs. The double difference-in-differences estimator calculates the above difference-in-differences estimator for time sensitive and non-sensitive industries separately and subtract the first from the second. Taking the industry difference ensures that the estimate is unaffected by heterogeneous trends across the treated and control country pairs (Figure 1) to the extent that the pattern of heterogeneity is common across the two groups of industries. This means that my estimation strategy controls for all sources of trade cost changes, which affect the two groups of industries the same way.

The double difference-in-differences estimator can be implemented with a regression equation, which includes the three dummy variables d_t, d_{ij}, d^k and their first- and second-order interactions. Here I also exploit the panel nature of the data and estimate a fixed effects equation, encompassing the double difference-in-differences estimator, with country pair-industry fixed effects (δ^k_{ij}) and a full set of industry-year dummies (μ^k_t),

$$\log\Theta^k_{ij,t}=\alpha d_{ij,t}+\beta d^k_{ij,t}+\mu^k_t+\delta^k_{ij}+\varepsilon^k_{ij,t}. \tag{4}$$

The regressors of interest are the first-order interaction term $d_{ij,t}=d_{ij}\cdot d_t$ and the second-order interaction term $d^k_{ij,t}=d_{ij}\cdot d_t\cdot d^k$. The coefficient α is the difference-in-differences estimator for non-sensitive industries, while β is the double difference-in-differences estimator. A significant and negative estimate for the latter would mean that EU enlargement made the trade cost index decline more in time sensitive industries than in non-sensitive ones. The sum of the two estimates gives the overall decline in the trade cost index due to EU enlargement in time sensitive industries.

3.2 IDENTIFICATION WITH TREATMENT INTENSITY

In an alternative estimation I refine the identification with the use of a treatment intensity indicator.[17] The treatment intensity indicator, which replaces the dummy variable d_{ij} in the estimation, captures the improvement in the timeliness

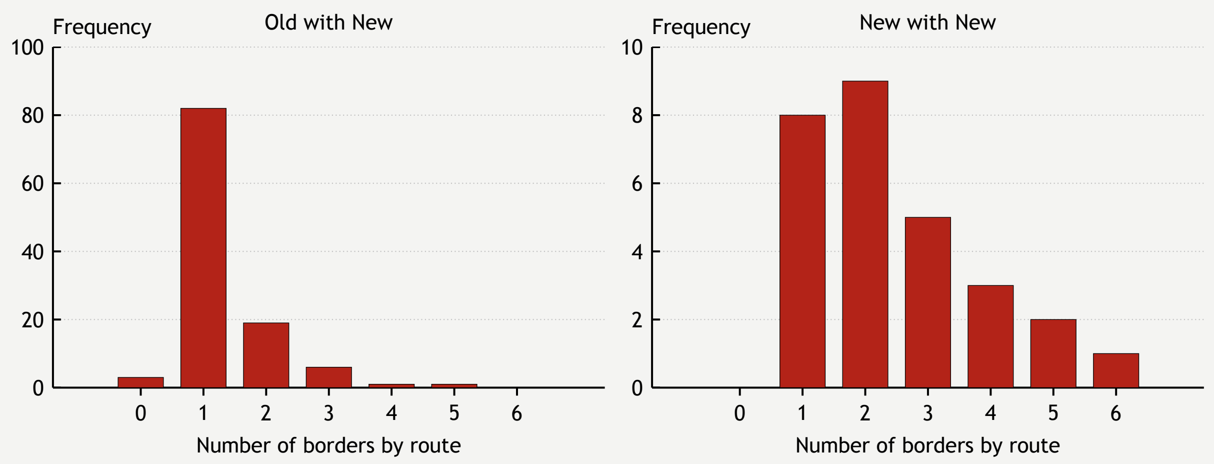
[17] Angrist and Pischke (2008) discuss this approach referring to Card (1992), who uses regional variation to measure the effect of the federal minimum wage.

of trade for each country pair. Using a continuous variable instead of a dummy allows me to test whether a larger time gain leads to a larger trade effect.

The treatment intensity indicator (denoted by h_{ij}) is the change in the waiting time (in hours) at national borders due to EU enlargement on the route between two countries. It is based on data on the pre-enlargement waiting time at land borders of new members and on the assumption that border waiting time within the EU is zero.[18] The construction of the indicator is as follows. First, I set $h_{ij} = 0$ for all control country pairs. Second, I create a route-specific border waiting time variable for each treated country pair in the pre-enlargement period. This involves determining the optimal transport route and then, summing up the waiting hours at the borders, which were abolished along the route.[19] Finally, to get h_{ij} for the treated country pairs, I take the negative of the route-specific border waiting time, assuming that waiting time fell to zero.

The number of abolished borders is typically 1 for country pairs of an old and a new member (Figure 2), since all the 8 new members are either neighbors to the old EU block or have a direct sea access. In contrast, for country pairs of two new members, the number is typically larger than 1.

Figure 2
Frequency distribution of number of abolished borders



Border waiting time data for the years preceding EU enlargement is from the International Road Union (IRU) and is based on regular (daily, from Monday to Friday), but voluntary, reporting from transport companies and authorities, as well as bus and truck drivers.[20] Original data is direction-specific and available for several crossing points per border. Data is not available for some new members (mostly the Baltic states) and for sea ferry ports in general. As a result, the treatment intensity indicator can be constructed only for 76 out of the 140 treated country pairs in the sample. Section 6 experiments with other treatment intensity indicators with better data coverage.

Table 2 illustrates on an example how I generate the route-specific border waiting time variable. On the route between Austria and Poland a truck has to cross two borders (Austrian-Czech, Czech-Polish), both of which were eliminated with EU enlargement. On both borders there are three crossing points, for which direction-specific waiting time data is available. Having no information on the distribution of traffic across crossing points, I take the simple average of the waiting time figures by border. Then, I add up the waiting hours at the two borders and take the simple average of the two directions.[21]

[18] Though EU enlargement immediately guaranteed the free movement of goods within the enlarged EU area, border police controls of persons' movements remained in place up until the 8 new EU members entered the Schengen Area in December 2007. However, most of the pre-enlargement border waiting time for cargos was due to the customs clearance at the border, which was completely eliminated at May 2004.

[19] I chose the economically optimal route between the capital cities of the two countries for a 40-tonne truck with the help of an online route planner (http://www.routenplaner-50.com/).

[20] I express my gratefulness to Peter Krausz (IRU) for providing me the data.

[21] Averaging the directions is necessary, because the trade cost index is not direction-specific.

Table 2
Calculation of waiting hours on route Austria-Poland

Crossing point	Hours (2000-2002) there	back
Austria - Czech Republic		
Wullowitz-Dologi Dvorista	1.3	1.5
Drasenhofen-Mikulov	0.4	1.1
Haugsdorf-Hate	0.9	0.5
Average at AT-CZ	0.9	1.1
Czech Republic - Poland		
Kudowa Slone-Nachod	7.7	5.2
Chalupki-Novy Bohumin	0.8	0.8
Clesyzn-C.Tesin	7.1	7.1
Average at CZ-PL	5.2	4.4
AT-CZ + CZ-PL	6.1	5.5

Waiting hours AT-PL $= 0.5 \cdot (6.1 + 5.5) = 5.8$.
Source is IRU and author's calculations.

Finally I get that, before EU enlargement, delivery time between Austria and Poland included on average 5.8 hours waiting at borders.

The frequency distribution of the route-specific border waiting time is shown on Figure 3. The waiting time on most routes is not more than 5 hours, and there are only a few routes with more than 10 hours of waiting.[22]

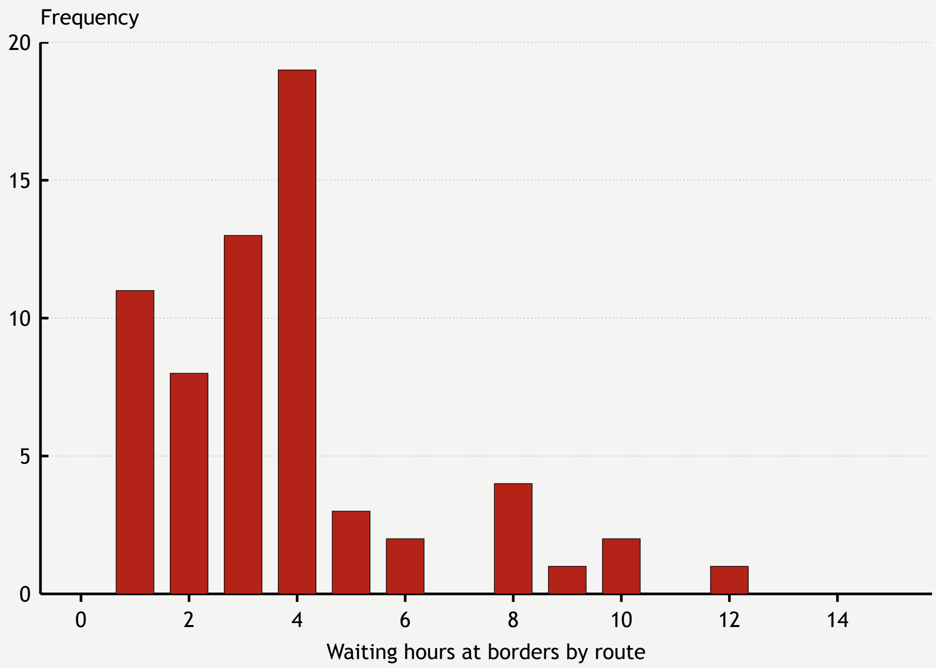
The estimating equation with the treatment intensity indicator is similar to (4), with h_{ij} replacing d_{ij},

$$\log \Theta^k_{ij,t} = \alpha' h_{ij,t} + \beta' h^k_{ij,t} + \mu^k_t + \delta^k_{ij} + \varepsilon^k_{ij,t}, \qquad (5)$$

where $h_{ij,t} = h_{ij} \cdot d_t$ and $h^k_{ij,t} = h_{ij,t} \cdot d^k$. The coefficient α' measures the response of the trade cost index to a one hour change in the border waiting time in non-sensitive industries, while β' captures the *additional* response in time sensitive industries.

[22] If there were no missing observations, the distribution would most probably be denser at the higher end, since the routes between the Baltic states and other (continental) countries cross more borders than other routes.

Figure 3
Frequency distribution of waiting hours by route



4 Estimation results

I estimate (4) and (5) on the balanced panel of country pairs and industries over years 2000-2006. In the error structure I allow for arbitrary patterns of correlation and heteroscedasticity within country pairs.[23]

In all regressions I include an additional control variable, which captures the difference in the macroeconomic trends of the two countries in the pair. Chen and Novy (2009) point out that the trade cost index is also affected by the nature of trade: for given level of trade barriers, the index is larger, when trade is based on comparative advantage driven by technology or factor endowment differences, and smaller, when trade is mainly intra-industry trade. With economic convergence to the more developed EU, the trade of new members shifted towards intra-industry trade, making their trade cost indices fall. I capture this trend with the absolute difference between the GDP per capita levels of the two countries in the pair.[24] Note that the estimates for β in (4) and for β' in (5) are not affected by the inclusion of this variable, as it captures a trend common across industries.

Table 3
Main results

Variable	w/o treatment intensity	with treatment intensity
Treatment	−0.031*** (0.009)	
Treatment x Sensitive	−0.040*** (0.011)	
Treatment intensity		0.003 (0.003)
Treatment intensity x Sensitive		0.009*** (0.003)
GDP per capita gap	0.150*** (0.041)	0.343*** (0.066)
Number of observations	25,641	19,117
Number of groups, of which:	3,663	2,731
- treatment, of which:	2,039	1,107
- sensitive	935	554
Adjusted within R^2	0.18	0.20

**** Significant at the 1% level.*

Estimates for equations (4) and (5) on a panel of country pairs and industries in period 2000-2006. Dependent variable is the log trade cost index. Treatment is being an old-new or new-new country pair after 2004. Treatment sensitivity of industries is based on the import content of exports. Treatment intensity is the decline in border waiting time between countries. Cluster robust standard errors (with country pair clusters) are in parentheses.

The estimation results are shown in Table 3. Estimates for (4) in the first column show that the decline of the trade cost index in time sensitive industries was more than twice larger (3% + 4%) than in non-sensitive industries (3%). According to the estimates with the treatment intensity indicator (second column), the decline in the border waiting time affected only the trade in time sensitive industries significantly. One hour shorter waiting time is associated with a 0.9% decrease in the trade cost index, equivalent to a decline in ad valorem tariffs of the same magnitude.

[23] Country pair clustering requires a less stronger assumption on the independence of errors than country pair-industry clustering.

[24] GDP per capita is in current euro prices. Source of data is Eurostat.

The estimate of 0.9% for an hour waiting is very large in comparison with the findings of other studies on timeliness. Both Hummels (2001) and Djankov et al. (2010) estimate the cost of a *day* to be around this magnitude. Although direct comparison of these figures is misleading due to the differences in the identification approaches, the large discrepancy calls for caution in interpreting the estimate directly in terms of a time unit. It is also very likely that the treatment intensity indicator does not only capture the cost of waiting at the border *per se*. At best, it also reflects the cost of uncertainty regarding the delay as border waiting time fluctuates.[25] Moreover, it cannot be ruled out that the estimate also captures the effect of improvements in other types of administrative inefficiencies in trading.

The estimates can be transformed into trade flow terms. Rearranging equation (3) and taking the logarithmic time difference yields

$$\Delta \log \left(\frac{X_{ij}^k X_{ji}^k}{X_{ii}^k X_{jj}^k} \right)^{\frac{1}{2}} = -(\sigma_k - 1) \Delta \log \Theta_{ij}^k. \tag{6}$$

Substituting the estimated coefficients for $\Delta \log \Theta_{ij}^k$ gives the percentage growth in international (relative to domestic) trade. I use the elasticity of substitution of 6.8 for time sensitive and 5.0 for non-sensitive industries (corresponding averages from Table 11). The 3% and 4% estimated trade cost declines translate into a 12% trade growth in non-sensitive and a 23% *additional* trade growth in time sensitive industries. The estimated 0.9% decline for an hour waiting is equivalent to a 5% boost in international trading.

I replicate the estimates separately for the two groups of treated country pairs: new with new and old with new. Control country pairs remain old with old in both cases. As expected, the estimated effects are larger for country pairs with two new members than for country pairs of an old and a new member in both types of industries. Importantly, the main finding that time sensitive industries are significantly more affected than non-sensitive ones holds in both estimations.

Table 4
Results by country pair group

	w/o treatment intensity		with treatment intensity	
	new with new	old with new	new with new	old with new
Treatment	−0.049*** (0.013)	−0.013 (0.009)		
Treatment x Sensitive	−0.103*** (0.017)	−0.032*** (0.011)		
Treatment intensity			0.009** (0.004)	0.000 (0.003)
Treatment intensity x Sensitive			0.018*** (0.003)	0.007** (0.003)
GDP per capita gap	0.224*** (0.077)	0.220*** (0.40)	0.242*** (0.072)	0.400*** (0.064)
Number of observations	13,825	23,184	12,628	17,857
Number of groups, of which:	1,975	3,312	1,804	2,551
- treatment, of which:	351	1,688	180	927
- sensitive	146	789	86	468
Within R^2	0.19	0.17	0.18	0.19

*** Significant at the 5% level.*

**** Significant at the 1% level.*

Estimates for equations (4) and (5) on a panel of country pairs and industries in period 2000-2006. Dependent variable is the log trade cost index. Treatment is either being a new-new or an old-new country pair after 2004. Treatment sensitivity of industries is based on import content of exports. Treatment intensity is the decline in border waiting time between countries. Cluster robust standard errors (with country pair clusters) are in parentheses.

[25] The maximum of the border waiting time, reported in Fink (1999) for 1999, was 24 hours or more at certain borders.

5 The role of the transport mode

The treatment intensity indicator captures the improvement in timeliness explicitly at land borders. Moreover, the timeliness gain I look at is not present in transportation by sea. Sea transportation within the EU is still subject to border controls and the customs procedure, as if the cargo left the EU territory.[26] This section checks how the estimates vary with the transport mode. I expect to get stronger estimates for country pairs and industries, where land transport is dominant.

In dividing the sample into "land" and "non-land" subsamples I rely on projected transport mode choice probabilities for each country pair-industry cell. The projection of modal choice is based on a multinominal logit model, which differentiates among the three main modes: air, sea and land. I estimate the multinomial logit on data on exports of EU members to some non-EU countries. The projection of model choice in intra-EU trade is necessary, because the mode of transport is reported by Eurostat only for extra-EU trade. Detailed description of the projection exercise is relegated to Appendix A.

The predicted modal shares are reported in Table 14 by industry and in Table 15 by country. Land transport is projected to have the highest probability (0.65) in intra-EU trade, reflecting the geographical closeness and contiguity of EU countries. Air and sea are of secondary importance, with air having relatively large shares in low weight-to-value industries (communication equipment, medical, precision and optical instruments) and sea being used more frequently in the transport of heavy products (wood and basic metals). Landlocked countries are naturally projected to use land transport the most frequently, while island countries and others with important sea access use sea transportation more often.

The land subsample includes country pair-industry observations, whose projected probabilities for land transportation is not smaller than 0.5. The non-land subsample contains the rest of the observations. Results of the estimation of (4) and (5) by subsample are in Table 5. The estimates in both specifications confirm that the timeliness effect is significant only in the land subsample. The coefficient estimates for the non-land subsample are not only insignificant (due partly to larger standard errors), but small in magnitude or even have the opposite sign.

[26] "Unlike road transport, which has been reaping the benefits of the internal market since 1993, shipments of goods by sea between the ports of the European Union are treated in the same way as shipments to third countries. Consequently, maritime transport between Member States involves many documentary checks and physical inspections by the customs, health, veterinary, plant health and immigration control officials." European Commission, Directorate-General for Energy and Transport: Memo - Maritime Transport without Barriers, 2007

Table 5
Results by transport mode

	w/o treatment intensity		with treatment intensity	
	land	non-land	land	non-land
Treatment	−0.038*** (0.010)	0.001 (0.024)		
Treatment x Sensitive	−0.042*** (0.013)	−0.021 (0.029)		
Treatment intensity			0.002 (0.003)	0.012 (0.010)
Treatment intensity x Sensitive			0.009*** (0.003)	−0.004 (0.010)
GDP per capita gap	0.086* (0.046)	0.285*** (0.071)	0.321*** (0.085)	0.241** (0.099)
Number of observations	19,082	6,559	13,517	5,600
Number of groups, of which:	2,726	937	1,931	800
- treatment, of which:	1,832	207	1,037	70
- sensitive	833	102	512	42
Within R^2	0.21	0.14	0.23	0.15

** Significant at the 10% level.*

*** Significant at the 5% level.*

**** Significant at the 1% level.*

Estimates for equations (4) and (5) on subsamples defined on transport mode propensities on a panel of country pairs and industries in period 2000-2006. Dependent variable is the log trade cost index. Treatment is being an old-new or new-new country pair after 2004. Treatment sensitivity of industries is based on import content of export. Treatment intensity is the decline in border waiting time between countries. Cluster-robust standard errors (with country pair clusters) are in parentheses.

6 Robustness to treatment intensity

This section experiments with three alternative treatment intensity indicators. One is the change in the number of borders on the route between the country pair ("abolished borders"). This variable have been used to construct the route-specific border waiting time and is described in Section 3.2.

The second is the approximate decline in the time to trade, due to the elimination of the customs procedure ("days to customs"). Time to trade by country is from the 2005 *Doing Business* survey, which is also used by Djankov et al. (2010). Raw data is presented in Table 16. Earlier surveys did not include questions on trading time. Nevertheless, it is most probably not a problem that the survey was conducted one year after EU enlargement, since the question refers to sea transportation and the customs procedure is not eliminated in intra-EU trade by sea. I approximate the time for the customs procedure as 15% of the total time to trade, based on information from more recent surveys.[27] The treatment intensity indicator for treated country pairs is then $-0.15 \cdot \frac{1}{2}\left(\text{dayim}_i + \text{dayim}_j\right)$, where dayim is the number of days to import. The indicator is set to zero for control country pairs.

The third alternative treatment intensity indicator captures the change in the burden firms face related to the customs procedure ("customs quality"). It is derived from two indicators (business impact of the customs procedure, efficiency of the customs procedure to import) from the Executive Opinion Survey of the World Economic Forum.[28] Since the survey was conducted in early-2004, it exactly captures the pre-enlargement situation. Survey scores by country are presented in Table 16. They range between 1 and 7, a larger score meaning a larger burden. The treatment intensity indicator for a country pair is then the negative of the average of the two countries' scores, $-\frac{1}{4}(\text{ce}_i + \text{ci}_i + \text{ce}_j + \text{ci}_j)$, where ce is the customs efficiency and ci is the customs business impact variable. Again, the indicator is set to zero for control country pairs.

Table 6 presents the estimates for (5) with h_{ij} being either of the alternative treatment intensity indicators. The results of all the three estimations confirm that time sensitive industries are significantly more strongly affected by the improvement in the timeliness of trade. The abolition of one border is estimated to be equivalent to a 2.4% decline in ad valorem tariffs in time sensitive industries. One day shorter trading time, due to the elimination of the customs procedure, is worth 1.7% of the value of a time sensitive shipment. Finally, the decline of the trade cost index was larger for country pairs, where firms reported a more burdensome customs procedure before enlargement. This effect, again, was twice larger in time sensitive than in non-sensitive industries.

[27] The 15% share holds both for all the surveyed countries and for the EU countries only.

[28] The Executive Opinion Survey is conducted every year among top management business leaders from several countries. The survey questions of the two indicators are: "What is the impact of your country's customs procedures on your business? 1=damaging, 7=beneficial,"and "For imports, inbound customs activities in your country are 1=slow and inefficient, 7=among the world's most efficient." I reverse the original ranking of the scores to make the interpretation similar to the other treatment intensity indicators.

Table 6
Estimates with alternative treatment intensities

Variable	Abolished borders	Days to customs	Customs quality
Treatment intensity	0.009* (0.005)	0.004 (0.003)	0.006*** (0.002)
Treatment intensity x Sensitive	0.024*** (0.006)	0.017*** (0.003)	0.012*** (0.003)
GDP per capita gap	0.292*** (0.051)	0.287*** (0.056)	0.247*** (0.053)
Number of observations	22,323	20,447	22,323
Number of groups, of which:	3,189	2,921	3,189
- treatment, of which:	1,565	1,500	1,565
– sensitive	750	717	750
Within R^2	0.19	0.21	0.19

* *Significant at the 10% level.*

*** *Significant at the 1% level.*

Estimates for equations (4) and (5) on a panel of country pairs and industries in period 2000-2006. Dependent variable is the log trade cost index. Treatment is being an old-new or new-new country pair after 2004. Industry treatment sensitivity is based on import content of export. Treatment intensity is either the change in the number of borders, the change in the days for the custom procedure, or the change in the burden related to the customs procedure. Cluster-robust standard errors (with country pair clusters) are in parentheses.

7 Conclusion

Evidence in this paper shows that time is an important trade barrier. In fact, the trade-reducing effect of time delays might be considerably stronger than what earlier empirical studies find. This can be explained with the change in the nature of trading in the recent decades. As production processes become more and more fragmented across borders, the trade effect of national border barriers get magnified (Yi, 2003; Yi, 2005). Fragmented production processes are sensitive to time delays, not only because trading time adds up as intermediate goods travel back and forth, but because a delay at one stage can potentially upset the whole production and distribution process.

This paper focuses on time costs and does not take into account other non-traditional trade barriers (of institutional, political or psychological nature), which could also influence the EU's trade developments in this period. The obvious difficulty is that these types of barriers are not observable. An upward omitted variable bias can be present in the estimate for β' in (5) if the following three conditions are met. The other trade barrier affects the time sensitive industries more than other industries. It fell from year 2003 to year 2004 and not during the preparation period preceding EU enlargement. Finally, its decline is positively correlated with the treatment intensity indicator.

Alternative reading of the findings of this paper lends support to the idea of the endogeneity of international production fragmentation to falling trade costs. The one-off decline in the trading time at EU enlargement was exogeneous to the nature of trade. That the following trade response was significantly larger in industries prone to production fragmentation suggests that falling time costs caused some cross-border fragmentation of production. When one stage of the domestic production process is relocated abroad, international trade increases and domestic trade decreases, both of which contribute to the decline in the trade cost index. Further exploring this issue can be a direction of future research.

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Appendix A Projection of transport mode shares

Below I describe how transport mode shares for intra-EU trade are projected from observed modal choices in extra-EU trade.

I model the transport mode choice with a random utility model, where the choices are assumed to be mutually exclusive. I differentiate among three types of transport modes: land (road + rail + inland waterways), sea and air.[29] Traders choose the mode of transport that yields the highest utility, based on factors, which are either observed or unobserved. Let us take the additive random utility model with the number of alternatives $A = 3$. The random utility of choosing alternative a by individual n is

$$U^*_{na} = \mathbf{x_n}\beta_a + \varepsilon_{na}, \qquad a = 1\text{:air, }2\text{:land, }3\text{:sea}$$

where U^*_{na} is the latent variable for utility, $\mathbf{x_n}\beta_a$ is its deterministic and ε_{na} is its random component. The $\mathbf{x_n}$ is a vector of observables that influence modal choice. They are assumed to vary with the individual (case-specific) and not with the transport mode (alternative-specific). The β_a are unknown parameters, also varying with the transport mode. It follows from utility maximization that the probability of the modal choice outcome u_n being alternative a is

$$\mathrm{P}(u_n = a \mid \mathbf{x_n}) = \mathrm{P}\left(\varepsilon_{n1} - \varepsilon_{na} \leq \mathbf{x_n}(\beta_a - \beta_1), \varepsilon_{n2} - \varepsilon_{na} \leq \mathbf{x_n}(\beta_a - \beta_2), \varepsilon_{n3} - \varepsilon_{na} \leq \mathbf{x_n}(\beta_a - \beta_3)\right).$$

If ε_{na} is assumed to be i.i.d. following a double exponential distribution, then the choice probabilities for individual n are given by

$$\mathrm{P}(u_n = a \mid \mathbf{x_n}) = \frac{\exp\left(\mathbf{x_n}\beta_a\right)}{\sum_{h=1}^{3} \exp\left(\mathbf{x_n}\beta_h\right)}.$$

The corresponding econometric model is the Multinomial Logit (NNL). It assures that the probabilities always fall between 0 and 1 and their sum across the alternatives is 1. The MNL can be applied only if the regressors are all case-specific. Though ruling out alternative-specific regressors precludes the use of transport prices e.g., such data is not available anyway. Estimation is done by Maximum Likelihood.

I estimate the modal choice MNL on a database of product-level export flows (in euro value) from the 22 EU members to 33 non-EU countries in period 2002-2003. The product dimension is very deep, covering more than 4000 six-digit HS product codes. Nevertheless, I do not observe shipments, the unit of transport mode choice, which means that potentially repeated actions of individual choice are compressed in one observation.[30]

Choosing the set of non-EU partner countries, which can produce valid out-of-sample projections, is not straightforward. EU countries form a more or less distinct block in both geographical and economic terms. Therefore I consider only countries in the vicinity of the EU and, in the estimation, I also control for differences in the level of economic development. The chosen 33 partner countries include EFTA, Balkan and East European countries, Turkey, as well as some countries of the Middle East, Central Asia and North Africa.[31,32]

[29] Self propulsion of vehicles is included in the group the vehicle belongs to, i.e. road and rail vehicles to land, air vehicles to air, and sea vehicles to sea. I do not consider other modes of transportation: post because of its marginal importance, or fixed mechanism, which is important mainly for energy products that are excluded from this analysis.

[30] Berry (1994) corrects for the lack of micro data with information on the number of purchases of each alternative per market (market share). This method is not applicable here, since I do not see the number of shipments (i.e. the purchases of transport mode) behind the country pair-product cell.

[31] Iceland, Norway, Switzerland, Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Macedonia, Romania, Belarus, Moldova, Russia, Ukraine, Turkey, United Arab Emirates, Israel, Iran, Jordan, Kuwait, Lebanon, Oman, Saudi Arabia, Syria, Yemen, Tunisia, Armenia, Azerbaijan, Georgia, Kazakhstan, Uzbekistan, Algeria, Egypt, Morocco.

[32] As a robustness check, I replicated the estimation and projection exercise for a restricted set of 14 non-EU European importers (around 50% of the original sample size). The in-sample predictive power of the model became somewhat worse than in the full sample case, while the out-of-sample predictions for intra-EU modal choices differed only marginally.

I estimate separate MNLs for each of the 19 manufacturing industries. Every industry MNL contains the same set of regressors, the choice of which is based on Bayesian Information Criteria (BIC). A specification is preferred if it yields lower BICs for most of the industry MNLs.

The general transport mode preferences of the EU exporters are captured by exporter dummies. Importer- and pair-specific regressors include a landlocked dummy, the number of days to reach the importer's main city from the nearest seaport[33], dummies for being an African or Asian importer (Europe is the benchmark), a dummy for sharing a border, as well as the geographical distance between the exporter and importer.[34] I also include GDP per capita and GDP of the importer, to control for differences in the level of economic development.

Products are captured by their weight-to-value ratios (kg/euro), which is an important determinant in choosing between high-price small-capacity versus low-price large-capacity modes (air versus land or sea). The large improvement in the BIC after including this variable reassures its importance. Further transport-specificities of industries are accounted for by the inclusion of sub-industry dummies (four-digit NACE). Table 7 shows the number of sub-industries per industry. Finally, I include interactions of the country-specific geographical variables with the product-specific weight-to-value. These interactions can handle some product-specificities of the effects of geography on modal choice.

Table 7
Selected regression statistics

NACE	industry	Number of observations	Number of sub-industries	Pseudo R^2
17	Textiles	72,738	9	0.27
18	Wearing apparel	27,125	6	0.29
19	Leather, luggage, footwear, etc.	11,807	3	0.28
20	Wood, excl. furniture	13,500	6	0.28
21	Pulp, paper products	24,598	7	0.26
22	Publishing, printing	8,892	7	0.18
24	Chemical prods	106,523	20	0.27
25	Rubber and plastic prods	77,732	7	0.23
26	Other non-metallic mineral prods	21,567	25	0.40
27	Basic metals	42,721	12	0.30
28	Fabricated metal prods	48,939	13	0.25
29	Machinery and equipment	105,807	20	0.25
30	Office machinery and computers	9,914	2	0.22
31	Electrical machinery and apparatus	38,887	7	0.22
32	Radio, tv and communication equip.	15,660	3	0.20
33	Medical, precision and optical instr.	30,342	4	0.22
34	Motor vehicles, trailers, semi-trailers	12,749	3	0.22
35	Other transport equipment	4,834	8	0.27
36	Furniture, manufacturing n.e.c.	34,434	13	0.23

Maximum Likelihood estimation summary statistics for the industry-specific transport mode choice Multinomial Logits. Modal choice alternatives are land (base category), air and sea. Unit of observation is country pair (EU exporter, non-EU importer) and 6-digit product. Sub-industries are 4-digit NACE industries.

A summary of the estimated coefficients are presented in Table 8. The reported coefficient estimates and p-values are the median values across the 19 industry regressions. They are shown for air and sea and can be interpreted relative to land transport (base category). A positive coefficient indicates that, as the value of the regressor increases, it is more likely that air or sea is chosen over land.[35] It is the case for bilateral distance, not sharing a border, having good access to a seaport, being in Africa or Asia, and having a relatively high GDP per capita. Finally, air is less likely to be chosen if the weight-to-value ratio of the product is high.

[33] Source of data is the World Bank's *Doing Business* survey.

[34] The inclusion of other typical gravity variables (common language, colonial ties, free trade agreements) were not supported by the BICs. The source of the gravity variables (distance, landlocked, common border) is CEPII.

[35] The interpretation of the interaction effects is however not straightforward, because the reported coefficients are not the marginal effects (cross-derivatives).

Table 8
Median values of estimates

	mode = air		mode = sea	
Regressor	Coefficient	p-value	Coefficient	p-value
Log Distance	1.285	0.000	0.127	0.269
Common Border	−1.029	0.005	−1.640	0.003
Landlocked	0.701	0.116	−0.499	0.083
Days from Seaport	−0.137	0.001	−0.176	0.000
Africa	1.225	0.001	2.758	0.000
Asia	1.396	0.000	2.401	0.000
Log GDP Per Capita	0.185	0.000	0.251	0.000
Log GDP	−0.071	0.000	−0.137	0.000
Log Weight-to-Value	−1.100	0.000	0.334	0.147
Log Weight-to-Value x Log Distance	0.062	0.004	−0.026	0.238
Log Weight-to-Value x Common Border	−0.127	0.008	−0.150	0.116
Log Weight-to-Value x Landlocked	0.104	0.185	0.014	0.351
Log Weight-to-Value x Days from Seaport	−0.009	0.079	−0.018	0.005
Log Weight-to-Value x Africa	−0.002	0.162	0.128	0.007
Log Weight-to-Value x Asia	0.097	0.081	0.193	0.000
Exporter dummies	yes		yes	
Industry dummies (4-digit)	yes		yes	

Median values of the coefficient estimates and median value of the corresponding p-values from the industry-specific transport mode choice Multinomial Logit estimations. The base category is land transport. Unit of observation is a country pair (EU exporter, non-EU importer) and 6-digit product.

Table 9 compares the in-sample predicted and the true transport mode choice probabilities. By construction, the MNL restricts the means of the predicted and the true probabilities to be equal. Standard errors of the predicted probabilities are however only half of the true ones. The prediction often assigns nonzero probabilities for all the three transport modes, while the true modal choice is either 0 or 1. Nevertheless, the range is basically the same for the true and the predicted, with 0 as minimum and 1 as maximum, which suggests a considerably good predictive power of the model.

Table 9
In-sample predicted and true modal choice probabilities

Variable	No. obs.	Mean	St. dev.	Min	Max
Predicted					
air	708,769	0.21842	0.21587	0.00000	1.00000
land	708,769	0.47214	0.27772	0.00000	1.00000
sea	708,769	0.30945	0.23787	0.00000	0.99312
True					
air	708,769	0.21842	0.41317	0.00000	1.00000
land	708,769	0.47214	0.49922	0.00000	1.00000
sea	708,769	0.30945	0.46227	0.00000	1.00000

Predicted choice probabilities for country pairs (EU exporter, non-EU importer) and 6-digit products are based on the transport mode choice Multinomial Logit estimations.

I present simple pairwise correlations of the predicted and true modal probabilities in Table 10 for three different levels of aggregation (product, sub-industry, industry). Sub-industry and industry modal shares are weighted averages of product modal probabilities with trade value weights. The correlation coefficients strictly increase with the level of aggregation due to the common weights. Product-level correlations are slightly above 0.5, industry-level correlations are close to 0.8 for all the three transport modes.

Finally, I make out-of-sample modal choice projections for intra-EU country pairs and products, which are then aggregated to the two-digit industry level with the use of the corresponding trade value weights. Summary statistics of the projected intra-EU modal shares by industry and country are presented in Tables 14 and 15, respectively.

Table 10
Correlation coefficients of predicted and true modal shares

Level of aggregation	Statistic	Mode of Transport air	land	sea	No. of obs.
6-digit product	correlation coef.	0.519	0.558	0.521	708,769
	p-value	0.000	0.000	0.000	
4-digit industry	correlation coef.	0.679	0.768	0.748	67,243
	p-value	0.000	0.000	0.000	
2-digit industry	correlation coef.	0.744	0.796	0.790	11,645
	p-value	0.000	0.000	0.000	

Predicted choice probabilities for country pairs (EU exporter, non-EU importer) and 6-digit products are based on the transport mode choice Multinomial Logit estimations. 4-digit and 2-digit industry modal shares are weighted averages of product-level modal choice probabilities with trade value weights.

Appendix B Figures and tables

Figure 4
Trade costs by industry

(in log, normalized to year 2000)

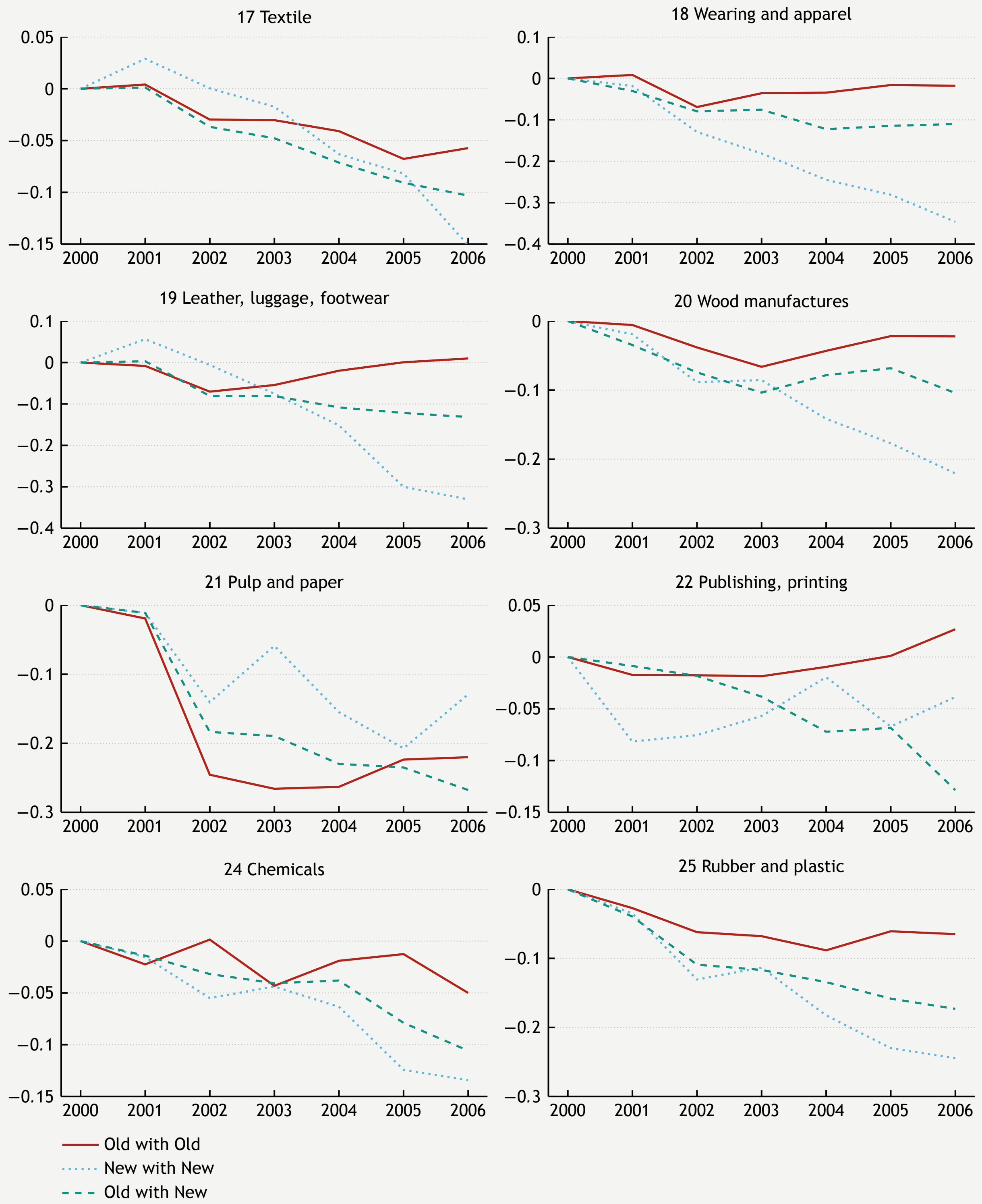

Figure 4
Trade costs by industry (continued)

(in log, normalized to year 2000)

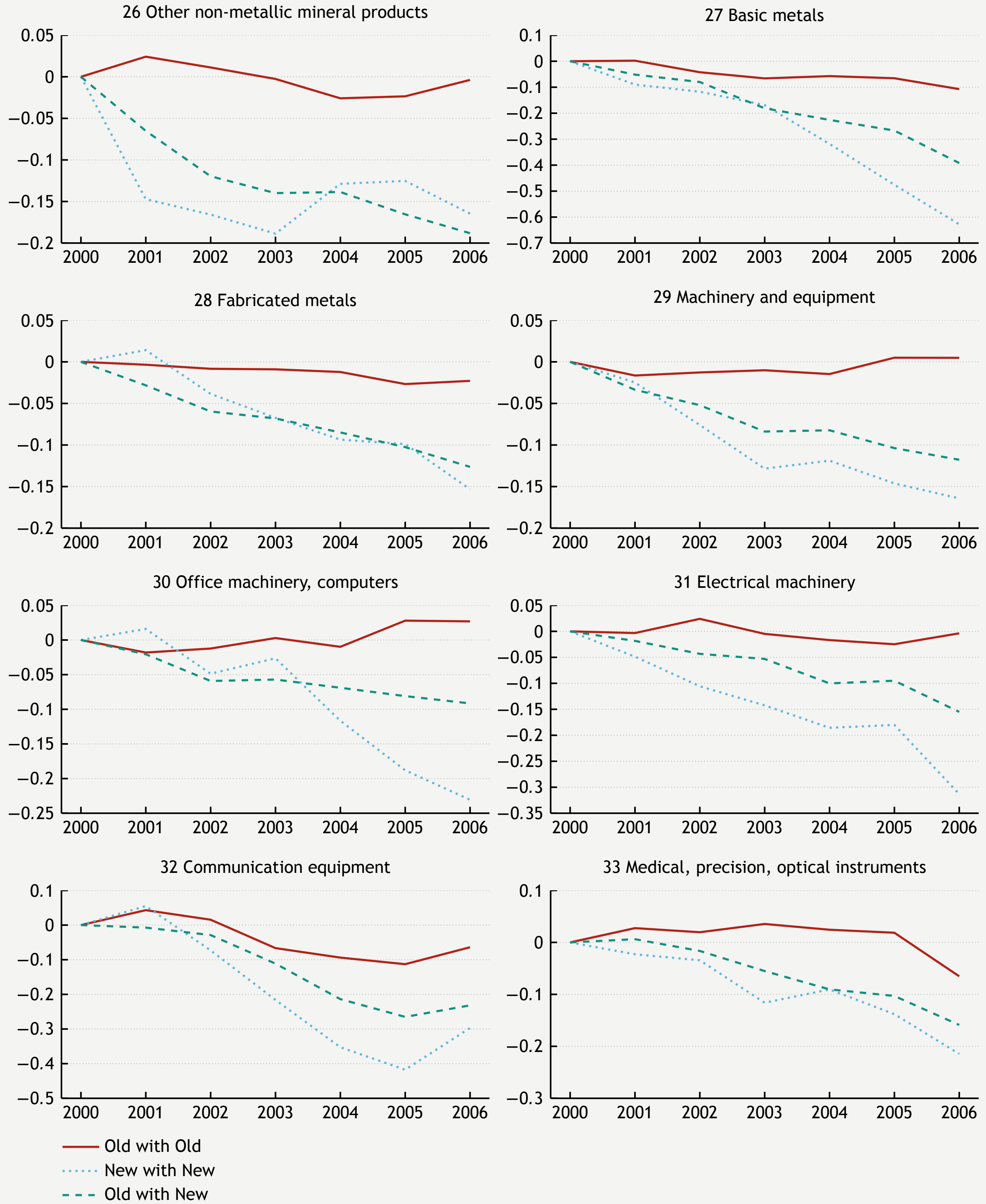

Figure 4
Trade costs by industry (continued)

(in log, normalized to year 2000)

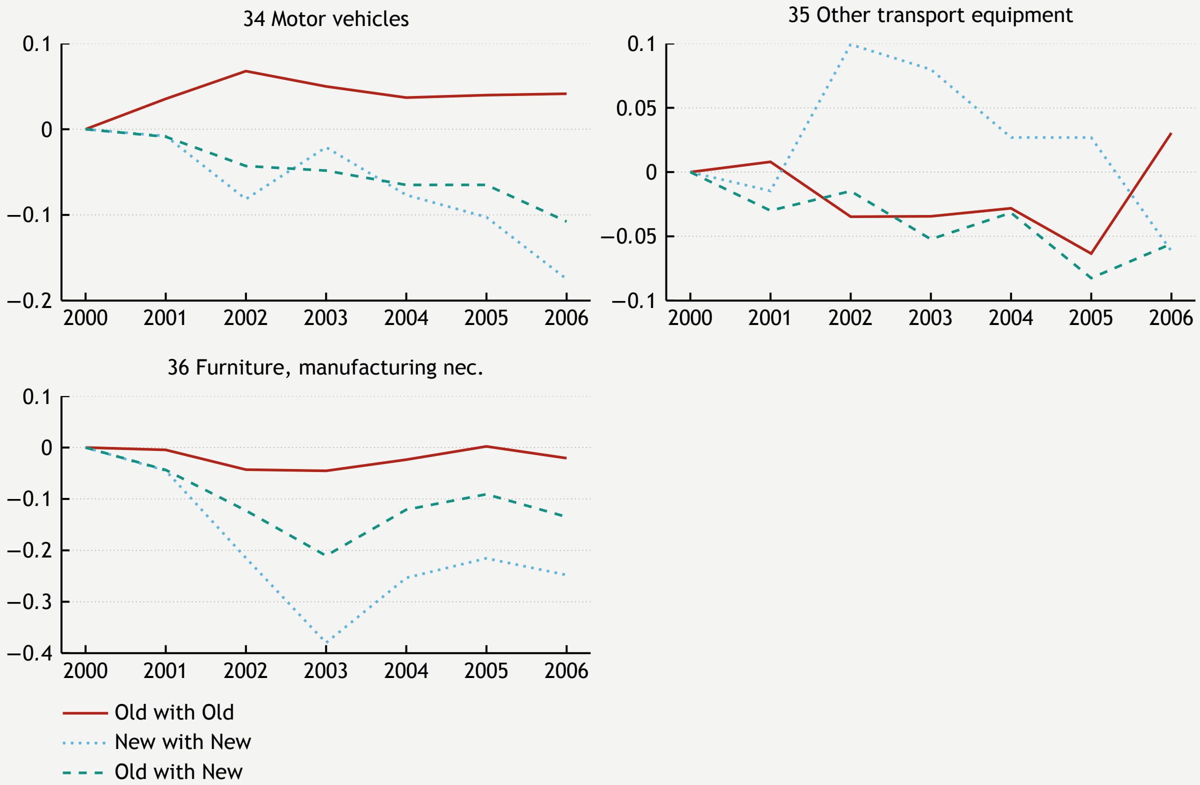

Table 11
Industry descriptive statistics

NACE	Description	Export share (%)	Output share (%)	sigma	Theta average	N
17	Textiles	2.5	2.8	7.3	1.8	1,442
18	Wearing apparel	1.7	1.7	5.7	2.6	1,253
19	Leather, luggage, footwear, etc.	1.3	1.1	7.2	1.9	1,148
20	Wood, excl. furniture	1.3	2.8	3.7	7.5	1,554
21	Pulp, paper products	2.8	3.7	4.4	4.5	1,372
22	Publishing, printing	0.7	5.3	5.1	6.6	1,393
24	Chemical products	14.9	12.7	7.1	1.8	1,449
25	Rubber and plastic products	4.0	5.4	5.2	2.9	1,547
26	Other non-metallic mineral prods	1.9	4.9	3.0	19.6	1,533
27	Basic metals	7.0	6.4	3.5	6.6	1,386
28	Fabricated metal products	3.6	9.6	4.9	4.4	1,561
29	Machinery and equipment	10.5	11.2	7.2	1.8	1,302
30	Office machinery and computers	3.6	1.3	10.9	1.5	1,113
31	Electrical machinery and apparatus	4.7	5.4	6.0	2.2	1,547
32	Radio, tv and communication equip.	5.9	3.6	5.9	2.1	1,288
33	Medical, precision and optical instr.	2.8	2.7	6.6	2.0	1,162
34	Motor, vehicles, trailers	25.7	13.0	7.3	1.7	1,253
35	Other transport equipment	1.7	2.4	7.5	2.1	889
36	Furniture, manufacturing n.e.c.	3.2	4.0	4.1	4.7	1,449
All	All	100.0	100.0			25,641

Statistics from the database of 19 industries (2-digit NACE), country pairs formed by 22 EU countries and 7 years between 2000-2006.

Table 12
Country descriptive statistics

Country	Export share (%)	Output share (%)	Theta average	N
Austria	3.4	2.3	3.7	1,295
Belgium	10.2	3.4	3.1	1,292
Czech Republic	2.5	1.7	3.9	1,285
Denmark	1.6	1.2	3.8	1,299
Estonia	0.1	0.1	6.6	532
Finland	1.6	1.9	4.3	1,278
France	12.4	14.6	3.4	1,302
Germany	24.1	25.7	2.5	1,113
Hungary	1.7	1.1	5.1	1,267
Ireland	2.4	1.9	5.9	1,190
Italy	9.4	16.9	3.7	1,299
Latvia	0.1	0.1	6.0	921
Lithuania	0.2	0.1	6.4	889
Luxembourg	0.6	0.1	5.2	949
Netherlands	7.3	3.1	3.2	1,236
Poland	2.2	2.3	3.7	1,299
Portugal	1.4	1.2	6.2	1,190
Slovakia	1.0	0.5	4.9	1,190
Slovenia	0.5	0.3	5.6	984
Spain	6.3	7.7	4.4	1,295
Sweden	3.0	3.2	3.5	1,302
United Kingdom	8.1	10.6	3.6	1,239
All	100.0	100.0		25,641

Statistics from the database of 19 industries (2-dig. NACE), country pairs formed by 22 EU countries and 7 years between 2000-2006.

Table 13
Waiting hours by land border

origin country	destination country	number of crossing points [a]	average hours (2000-2002) [b]
Lithuania	Poland	1	5.6
Czech Republic	Poland	3	5.2
Poland	Germany	8	5.0
Poland	Czech Republic	3	4.4
Poland	Slovakia	2	4.2
Slovakia	Poland	2	3.9
Germany	Poland	8	3.6
Poland	Lithuania	1	3.4
Czech Republic	Germany	7	3.3
Germany	Czech Republic	7	2.8
Hungary	Austria	3	2.3
Austria	Hungary	3	2.0
Czech Republic	Slovakia	6	1.9
Slovakia	Austria	1	1.8
Slovakia	Czech Republic	6	1.8
Hungary	Slovakia	4	1.7
Hungary	Slovenia	1	1.6
Slovakia	Hungary	4	1.4
Slovenia	Hungary	1	1.3
Austria	Slovakia	1	1.1
Czech Republic	Austria	3	1.1
Austria	Czech Republic	3	0.9

[a] *Number of crossing points with waiting time data per border.*

[b] *Simple averages across years and crossing points.*

Source is International Road Union (IRU).

Table 14
Intra-EU modal share projections by industry

NACE	industry	air	land	sea
17	Textiles	0.10	0.72	0.17
18	Wearing apparel	0.19	0.79	0.02
19	Leather, luggage, footwear, etc.	0.19	0.69	0.12
20	Wood, excl. furniture	0.04	0.67	0.29
21	Pulp, paper products	0.05	0.67	0.27
22	Publishing, printing	0.24	0.58	0.18
24	Chemical prods	0.18	0.60	0.21
25	Rubber and plastic prods	0.15	0.63	0.22
26	Other non-metallic mineral prods	0.12	0.85	0.03
27	Basic metals	0.05	0.66	0.29
28	Fabricated metal prods	0.10	0.67	0.24
29	Machinery and equipment	0.10	0.68	0.22
30	Office machinery and computers	0.31	0.54	0.15
31	Electrical machinery and apparatus	0.21	0.60	0.18
32	Radio, tv and communication equip.	0.35	0.52	0.13
33	Medical, precision and optical instr.	0.33	0.54	0.13
34	Motor vehicles, trailers, semi-trailers	0.07	0.65	0.27
35	Other transport equipment	0.20	0.59	0.21
36	Furniture, manufacturing n.e.c.	0.11	0.66	0.23
	Mean	0.16	0.65	0.19

Projection described in Appendix A. Reported modal shares are averages across country pairs.

Table 15
Intra-EU modal share projections by country

Country	air	land	sea
Austria	0.17	0.72	0.11
Belgium	0.13	0.70	0.17
Czech Republic	0.11	0.82	0.06
Germany	0.14	0.66	0.20
Denmark	0.16	0.59	0.25
Estonia	0.15	0.59	0.26
Spain	0.19	0.58	0.23
Finland	0.18	0.54	0.27
France	0.17	0.67	0.16
Hungary	0.13	0.80	0.07
Ireland	0.31	0.35	0.34
Italy	0.17	0.62	0.21
Lithuania	0.14	0.68	0.18
Luxembourg	0.15	0.72	0.13
Latvia	0.14	0.69	0.17
Netherlands	0.15	0.67	0.18
Poland	0.11	0.74	0.14
Portugal	0.21	0.57	0.21
Sweden	0.20	0.53	0.27
Slovenia	0.12	0.75	0.13
Slovakia	0.08	0.85	0.07
United Kingdom	0.24	0.43	0.33
Mean	0.16	0.65	0.19

Projection described in Appendix A. Reported modal shares are averages across industries and trade partners.

Table 16
Days to trade and customs quality raw data

Country	Doing Business Survey		Executive Opinion Survey	
	days to export	days to import	customs business impact [a]	import customs efficiency [a]
Austria	8	9	3.3	3.2
Belgium	7	9	3.2	3.3
Czech Republic	20	22	4.1	4.3
Denmark	5	5	2.7	2.4
Estonia	12	14	3.4	3.2
Finland	7	7	2.7	2.4
France	22	23	4.0	4.0
Germany	6	6	2.8	2.9
Hungary	23	24	4.2	4.7
Ireland	14	15	2.8	3.0
Italy	28	38	4.3	4.4
Latvia	25	26	4.3	4.5
Lithuania	6	17	4.2	4.9
Luxembourg	n.a.	n.a.	3.2	2.7
Netherlands	7	8	2.6	2.6
Poland	19	26	4.8	5.3
Portugal	18	18	3.3	3.7
Slovakia	30	31	3.4	4.0
Slovenia	20	24	4.1	3.8
Spain	9	10	3.9	3.9
Sweden	6	6	2.5	2.3
United Kingdom	16	16	2.5	2.9

[a] Scores range between 1 and 7. Original scores reversed, here larger reflects worse evaluation.

Source of Doing Business data is Djankov et al. (2010). Year of the survey is 2005. Source of the Executive Opinion Survey scores is the Global Competitiveness Report 2004/2005 of the World Economic Forum (WEF).