Wiener Institut für Internationale Wirtschaftsvergleiche
The Vienna Institute for International Economic Studies

Working Papers | 75 | April 2011

Cecília Hornok

Need for Speed: Is Faster Trade in the EU Trade-Creating?

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Abstract

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Keywords: *time cost of trade, difference-in-difference-in-differences estimation, treatment intensity, EU enlargement, transport mode choice*

JEL classification: *F13, F14, F15*

Need for Speed: Is Faster Trade in the EU Trade-creating?

Cecília Hornok*

Abstract

Timeliness has gained growing importance in international trade. This paper provides empirical evidence on the significant cost of time in trade by exploiting the quasi-experimental nature of the European Union (EU) enlargement in 2004. It applies a difference-in-difference-in-differences econometric strategy on a European industry-level database of bilateral trade barriers, where industries are differentiated according to their time sensitivity. The use of a treatment intensity indicator that captures the decline in the waiting time at borders supports the identification. Results are cross-checked on subsamples defined along transport mode choice probabilities, where intra-EU transport mode choice projections are obtained from an estimated discrete choice model on extra-EU trade. Robustness checks experiment with alternative definitions of treatment sensitivity and treatment intensity.

1 Introduction

Time matters in trade and it has been growing in importance in recent decades. Timely trade is demanded for several reasons. Some traded goods are inherently perishable such as fresh food and need fast deliveries. Others, such as fashion articles, depreciate quickly and need to be sourced frequently because of varying consumer tastes. And, most importantly, the fast development of transportation technologies enabled the spread of international production fragmentation, which increasingly requires timely trade. The importance of timeliness is multiplied if several intermediate production stages at different parts of the world should be synchronized in a timely fashion.

This paper provides empirical evidence on the effect of timeliness on trade. Trade barriers, different from direct trade policy instruments like tariffs, constitute a major share of total barriers in international trade, as it is argued in Anderson and van Wincoop (2004). Some of these barriers, such as border controls or administrative hurdles, mostly incur time (rather than purely financial) costs to the trading firm. This paper measures to what extent the improvement in timeliness contributes to the decline in trade barriers. It builds on an empirical strategy, which was so far uncommon in the trade literature. It takes the episode of the European Union (EU) enlargement in 2004 as a quasi-experiment and uses difference-in-difference-in-differences (DIDID) estimation. Improved timeliness arose from the fact that EU enlargement eliminated the time-consuming customs procedures and border controls in cross-border trade of the new member states with the EU-15 and with each other.

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I argue that the enlargement of the EU with the eight Central and Eastern European countries[1] can be considered as a quasi-experiment from a trade policy point of view, because traditional trade policy barriers (tariffs, quantitative restrictions, rules of origin) between these eight countries and the countries of the pre-enlargement EU, as well as among the eight themselves, had already been abolished or harmonized by around 2000 in the trade of most manufactured products. This no-(trade)-policy-change environment offers the possibility to study the impact of some non-conventional trade barriers, such as the time cost of trade.

The paper uses a data set of country pairs, formed by 22 EU countries (14 countries of the pre-enlargement EU and 8 countries that joined the EU in 2004), and 19 manufacturing industries over the period 2000-2006. I call the eight new member states 'new countries', the fourteen others 'old countries'. The choice of countries, industries and years ensures that the no-policy-change environment applies in the entire panel.

Country pairs with at least one new country form the treatment group, country pairs of old countries are the control group. Hence, a country pair becomes treated, when the two countries become members of the EU jointly. Industries are classified whether they are sensitive or not sensitive to the timeliness of trade (treatment sensitive versus non-sensitive) according to the time sensitivity classification of Hummels (2001b). The DIDID estimate captures the effect of EU enlargement on trade barriers for the treatment, relative to control, country pairs and for time sensitive, relative to non-sensitive, industries.

The identification is supported in two ways. First, the estimation is based on the trade restrictiveness index that was propagated in Head and Ries (2001), and later in Novy (2008) and Jacks, Meissner, and Novy (2008). This index has the advantage that it fully controls for all the country-level variables in the gravity equation, most notably the unobserved multilateral trade resistance. Second, I refine the identification with the use of a treatment intensity indicator, which is the change in the waiting time at land border crossings on the route from the exporting to the importing country. I ask whether trade restrictiveness in time-sensitive industries have declined more in response to a reduction in border waiting times than trade in non-sensitive industries. I experiment with alternative indicators of treatment intensity in the robustness part.

The measured trade-creating effect of improved timeliness should depend on the mode of transport in trade for at least two reasons. First, the treatment intensity indicator is valid only for land transport. Second, the main cause of the timeliness gain, the abolition of the customs procedure, did not take place in sea transportation. To learn about transport mode choices within the EU, I estimate a discrete choice model that provides projections for transport mode choice probabilities (land, air or sea) in intra-EU trade with the help of extra-EU trade data. Then, I define transport mode subsamples in intra-EU trade and cross-check the DIDID estimates by subsample.

This paper is a contribution to the empirical literature on the cost of time in trade. The literature claims that time is more valuable in trading than what would follow from the direct financial cost of a delay (interest cost or overtime wage cost). Hummels (2001b) demonstrates that firms are willing to pay a disproportionately large premium for air transportation to get fast delivery. The estimated

[1] Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia, Slovenia.

premium is 0.5% of the product value per day. On Doing Business data, Djankov, Freund and Pham (2010) find that in country relations, where trading time is one day longer, the volume of trade is 1% smaller. Beside reinforcing the evidence on the substantial cost of time in trade, this paper, I argue, employs an econometric strategy that is more powerful in controlling for the unobserved heterogeneity.

A more theory-oriented line of the literature looks at the implications of the demand for timeliness on the production location decision of firms. An early example is the informal model of Deardorff (2002), which was followed by Evans and Harrigan (2005) and Harrigan and Venables (2006). All in all, these models imply that the cost of time in trade can hinder the outsourcing of time-sensitive production to more distant and/or less developed locations, thereby reducing the volume of international trade.

Harrigan and Venables (2006) point out that the effect of timeliness is amplified by the uncertainty associated with time delays. The possibility of delays in trade, especially if production stages are located in different venues, makes it uncertain when the product can reach the final market. If delays are expected, production should be started and orders must be placed earlier, even before demand and cost conditions are known. This suggests that demand for timeliness should be especially strong in the case of fragmented production processes. Among the robustness checks I find support for the hypothesis that the estimated timeliness effects are stronger for industries with strong prevalence of international production fragmentation.

The paper is structured as follows. Section 2 introduces the index of trade restrictiveness and presents its evolution around EU enlargement. Section 3 builds the empirical framework, presents the classification of industries according to time sensitivity, and describes the construction and the use of the treatment intensity indicator. Section 4 presents the baseline estimation results. Section 5 describes the projection of intra-EU transport mode choice probabilities and cross-checks the results by transport mode subsamples. Section 6 presents the robustness checks. Section 7 concludes.

2 Measuring bilateral trade restrictiveness

I measure trade restrictiveness with the index developed by Novy (2008) in the spirit of an earlier paper of Head and Ries (2001). Originally, Novy derives the index from the gravity theory of Anderson and Van Wincoop (2003), but Jacks, Meissner and Novy (2010) show that the same index measure can be derived from several competing trade theories.[2]

A big advantage of applying this index over the traditional way of inferring trade barriers from the gravity estimation is that the index completely wipes out the so-called multilateral trade resistance terms from the gravity equation, i.e. it fully controls for the evolution of trade barriers with third-countries. The multilateral resistance terms are mostly unobservable and can cause omitted variable bias in the traditional gravity estimation.[3]

[2]Such as the models of Eaton and Kortum (2002), Chaney (2008), as well as Melitz and Ottaviano (2008).

[3]A potential disadvantage of the Novy/Head-Ries index is that it cannot treat direction-specific trade flows separately, since it is only the average of them, which enters the expression. In reality, bilateral trade barriers

2.1 The trade restrictiveness index

I model trade costs at the industry level based on the industry-specific gravity equation of Anderson and van Wincoop (2004). A similar approach is taken in Chen and Novy (2009) and Jacks, Meissner and Novy (2008). The gravity equation for exports 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 on products of industry k, Y_W^k is world output in the same industry, and T_{ij}^k is international trade cost between country i and j for the same industry. Exports, output and expenditure are in current values. The terms Π_i^k and P_j^k are the outward and inward oriented multilateral trade resistance terms for the exporter and the importer country, respectively, specific to industry k. The elasticity of substitution among varieties σ^k is also industry-specific.

Accounting for the multilateral trade resistance terms in the empirical applications of the gravity equation is often problematic, for Π_i^k and P_j^k are not observed. In the followings, the aim is to express trade costs without these two terms. For this to achieve, notice that the gravity equation also holds for domestic trade. The domestic analogue of the gravity equation for trade *within* country i of products from industry k is

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

where T_{ii}^k is now 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 of X_{ji}^k. Then, substitute back the expressions for $\Pi_i^k P_i^k$ and $\Pi_j^k P_j^k$. After simple manipulations one can get the ratio of international to domestic trade costs, expressed as a function of the domestic to foreign trade ratio. Finally, take the geometric mean of the equation and get

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

the average bilateral trade restrictiveness between country i and country j, denoted by Θ_{ij}^k.

The index reflects that trade restrictiveness between two countries is 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

can be asymmetric and policy changes can have asymmetric effects on the direction-specific trade costs. Discovering such asymmetries is however out of the scope of the current analysis.

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 restrictiveness index also corrects for the level of the substitution elasticity between home and foreign goods (σ). This is the point, where the index of Novy (2008) differs from the one proposed by Head and Ries (2001). When σ is high, i.e. demand shifts rapidly between domestic and imported varieties in response to a relative price change, relatively large openness can prevail under high trade barriers. On the contrary, when σ is low, the economy can be considerably closed even under small trade restrictiveness.

2.2 Data and index calculation

I calculate the trade restrictiveness index (henceforth, Θ) in equation (3) for country pairs and industries within the enlarged EU for years between 2000 and 2006. It is important to note that interpreting the Θs as trade barriers for different points in time requires the assumption that the gravity equation holds in each year.

The data set is a panel of yearly data for 7 years between 2000 and 2006. Foreign trade data is bilateral exports in euros from Eurostat.[4] The set of countries includes 22 EU members (14 old and 8 new), altogether the EU-25 less Greece, Cyprus and Malta.[5] 19 manufacturing industries are considered in the 2-digit NACE classification. I exclude food and beverages as well as energy manufactures, because most of these products were not traded freely by new members before enlargement.[6]

An empirical challenge in the calculation of the Θs is to measure domestic trade (X_{ii} and X_{jj}). A good candidate is gross domestic sales, which can be calculated as gross production minus total exports within an industry, i.e. the total value of goods that are produced by an industry domestically but not sold abroad.[7] There is however one important discrepancy in this definition: exports also include re-exports, which is then mistakenly subtracted from domestic production. To overcome this problem I correct for re-exports with the help of national input-output tables.[8]

While export data is fully available for all country pairs, industries and years, gross production is missing for 14 data points (Ireland and UK in NACE industry 36 for all years). A further - and more serious - data limitation is that the calculated domestic trade variable sometimes takes negative

[4]Original data is available either in 6-digit HS or in 5-digit SITC product-level breakdown, which was classified into 2-digit NACE industries using the relevant correspondence tables.

[5]These three countries are excluded because the natural experiment argument does hold for them. It is because of Greece's late euro area entry and the different pre-2004 trade policies of Cyprus and Malta towards the then EU from the trade policies of the Central and Eastern European countries.

[6]More precisely, the two excluded industries are Manufacture of food products and beverages (NACE codes 15 and 16) and Manufacture of coke, refined petroleum products and nuclear fuel (23).

[7]Gross output data by 2-digit NACE industries is either from Eurostat or the OECD STAN database, current value flows in euros.

[8]The share of re-exports in total exports can be especially sizeable for countries with important maritime ports such as the Netherlands. The re-export share is calculated for each country and 2-digit NACE industry from input-output tables for year 2000 (the year for which I-O tables for most countries are reported by Eurostat). The same re-export share is assumed for all years in the sample.

values. Production and trade statistics may not always be consistent (e.g. due to inventories), and I cannot account for re-exports properly. Overall, domestic trade is negative in almost one-forth of the observations.[9] In these cases, I impose domestic trade to be zero. After taking the log of Θ, these observations ultimately drop out from the estimation sample.

Industry-specific elasticities of substitution (σ^k) are taken from Chen and Novy (2009), who borrow the estimates from Hummels (2001a), and transform them to the NACE industry classification.[10] It is important to note that the relative time paths of the Θs across countries are robust to different values for the σ^k, as long as the σ^ks are time-constants and identical across countries. Since the estimation strategy to be applied here identifies the treatment effect from the differences in the time changes of the Θs across country pair groups, there is no need to worry about how accurate the assumed values for σ^k are.

I construct a balanced panel sample, keeping only those country pair - industry panels, where none of the observations are missing (either because of true missings or zero-imposed Θs) throughout the sample period. Summary statistics of the balanced panel are presented in Tables 6 and 7. In the balanced panel, 59% of the maximum possible country pair - industry panels are retained (5170 out of 8778). Hence, the total number of observations for the 7 years is 36,190. Almost 40% of the sample belong to country pairs, where both countries were EU members already before 2004 (control country pairs in the estimation).

2.3 Trade restrictiveness around EU enlargement

Figure 1 presents the time path of trade restrictiveness (Θ in logs) within the EU between 2000 and 2006. The plotted lines are averages across the 19 manufacture industries and three groups of country pairs: country pairs with two old countries (old with old), with two new countries (new with new) and with one old and one new countries (old with new).

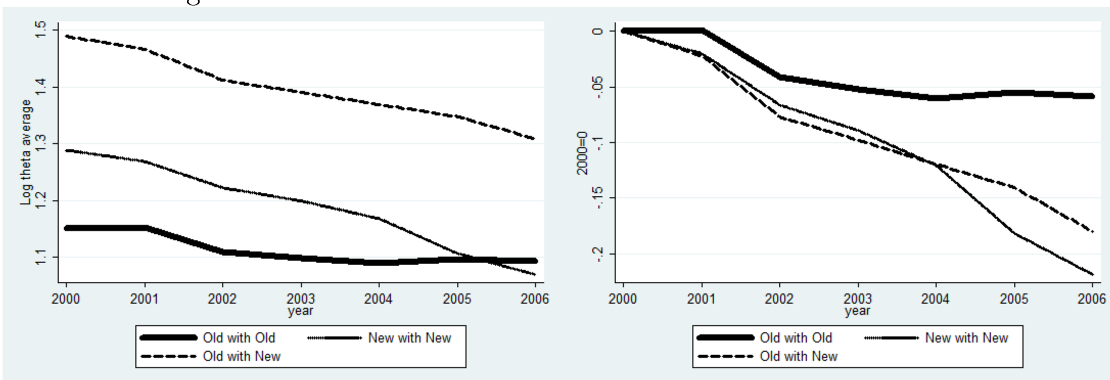
On the left panel of the chart, the levels of the trade restrictiveness indices (in logs) are shown. On the right panel, the same variables are normalized to year 2000. A value of 1.1 on the left panel means that trade restrictiveness in international trade (the numerator of the index) is 3 ($= e^{1.1}$) times larger than trade restrictiveness in domestic trade (the denominator). And a decline of 0.2 in the value of the index is approximately 20 percentage points decline in international trade restrictiveness (relative to domestic trade restrictiveness) in ad valorem tariff equivalent terms.

The index reflects trade restrictiveness in the broadest possible sense. It accounts for all the factors that hinder cross-border trade, be they of geographical, cultural, institutional, political, or even psychological nature. Hence, the differences in the levels of the index by country pair

[9] There are two countries and two industries with relatively large shares of negative domestic sales figures: Luxembourg (65%), Belgium (43%), Rubber and plastic manufactures (83%) and Office machinery and computers (61%). The share of negatives increases with the years (18% in 2000 to around 30% in 2006), probably reflecting the preliminary nature of more recent data.

[10] Hummels (2001a) estimates the σ's on a 2-digit SITC breakdown, which classifies all traded goods into 63 product categories. I take the weighted averages of the 3-digit σs in Chen and Novy (2009) for each 2-digit NACE industry, where the weight is the average share of the 3-digit industry in the corresponding 2-digit industry in total intra-EU export value during the 2000-2006 period. The σ's for the 2-digit NACE industries are shown in Table 6.

Figure 1: Trade restrictiveness for manufactures within the EU



groups can be explained by the fact that, in many of these factors, old countries are closer to other old countries and new countries to other new countries. Trade restrictiveness for old-new pairs is considerably higher even at the end of the period than trade restrictiveness for either old-old or new-new pairs.

The right hand panel of the chart is more suited for observing the developments over time. Trade restrictiveness for old-old country pairs is relatively stable over the period, apart from a slight decline in the early years. In contrast, trade barriers seem to have declined steadily among new countries and between new and old countries. It suggests that, regardless the possible one-off event of EU enlargement, an overall trade integration process was present in new countries' trade during the whole period.

Chen and Novy (2009) admits that, apart from pure trade costs, the value of the index may depend on the nature of trade as well. The index tends to be smaller if trade is mainly intra-industry trade and larger if trade is based on comparative advantage driven by technology or factor endowment differences. With economic convergence to the more developed EU, the trade of new EU countries shifted more and more towards intra-industry trade, which can explain the steady decline in their trade restrictiveness indices. In the estimation part, I will control for this declining trend, using differences in the GDP per capitas of trading partners.

There are some signs that the above declining trend accelerated after 2004, especially for trade within new members, which suggests that EU enlargement also played a role in the development of trade barriers. The break in the trend around 2004 is more apparent from some of the industry trade restrictiveness indices, presented on Figures 4 to 6 in the Appendix. The group of apparently affected industries mainly include technology intensive branches such as Machinery and equipment, Office machinery, Electrical machinery, or Motor vehicles, but also some others like Wood manufactures, Chemicals, or Basic metals.

3 Empirical strategy

What explains the apparent change in the time path of the trade restrictiveness indices for new countries after 2004 and why is the change more apparent in some industries and not in others? Improved timeliness is a possible explanation. Before EU enlargement lengthy customs and border crossing procedures hindered trade between new member states. And certain products were more sensitive to such barriers than others. In the followings, I describe the empirical strategy that aims to identify the role of the improvement in timeliness in the decline of trade barriers around EU enlargement.

3.1 Difference-in-difference-in-differences

As an empirical strategy I opt for a quasi-experiment setup and difference-in-difference-in-differences (DIDID) estimation.[11] I take the episode of EU enlargement as a quasi-experiment, which helps identify the effects of changes in non-policy-related trade barriers. Trade policy in the enlarged EU area, comprising the countries considered in this study, guaranteed free trade of most manufactured products basically from year 2000 onwards, i.e. several years before 2004. I argue that this no-policy-change environment enables the use of the episode to study non-policy trade barriers.[12]

The DIDID estimation identifies from three dimensions. The first is the time dimension: how much did trade restrictiveness decline from the pre-enlargement to the post-enlargement period? The second is the country pair dimension: how much larger was the above decline for country pairs that became intra-EU in 2004, relative to the old-old country pairs? And the third is the industry dimension: how much larger was the above excess decline for country pairs that became intra-EU in 2004 in the treatment sensitive (time sensitive), relative to the non-sensitive, industries?

More formally, the DIDID estimation is built up as follows. The time of the EU enlargement is denoted with the dummy d_t, taking value 1 for years larger than or equal to 2004 and 0 otherwise.[13] I differentiate between country pairs that are always inside the EU (old-old pairs) and country pairs that get inside only in 2004 (all pairs involving at least one new member) and call the former the control, the latter the treatment country pairs. The corresponding dummy is d_{ij}, which equals 1 for the treatment pairs and 0 otherwise. Note that the treatment is defined as two countries *jointly* becoming members of the EU. This involves the case when one country is already a member and the case when neither of them is a member before the treatment takes place. Such a treatment definition implies that it is the joint (and not the individual) EU membership that reduces bilateral trade restrictiveness.

I introduce a treatment sensitivity dummy, d^k, which takes value 1 if the industry is classified as treatment sensitive (time sensitive) and 0 otherwise. Timeliness is ultimately important for products

[11] Description of the method is provided, among others, in Meyer (1995) and Angrist and Krueger (2000).

[12] Hornok (2010) gives a more detailed description on the trade policy environment around EU enlargement.

[13] Notice that, because of the annual frequency of the data, I need to take the whole year 2004 as treated, though enlargement took place only in May. If it causes any bias in the estimated effect, that should be a downward bias, since it puts a couple of untreated months in the treatment part of the sample.

that are, for whatever reason, sensitive to time, and may be irrelevant for non-sensitive products. Notice that taking the difference along the sensitive versus non-sensitive industry dimension has the advantage that the estimation controls for any unobservable differences in the trends between the treatment and the control country pairs, as long as these differences are the same for time sensitive and non-sensitive industries. Such heterogeneity may e.g. come from an EU enlargement-induced increase in the political stability of new members or from a decrease in informational costs in trade with new countries.

The DIDID treatment effect can be captured by estimating an equation that includes the above three dummies d_{ij}, d_t, d^k and their first- and second-order interactions. And the DIDID estimate is the coefficient estimate on the second-order interaction term ($d^k_{ij,t} = d_{ij} \cdot d_t \cdot d^k$). In panel estimation the estimating equation can be simplified by using a full set of country pair-industry and industry-year effects as follows:

$$\theta^k_{ij,t} = \delta^k_{ij} + \delta^k_t + \beta_1 d_{ij,t} + \beta_2 d^k_{ij,t} + \varepsilon^k_{ij,t}, \tag{4}$$

where $\theta = \ln \Theta$, δ^k_{ij} are country pair-industry fixed effects and δ^k_t denotes a full set of industry-year dummies. The fixed effects and the industry-year dummies control for any time-constant country and industry characteristics as well as any industry-specific trends that are common across country pairs.

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 of the first (β_1) shows the magnitude of the EU enlargement-induced trade cost decline for industries that are not sensitive to time. The coefficient of the second (β_2) shows how much different this trade cost decline was for time sensitive, relative to non-sensitive, industries. A negative and significant estimate for the latter would show that the improvement of timeliness was indeed among the factors that contributed to the decline in trade costs after enlargement.

3.2 Time sensitivity of industries

Classifying industries to time sensitive and non-sensitive categories is not a straightforward exercise. Most previous attempts were restricted to a narrow subset of products, where time-sensitivity can be easily defined.[14] The only comprehensive estimation for time-sensitivity, to my knowledge, is Hummels (2001b). He uses information on the choices between the fast and expensive air and the slow and cheap ocean transportation in US imports and estimates the premium that trading firms are willing to pay for a faster delivery.

Hummels (2001b) reports the estimates for 2-digit SITC product groups. I create a broad correspondence between SITC groups and NACE industries and determine two sets of industries:

[14] Fresh foodstuff is clearly more time-sensitive than preserved foodstuff, for instance. Evans and Harrigan (2005) restrict attention to apparel products and use a special database to distinguish between replenishment versus non-replenishment clothing.

Table 1: Industries classified by time sensitivity

Time-sensitive		Time-insensitive	
NACE	industry	NACE	industry
29	Machinery and equipment	17	Textiles
30	Office machinery and computers	18	Wearing apparel
31	Electrical machinery and apparatus	19	Leather, luggage, footwear, etc.
32	Radio, tv and communication equip.	20	Wood, excl. furniture
33	Medical, precision and optical instr.	21	Pulp, paper products
34	Motor vehicles, trailers, semi-trailers	22	Publishing, printing
35	Other transport equipment	26	Other non-metallic mineral prods
		27	Basic metals

Notes: Own classification, based on Hummels (2001b).

time sensitive and non-sensitive ones (Table 1).[15] Not all industries are classified however: if the estimates for the SITC groups corresponding to an industry are mixed, the industry is left out from both categories.[16]

The resulting classification suggests that time sensitivity is associated mostly with higher technology industries. One reason for this may be that preferences change rapidly for fast developing high technology products. Moreover, these are the industries that are more strongly affected by the geographical fragmentation of production, where timely deliveries of intermediates between the different production platforms is very important.

3.3 Identification with treatment intensity

The identification can be refined with the use of some indicator that explicitly captures the magnitude of the timeliness gain due to enlargement and its variation across the treatment country pairs. In this case, the treatment is described by a variable of treatment intensity and not by a simple dummy variable.[17] An important advantage of identifying with treatment intensity is that it offers a way to check whether the direction of the measured effect corresponds to the a priori expectations (larger time gain, larger effect).

I construct a treatment intensity indicator that captures the change in the waiting time at national borders from the pre- to the post-enlargement period. With the opening of national borders to free movement of goods after May 2004, border waiting times between old and new member states and among new members were eliminated.[18] Variation in the enlargement-induced timeliness gain

[15] Evaluation is based on results in Table 3 in Hummels (2001b). An SITC product group is time-sensitive, when the estimate for the Days/Rate ratio is significantly positive.

[16] Four of the 19 industries are left out: NACE codes 24, 25, 28, 36.

[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.

[18] Though EU enlargement immediately guaranteed the free movement of goods within the enlarged EU area, zero waiting time after May 2004 is most probably an approximation. At most, border police controls remained in place up until the 8 new EU members entered the Schengen Area in December 2007, when finally the free movement of persons was also achieved. However, I think that this approximation is valid. 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.

across country pairs comes from the fact that countries with inefficient pre-2004 border procedures experienced a larger improvement in timeliness than countries with fast procedures.

The treatment intensity indicator is based on data on the pre-enlargement waiting time at borders and on the assumption that border waiting time within the EU is zero. Let us denote the pre-enlargement border waiting time for each country pair by h_{ij}. It takes value zero for control country pairs and positive values for treatment country pairs. Then, define the time-varying indicator for treatment intensity, $h_{ij,t}$, as follows:

$$h_{ij,t} = \begin{cases} h_{ij} & if \quad d_{ij,t} = 0 \\ 0 & if \quad d_{ij,t} = 1, \end{cases}$$

i.e. border waiting time equals the pre-enlargement waiting time in the untreated part of the sample, which falls to zero for treatment country pairs after they got the treatment.

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

$$\theta^k_{ij,t} = \delta^k_{ij} + \delta^k_t + \gamma_1 h_{ij,t} + \gamma_2 h^k_{ij,t} + \varepsilon^k_{ij,t}, \tag{5}$$

where $h^k_{ij,t} = h_{ij,t} \cdot d^k$. The interpretation of the two coefficients (γ_1 and γ_2) are now in terms of the unit of treatment intensity (unit of time). More precisely, it shows the marginal change of trade costs of treatment, relative to control, country pairs for time sensitive, relative to non-sensitive, industries in response to a one unit change in the border waiting time.

3.4 Pre-enlargement border waiting time

In the followings, I describe the construction of the pre-enlargement border waiting time variable (h_{ij}). The constructed variable is route-specific and captures the number of hours that a truck had to wait on average at national borders before EU enlargement on its way from the exporting to the importing country. The construction of the variable involves two steps. First, the optimal transport route from the exporting to the importing country is determined. Second, the pre-enlargement number of waiting hours at the corresponding borders are summed up.

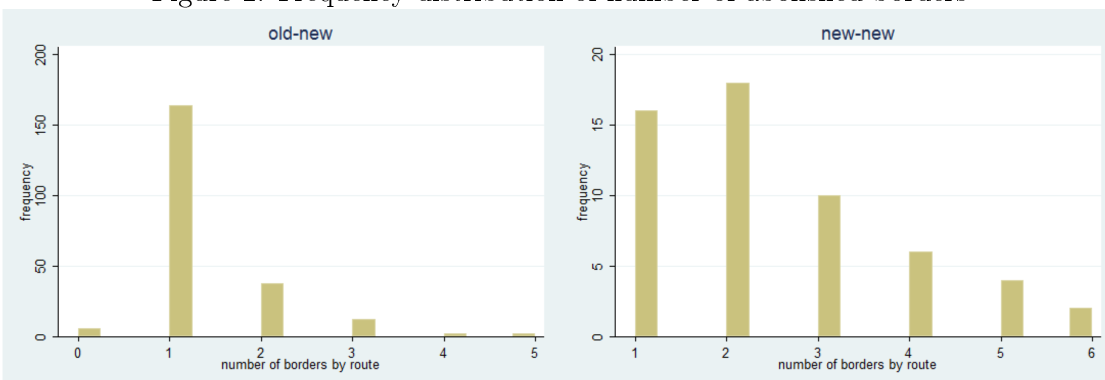
The transport routes are determined with the help of an online route planner.[19] The economically optimal route between the capitals of the two countries for a 40-tonne truck is taken. In some cases, routes may also involve the taking of a freight ferry to cross the sea. The optimal route determines the borders that the transport route crossed and that were eliminated with EU enlargement (number of abolished borders). Borders with third countries (no change in waiting time assumed) are not taken into account.[20]

[19] http://www.routenplaner-50.com/

[20] In trade of Lithuania with some old EU countries, the optimal route involves crossing the Lithuanian-Russian border and taking a ferry from Russia (Kalinyingrad) to Germany. In this case, the number of borders is zero, since borders with Russia were not eliminated with EU enlargement.

The frequency distribution of the number of abolished borders by route is shown in Figure 2. The figure does not contain old-old country pairs, since the number of abolished borders for them is always zero. For old-new country pairs most routes had to cross only one border. All the 8 new members are either neighbors to the old EU block or have a direct sea access (the Baltic states). In contrast, for new-new country pairs, the number of abolished borders are in most of the cases larger than one.

Figure 2: Frequency distribution of number of abolished borders



The border waiting time data is provided by the International Road Union (IRU) and is based on regular (daily, from Monday to Friday), but voluntary, reportings by transport companies and authorities, as well as bus and truck drivers.[21] Raw data is presented in Table 8. Waiting time is direction-specific and reported in hours for one or more border crossing points by national border. If there are more crossing points at the same border, I take the average of waiting times and not only the crossing point the optimal route determines. Not all trucks start from or are destined to the capital city, and trucks may also deviate from the optimal route for certain reasons. I retain the direction-specific nature of the data. To capture the pre-enlargement situation, I take the averages of the waiting times in years 2000-2002.

Table 2: Calculation of waiting hours on route Austria-Poland

Border	Crossing point	Waiting hours (2000-2002)
AT to CZ	Wullowitz-Dolni Dvorista	1.33
	Drasenhofen-Mikulov	0.43
	Haugsdorf-Hate	0.87
	Average of crossing points	**0.88**
CZ to PL	Kudowa Slone-Nachod	7.67
	Chalupki-Novy Bohumin	0.83
	Clesyzn-C.Tesin	7.13
	Average of crossing points	**5.21**
Waiting hours on route from AT to PL		**6.09**

Source: Own calculations based on IRU data.

Table 2 illustrates it on an example how the pre-enlargement border waiting time by route is calculated. If a truck goes from Austria to Poland, it has to cross the Austrian-Czech and the

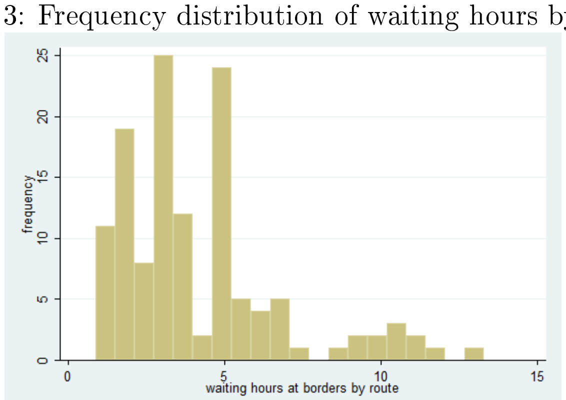
[21] I express my gratefulness to Peter Krausz (IRU) for providing me the data.

Czech-Polish borders along the optimal route. Along the Austrian-Czech border there are three border crossing points IRU provides data for: Wullowitz-Dolni Dvorista, Drasenhofen-Mikulov and Haugsdorf-Hate. They give the average waiting hours at the Austrian-Czech border in the pre-accession years (average of the three crossing points), which is 0.88 hours. Similarly, there are three crossing points on the Czech-Polish border with average pre-enlargement waiting time of 5.21 hours. Hence, the total waiting time on the optimal route from Austria to Poland is the sum of 0.88 and 5.21, i.e. 6.09 hours.

The waiting time data is unfortunately not available for Estonia and Latvia, and only partly available for Slovenia (Slovenian-Hungarian border only). Moreover, routes may also involve the taking of a sea ferry, while there is no waiting time information for sea ferry ports. Most of the ferry cases involve trade of Estonia and Latvia, for which there is no data anyway, but part of them are routes involving Lithuanian and Polish trade. Altogether waiting time data is missing for 152 out of the 280 treatment country pairs.[22]

The frequency distribution of the pre-enlargement border waiting time by routes 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. If there were no missing observations, the distribution would most probably be denser at the higher values, 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



Notice that border waiting time (or more precisely, the decline in the border waiting time) as a measure of the improvement in timeliness is relevant only for land transportation. Although land transportation is the dominant transport mode in intra-EU trade, later I will explicitly control for the mode of transport.

4 Estimation

I estimate equation (4) and equation (5) on the panel of country pairs and industries with 7 years. The balanced panel database is described in Section 2.2.

[22]The Robustness section experiments with other treatment intensity measures with better data coverage.

Motivated by the argument in Section 2.3, an additional control variable is also included in the estimating equation. I capture differences in the macroeconomic convergence trends of the treatment and the control country pairs with the absolute difference between the GDP per capitas in the exporter and the importer countries. Formally, $gap_{ij,t} =\mid \ln GDPPC_{i,t} - \ln GDPPC_{j,t} \mid$, where $\ln GDPPC_{i,t}$ denotes the natural logarithm of GDP per capita in country i at time t. Since the GDP per capitas are in current (euro) prices, the gap reflects both real and price convergence trends.[23] The estimate for its coefficient is expected to be positive: a declining gap (convergence) comes with a declining Novy index.

In the error structure I allow for arbitrary patterns of correlation and/or heteroskedasticity within country pairs. Hence, I apply cluster-robust standard error estimation with country pair clusters and not with country pair-industry clusters. The latter would require a stronger assumption on the independence across country pair-industry groups.

The results are presented in Table 3, estimates of equation (4) in the first, estimates of equation (5) in the second column. Due to the construction of θ, the estimated coefficients can directly be interpreted in ad-valorem tariff equivalent terms. Note that the number of observations vary with the specification, due to unclassified industries in terms of time sensitivity and missing data on the border waiting time. Both specifications contain a full set of county pair-industry and industry-year effects, as well as the GDP per capita gap variable. The coefficient of the latter is positive and significant.

Table 3: Main results

Variable	w/o treatment intensity	with treatment intensity
Treatment	-0.024***	
	[0.008]	
Treatment x Sensitive	-0.026***	
	[0.007]	
Treatment intensity		0.001
		[0.002]
Treatment intensity x Sensitive		0.008***
		[0.002]
GDP per capita gap	0.217***	0.360***
	[0.037]	[0.051]
Country pair - industry effects	yes	yes
Industry - year effects	yes	yes
Number of observations	29316	20860
Number of groups, of which:	4188	2980
- treatment, of which:	2402	1194
– sensitive	952	458
Adjusted within R^2	0.26	0.31

Notes: Estimates for equations (4) and (5) on a panel of country pairs and industries in period 2000-2006. Dependent variable is the log of the Novy index. Treatment is being an old-new or new-new country pair after 2004. Treatment sensitivity of industries is based on Hummels (2001b). Treatment intensity is the decline in border waiting time between countries (described in Section 3.4). Cluster robust standard errors (with country pair clusters) are in brackets. * significant at 10%; ** at 5%; *** at 1%.

The estimates in the first column justify that a considerable part of the decline in trade costs around EU enlargement can be due to the timeliness gain. The decline in trade costs for industries that are not time sensitive is estimated to be 2.4 percentage points (first row). In contrast, the decline in trade costs for time sensitive industries was twice that large. The coefficient on the interaction

[23] The source of the GDP per capita data is Eurostat.

of the treatment dummy and the time sensitivity dummy (second row) shows an *additional* 2.6 percentage points decline in trade costs for time sensitive industries.

When the decline in border waiting time as treatment intensity is included (second column), the significant contribution of the timeliness gain to the overall effect is further strengthened. The estimate is significantly different from zero only for time sensitive industries, i.e. only for the interaction of the treatment dummy with the treatment sensitivity dummy. The direction of the effect is the expected: a larger decline in border waiting time comes with a larger decline in trade barriers. The coefficient reads as follows: if border waiting time decreases by an additional hour (relative to its average change) for a treatment country pair, then trade barriers decrease with 0.8 of a percentage point more for time sensitive than for a non-sensitive industries. The marginal effect for non-sensitive industries is, in fact, zero.

One may find the 0.8 percentage point pretty large for one hour. Hummels (2001b) estimates the cost of a *day* to be 0.5% of the product value. Consider however that the estimated effect of an hour may not merely reflect the cost of waiting at the border per se. But it also reflects the cost of uncertainty regarding the delay, which could in the longer run lead to otherwise sub-optimal logistics, or even production location, decisions. Data on the waiting time is an average measure, which can potentially obscure large variation of waiting hours. Moreover, border waiting time can also proxy other types of administrative inefficiencies in a country. Though it is less clear why these other factors should affect only time sensitive industries, this possibility calls for carefulness in interpreting the results explicitly in terms of a time unit.

5 The role of the transportation mode

The effect of the timeliness gain may vary across the mode of transportation for at least two reasons. First, the abolition of the customs procedure did not take place in intra-EU sea transportation.[24] Trade in goods that are dominantly transported within the EU via sea therefore should be affected less, if at all, than air and land trade. Second, the applied treatment intensity measure (the decline in border waiting time) captures the timeliness gain explicitly for land transportation.

The aim of this section is to check if the estimated results correspond with the above hypotheses. I want to replicate the estimation after controlling for the (typical) transportation mode of each country pair and industry observation. Since there is no data on the mode of transportation for intra-EU trade, I first make projections for transport mode choice probabilities in intra-EU trade, based on extra-EU trade data and Multinomial Logit estimation. Then, on the basis of the projected probabilities, I form transport mode subsamples of the intra-EU sample with observations of relatively high shares in each of the modes.

[24] "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

5.1 Projection of intra-EU transport shares

Transport mode information is available from Eurostat for exports of EU members to third countries. In the followings I project transport mode shares for intra-EU exports based on the observed modal choices in extra-EU exports.[25] Non-EU destination countries may be quite different in several respects than EU countries, including their level of economic development, geographical proximity, or availability of transport modes. Choosing the sample of non-EU importers, the empirical specification and the explanatory variables is crucial to provide valid out-of-sample predictions.

5.1.1 Modeling transport mode choice

I model 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.[26] 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

$$U^*_{na} = \mathbf{x_n}\beta_a + \varepsilon_{na}, \qquad a = 1...A, \tag{6}$$

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 that vary with the transport mode. It follows from utility maximization that the probability of the modal choice outcome u_n being alternative a is

$$\mathrm{P}(u_n = a \mid \mathbf{x_n}) = \mathrm{P}\left(\varepsilon_{n1} - \varepsilon_{na} \leq \mathbf{x_n}(\beta_a - \beta_1)...\varepsilon_{nA} - \varepsilon_{na} \leq \mathbf{x_n}(\beta_a - \beta_A)\right), \qquad a = 1...A. \tag{7}$$

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

$$\mathrm{P}(u_n = a \mid \mathbf{x_n}) = \frac{\exp(\mathbf{x_n}\beta_a)}{\sum_{h=1}^{A} \exp(\mathbf{x_n}\beta_h)}, \qquad a = 1...A. \tag{8}$$

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 e.g. transport prices as regressors, such data is not available anyway. Estimation is done by Maximum Likelihood.

[25] The recorded mode of transport in the extra-EU trade database is the active mode of transport at the entry or exit to/from the borders of the EU.

[26] 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.

5.1.2 MNL specification

Applying the MNL to predict out-of-sample modal shares for intra-EU trade brings up a couple of important considerations. How to reconcile the structure of trade data with individual choice? What is the most appropriate set of non-EU importers? Given data limitations, what estimation strategy and regressors serve the best?

In principle, the individual that makes the transport mode choice is the firm. In contrast, trade statistics observe the exporter and importer countries and the traded product per each transport mode. Whether a unit of observation in trade statistics corresponds to the choice of one firm or several firms is unknown. Hence, it is important to bear in mind that applying a discrete choice model in these circumstances implicitly allows for compressing repeated actions of individual choice within one observation.[27]

The product dimension is very deep, covering more than 4000 different 6-digit HS product codes. Such as in the timeliness regressions, only non-food, non-energy manufactures are considered. The unit of observation is a cell of the exporter, importer and product dimensions, but the projection is ultimately made for a more aggregate unit with products grouped into the 19 manufacturing industries.[28] Projected modal shares for each exporter, importer and industry are calculated as weighted averages of the product-level probabilities, using trade value weights. The estimation and projection is done on a cross-section of the average of the two pre-enlargement years 2002 and 2003.

The 22 EU countries are taken as exporters. The choice of an appropriate set of non-EU importing countries, which ensures that out-of-sample predictions be valid for intra-EU trade, is not straightforward. EU countries form a more or less distinct block in both geographical and economic terms. I opt for taking a set of importers that corresponds to most of the useful variation in transport mode choice. This means taking trade partnerships, where more or less the same transport mode options are present as in intra-EU trade. Practically, this makes me exclude far-distanced importers. A group of 33 importing countries is chosen, which involves EFTA, Balkan and East European countries, Turkey, as well as some countries of the Middle East, Central Asia and North Africa.[29] The sensitivity of the results is checked by replicating the estimation and projection with only the 14 non-EU European importers.

Separate MNLs are estimated for each of the 19 industries (2-digit NACE). An advantage of the industry-by-industry estimation is that it allows for identifying industry-specific effects of the regressors. Each industry MNL contains the same set of regressors, as it is listed in Table 4. The

[27] To overcome the lack of micro data in discrete choice modeling, Berry (1994) suggests a method that needs information only on the number of purchases of each alternative per market (market share). However, the method is not applicable in the current case, since international trade data do not contain information on the number of transport mode purchases. Market shares in terms of trade value or weight are endogenous to the modal choice (larger cargos are sent via sea than air, etc.).

[28] Although trade is zero in many exporter-importer-product cells, possible selection effects are not handled here.

[29] 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.

choice of regressors is supported by Bayesian Information Criteria (BIC), i.e. a specification is preferred if it yields lower BICs for most of the industry MNLs.

Table 4: List of regressors in the transport mode MNL

Dimension	**Regressor**
Exporter	dummies
Importer	Landlocked, Days from Port, Africa, Asia, Log GDP Per Capita, Log GDP
Exporter-Importer Pair	Log Distance, Common Border
6-digit HS Product	Log Weight-to-Value Ratio
4-digit NACE Industry	dummies
Interactions:	
Importer * Product	Landlocked, Days from Port, Africa, Asia * Log Weight-to-Value Ratio
Exp.-Imp. Pair * Product	Log Distance, Common Border * Log Weight-to-Value Ratio

The exporter countries (the 22 EU members) are accounted for by exporter dummies. Given that I aim to project their modal choices, this is the most powerful way to capture their general transport mode preferences. Importers (and the exporter-importer country pairs) are captured by their geographical characteristics that explain the relative efficiency and availability of the different transport modes. I include a dummy for being landlocked, a variable from the World Bank's Doing Business survey on the number of days to transport a shipment from the nearest seaport to the importer's main city[30], dummies for being an African or Asian importer (Europe is the benchmark), as well as the geographical distance between the exporter and importer and a dummy for sharing a border.[31]

GDP per capita and GDP of the importer are also included. The GDP per capita controls for the differences in the level of economic development between the EU and the non-EU sample of importers. Though the inclusion of the GDP is less intuitive, GDP per capita and GDP were found to be *jointly* important explanatory variables based on the BICs.

Products are captured by their weight-to-value ratios, which is trade quantity in kilograms over trade value in euros. How heavy a product is relative to its value is probably one of the most important determinants in choosing between high-price small-capacity versus low-price large-capacity modes (air versus land/sea). The dramatical improvement in the BIC after including this variable also suggests its importance.

Further transport-specificities of industries are accounted for by the inclusion of sub-industry dummies (4-digit NACE). Their inclusion in the regression is supported by the BICs in 16 out of

[30]The days to transport from the nearest seaport is an indicator from the World Bank's Doing Business survey. It refers to the number of days needed to transport a standardized container cargo from the nearest seaport to the destination country's main city. Data is from the survey conducted in 2009, since earlier figures for this indicator are not publicly available.

[31]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.

the 19 industry MNLs. Altogether the 4-digit sub-industry dummies control for 175 sub-industries. Table 9 shows the number of sub-industry dummies per industry MNL.

Finally, interactions of the country-specific geographical variables with the product-specific weight-to-value variable are included. These interactions can handle some product-specificities of the effects of geography on modal choice. The inclusion of interactions of the weight-to-value with the GDP variables are however not supported by the BICs in 15 out of the 19 industry MNLs.

5.1.3 Estimation and in-sample prediction results

Basic regression statistics and a summary of the estimated coefficients of the industry MNLs are presented in Table 9 and Table 10. The Pseudo R^2 statistics, ranging between 0.2 and 0.4, suggest a satisfactory explanatory power for a cross-section regression.

The reported coefficient estimates and p-values are the median values across the 19 industry regressions. They are reported for the air and sea transport modes, 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/sea is chosen than land. Be aware however that the interpretation of the interaction term effects are not straightforward; the reported coefficients are not the marginal effects (cross-derivatives).

What one can assess from the coefficient estimates on the single variables is fairly intuitive. Air and sea transport is more likely to be chosen than land if bilateral distance is large, the exporter and importer do not share a border, the importer has good access to a seaport, the importer is in Africa or Asia, and GDP per capita of the importer is relatively high. And air is less likely to be chosen than land if the weight-to-value ratio of the product is high.

Table 11 compares the in-sample predicted and the true transport mode choice probabilities. MNL by construction 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. At the product level, the true modal choice probabilities are either 0 or 1, while the prediction often assigns nonzero probabilities for all the three transport modes. 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.

Simple pairwise correlations of the predicted and true modal probabilities are presented in Table 12 for three different levels of aggregation (product, sub-industry, industry). Subindustry 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. Land transport is somewhat better predicted (the correlation coefficients are higher) than the other two modes.

As a robustness check, the estimation and projection exercise is replicated for a restricted set of 14 non-EU European importers (around 50% of the original sample size). For these importers the modal choice is presumed to fall closer to the intra-EU modal choice. In fact, as one would expect, the share of land transportation for this subset of importers is larger than for the full set of importers at the expense of both air and sea. The in-sample predictive power in the restricted case is however somewhat worse than in the full sample case, while the out-of-sample predictions for intra-EU modal choices differ only marginally.[32]

5.1.4 Out-of-sample prediction

The estimated industry MNLs form the basis of the out-of-sample projections for intra-EU modal choices. The aim is to provide projected transport mode probabilities for all intra-EU country pairs and 2-digit industries. These projections then provide the basis for creating subsamples of country pairs and industries, where either of the three transport modes are predicted to be used relatively frequently.

Having the same regressors as listed in Table 4 also for intra-EU country pairs and products, it is straightforward to make out-of-sample projections of transport shares.[33] The predicted product modal choice probabilities are then aggregated to the industry level with the use of the corresponding trade value shares as weights. There are country pairs, for which trade is zero for all products belonging to an industry. For these observations, which account for 2% of all intra-EU country pair and industry cells, no projection can be made.

Tables 13 and 14 report the out-of-sample predicted transport mode shares for intra-EU trade as averages by industry and by country. The variation of shares across industries and countries seem to be quite intuitive. In general, land transport is projected to have the highest probability (0.65) in intra-EU trade, reflecting the geographical closeness and contiguity of these countries. Air and sea transport are, in general, projected to be of secondary importance.[34] More specifically, air is projected to be relatively important in the low weight-to-value industries like communication equipment or medical, precision and optical instruments, while sea is projected to be more frequent in the transport of heavy wood and basic metal products.

The country variation of out-of-sample predicted transport mode shares supports the general view that landlocked countries use land transport the most frequently. The projected land shares for the Czech Republic, Hungary, Luxembourg, Slovenia, and Slovakia all exceed 0.8, while their projected sea shares are practically zero. In contrast, island countries (Ireland, UK) show higher propensities to use air or sea, and the Northern countries with sea access (Denmark, Estonia, Finland, Sweden), sea transportation. Although the patterns are more or less similar by countries as importers, the relatively small variation of the projected transport mode shares along this dimension reflects the weaker explanatory power of the model on the importer side.

[32] Results of the MNLs on the restricted sample of importers are available from the author on request.

[33] Trade data for intra-EU exports of Poland and Slovakia is from years 2004 and 2005 (as opposed to 2002-2003), because Eurostat provides no data for these countries for the pre-2004 years at the 6-digit product level.

[34] Note that the relative shares of air versus sea would change considerably in favor of sea transport, if the product-level predicted probabilities had been weighted by trade quantities and not by trade value, since high (low) weight-to-value products are more likely to be shipped via sea (air).

5.2 Results by mode of transport

I define subsamples on the intra-EU country pairs and industries for the three transport modes as follows. An observation belongs to the land transport subsample, if its projected probability for land transportation is not smaller than 0.5. The rest of the observations belong to the air (sea) transport subsample, if their projected probability for air (sea) is larger than the projected probability for sea (air). In this way, the subsamples of neither air nor sea transport contain observations with their own probabilities being smaller than 0.25.

The construction of the transport subsamples tries to achieve two goals. It aims to reflect the relative importance of the three modes and it also tries to ensure that a sufficient number of observations fall into each subsample. Nevertheless, it is important to see that the resulting air and sea subsamples do not represent as high propensities for air and sea transport as the probabilities for land transport are in the land subsample. The median probability for land transport in the land subsample is 0.7, while the median probabilities for air and sea transport in the air and sea subsamples, respectively, are both only slightly above 0.4.

I estimate equations (4) and (5) on the three transport mode subsamples, as well as on a non-land (air+sea) subsample. The estimation results are presented in Table 5. The first four columns show estimates of (4), the last four columns present estimates of (5).

The estimates in both specifications confirm that the timeliness effect is significant only for country pairs and industries with a high propensity to use land transport. The coefficients on the interaction terms of the treatment dummy (or treatment intensity variable) with the time sensitivity dummy are significantly different from zero only in the land subsample. One has to note however that larger coefficient standard errors (smaller subsample sizes) may also be behind the insignificance of non-land subsample estimates.

Estimation results from the specification with treatment intensity (change in border waiting time) are more convincing. The coefficients on the interaction variables in the non-land, air and sea subsample estimations are not only insignificant, but also small in magnitude or even have the opposite sign. This finding suggests that one can more successfully separate the effect of timeliness within a DIDID framework with the help of an explicit timeliness variable than with a single dummy variable.

6 Robustness

I carry out two types of robustness checks for the above results. First, I classify industries along their treatment sensitivity in an alternative way. Second, I experiment with alternative measures for treatment intensity.

6.1 Production fragmentation as indicator of time sensitivity

So far I used the grouping of industries into time sensitive and non-sensitive industries as a treatment sensitivity indicator. An alternative way to capture treatment sensitivity is to consider that

Table 5: Results by transport mode

	w/o treatment intensity				with treatment intensity			
	land	non-land	air	sea	land	non-land	air	sea
Treatment	-0.019**	-0.023	-0.043*	-0.021				
	[0.010]	[0.016]	[0.024]	[0.021]				
Treatment x Sensitive	-0.016**	-0.025	0.004	-0.019				
	[0.008]	[0.016]	[0.030]	[0.019]				
Treatment intensity					0.000	0.008	0.014	0.002
					[0.002]	[0.006]	[0.010]	[0.005]
Treatment intensity x Sensitive					0.008***	-0.002	-0.009	0.003
					[0.002]	[0.008]	[0.013]	[0.008]
GDP per capita gap	0.197***	0.242***	0.361***	0.104	0.275***	0.389***	0.476***	0.252**
	[0.048]	[0.052]	[0.067]	[0.076]	[0.062]	[0.068]	[0.070]	[0.097]
Country pair - industry effects	yes	yes	yes	yes	yes	yes	yes	yes
Industry - year effects	yes	yes	yes	yes	yes	yes	yes	yes
Number of observations	19495	9821	5264	4557	13531	7329	3997	3332
Number of groups, of which:	2785	1403	752	651	1933	1047	571	476
- treatment, of which:	1889	513	300	213	1037	157	119	38
– sensitive	652	300	210	90	368	90	79	11
Adjusted within R^2	0.29	0.21	0.17	0.29	0.34	0.26	0.18	0.40

Notes: 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 of the Novy index. Treatment is being an old-new or new-new country pair after 2004. Treatment sensitivity of industries is based on Hummels (2001b). Treatment intensity is the decline in border waiting time between countries (described in Section 3.4). Cluster-robust standard errors (with country pair clusters) are in brackets. * significant at 10%; ** at 5%; *** at 1%.

geographical production fragmentation is probably the most important factor behind the increasing demand for timeliness. Hence, industries, where production fragmentation is relatively more prevalent, are expected to be more strongly affected by the trade-creating effect of EU enlargement.

The extent of production fragmentation can be captured by the importance of intra-firm trade in cross-country trading. I proxy the extent of intra-firm trade in the pre-enlargement years with two industry-specific indicators: one is the share of parts and accessories within an industry in the total bilateral trade among the 22 EU countries (henceforth, intra-EU trade), the other is the industry-specific FDI intensity (FDI stock over value added) in the eight new member states. Both indicators are based on data from the average of the two pre-enlargement years, 2002-2003.

Cross-border parts and accessories trade captures in large part trade between assembly plants located abroad and their parent companies. The parts and accessories share is calculated as the euro value trade share of parts and accessories (codes 42 and 53 under the Broad Economic Categories, BEC, classification) within each 2-digit NACE industry.[35] Formally, $SHPA^k = \sum_{p' \epsilon k} X^{p'} / \sum_{p \epsilon k} X^p$, where the numerator is total intra-EU exports in products classified as parts and accessories (indexed by p') belonging to industry k and the denominator is total intra-EU exports in all products (indexed by p) belonging to the same industry.

The other indicator is the pre-enlargement industry FDI intensity in the new member states. Outsourcing of production in the eight new EU members both by the EU-15 and other countries has become a widespread phenomena already in the pre-enlargement years. A significant part of this activity takes the form of direct investments of multinational companies and potentially initiates a large amount of intra-firm trade. Industry FDI intensity is defined as $FDIVA^k = FDI^k / VA^k$, where the numerator is total inward FDI stock in industry k and the denominator is total value added in the same industry in the eight new countries.[36]

The index values and the corresponding groupings of industries are presented in Table 15. An industry is classified to have relatively high (low) treatment sensitivity, if the index takes higher (lower) values than the median index value. The median industry is put in the treatment sensitive group in both cases. It is the textile industry for the parts and accessories trade share and rubber and plastic manufacturing for the FDI intensity.[37] An advantage of the alternative classifications is that, as opposed to the baseline case, they avoid the loss of observations, since now all industries are classified.

The grouping of industries according to the parts and accessories index is surprisingly close to the time sensitivity classification in Table 1; only the borderline textile industry switched status. The grouping according to the FDI intensity is however considerably different, although most of the high-tech industries are still classified as treatment sensitive.

Estimations of equations (4) and (5) are carried out with the treatment sensitivity dummy variable based either on the parts and accessories share index or on the FDI intensity index. The

[35] I start from 6-digit HS product-level trade data and use the concordance table that links the HS to the BEC classification.

[36] The FDI stock data is from the FDI database of the Vienna Institute for International Economic Studies (WIIW). The source of value added data is OECD STAN and, for non-OECD countries, Eurostat.

[37] Changing the status of these borderline industries leaves the estimation results qualitatively unaltered.

corresponding estimation results are presented in Tables 16 and 17, respectively. Both tables contain estimates for the two specifications (with and without treatment intensity) and also for land and non-land subsamples separately.

The qualitative assessment of the results is similar to the baseline case. Significant timeliness effects are detected from both specifications, and these effects come entirely from the part of the sample with relatively high projected probabilities of land transportation. The magnitude of the estimates is however mitigated, as compared with the baseline case. The estimated effects of an additional hour decline in the border waiting time on the trade cost of treatment sensitive industries are basically halved to 0.4 of a percentage point for both treatment sensitivity indicators.

6.2 Other indicators of treatment intensity

As another robustness check, I experiment with three alternative treatment intensity measures. One is the change in the number of borders on the route from the exporter to the importer country. The second is the (approximate) change in the days to complete a trade transaction, which I derive from the Doing Business survey of the World Bank. The third is a survey-based measure of the change in the customs-related burden of trading.

The alternative treatment intensity measures also make it possible to check whether the missing observations in the border waiting time variable significantly influence the results. The coverage of country pairs by the alternative measures is almost complete.[38]

Change in the number of borders The change in the number of borders is the negative of the number of abolished borders variable that was created as a first step in the calculation of the border waiting time variable. The reader is directed to Section 3.4 for a description. Similar to the change in the border waiting time variable, this variable also refers to land transportation only. However, it is not specific to waiting time and potentially captures other than time-related elements of border crossings (e.g. financial costs of crossing the border) as well.

Change in the days to trade Information on the pre-enlargement days to export and days to import is from the Doing Business survey database that is used in Djankov, Freund and Pham (2010).[39] Raw data by country is presented in Table 18. This wave of the survey was the first that incorporated questions to large freight forwarding companies on the time needed for a foreign trade transaction by country. Though it is from year 2005, I believe it is a good measure of the pre-enlargement situation, because the survey question explicitly refers to sea transport, where border control and customs inspection remained in place even after 2004.

For exactly the same reason, the subsequent surveys cannot be used to get information on the post-enlargement time to trade. More recent surveys however contain information on the breakdown

[38]The second measure does not cover country pairs with Luxembourg.

[39]The database of Djankov, Freund and Pham (2010) is downloadable from http://www.doingbusiness.org/methodology.

of the days to trade into four procedures, one of which is the customs clearance and inspection.[40] The time for the customs procedure is on average around 15% of the total time to trade.[41]

Using the above information and assuming that the time for the other three procedures did not change, I simply approximate the change in the days to trade that arose from the abolition of the customs procedure as 0.15 times the negative of the sum of the exporter's day to export ($dayex_i$) and the importer's day to import ($dayim_j$), i.e. $\Delta day_{ij} = -0.15 \cdot (dayex_i + dayim_j)$. The indicator is set to zero for the control country pairs.

Change in the customs burden The third alternative measure for treatment intensity captures the change in the burden firms face related to the customs procedure. The idea is that the level of the customs-related burden shortly before May 2004 is proportional to the subsequent improvement in timeliness that happened with the abolition of the customs procedure after EU enlargement.

I derive the customs burden measure from two survey variables from the Global Competitiveness Report 2004/2005 of the World Economic Forum (WEF). The WEF conducts its Executive Opinion Survey each year among top management business leaders from several countries. The two variables are the business impact of the customs procedure and the efficiency of the customs procedure to import.[42] They take values between 1 and 7, a larger score meaning a larger burden. Since the survey was conducted in early-2004, it exactly captures the pre-enlargement situation. Survey scores by country are presented in Table 18.

I construct a bilateral variable for the treatment country pairs by taking the average of the exporter's and the importer's scores as $\Delta customs_{ij} = -(0.5 \cdot ci_i + 0.25 \cdot ci_j + 0.25 \cdot ce_j)$. The weights take into account that the import customs efficiency variable (ce) explicitly refers to importing, while the customs business impact variable (ci) is independent of the direction of trade. I take the negative of the average to capture the change in the burden. Again, the indicator is set to zero for the control country pairs.

Results Estimates of equation (5) with the treatment intensity being either of the three alternative indicators are presented in Table 19. Notice that the industry treatment sensitivity dummy is again defined along the baseline time sensitivity dimension.

The treatment effect on the time sensitive industries (second row) is significantly larger than the treatment effect on the non-sensitive industries (first row) for the days to trade and the customs burden indicators. The same is not true for the number of borders indicator, which possibly also captures many other factors that are not associated with timeliness.

[40] The four procedures are document preparation, customs clearance and inspection, port and terminal handling, and land transport to/from the nearest seaport.

[41] It is true both for the whole survey sample and for the EU sample only.

[42] The exact survey questions 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 reversed the original ranking of the scores to make the interpretation similar to the other treatment intensity variables.

The pattern of estimates for the decline in days to trade is quite similar to the baseline estimates. The time sensitive industries are significantly affected, while the effect on the non-sensitive industries is statistically zero. This finding justifies that a purely timeliness-related treatment intensity indicator is indeed effective only in the time sensitive part of the sample. In contrast, the estimate from the regression with the customs burden indicator is significantly different from zero also for non-sensitive industries. Again, the customs burden indicator can possibly also capture factors other than timeliness.

A surprising result is that the magnitude of the estimates from the regression with the days to trade indicator and the magnitude of the baseline estimates are similar, although the unit of the treatment intensity indicator is days in the current and hours in the baseline case. This suggests that strictly interpreting the estimates in terms of time units is probably over-ambitious and may be misleading. The main advantage of the treatment intensity variable rather lies in the fact that it helps narrowing down the focus of the specification to the phenomenon of interest.

Finally, Table 20 presents the corresponding estimates separately for the land and non-land subsamples. Unlike the border waiting time and the number of borders, the days to trade and the customs burden indicators are not restricted to land transport but could also have a strong impact on trade costs related to air shipments. Accordingly, the timeliness estimates (second row of Table 20) for the latter two indicators are also significant or at least large in magnitude in the non-land subsample.

7 Conclusion

This paper used the episode of EU enlargement in 2004 to infer the importance of timeliness in international trade. It applied a DIDID econometric strategy that compared the changes in trade barriers of treatment, relative to control, country pairs in time sensitive versus non-sensitive industries. The identification was supported by the use of a novel treatment intensity indicator. The improvement in timeliness is shown to have significantly contributed to the EU's trade cost reducing effect. The main findings seem to be robust to cross-check estimations on projected transport mode subsamples, to changes in the definition of treatment sensitivity, and to alternative treatment intensity indicators.

Acknowledgements

I express my gratitude to Miklós Koren, my Ph.D supervisor. I also thank for useful comments and suggestions from Joe Francois, Gábor Kézdi, Carolina Lennon, Anna Naszódi, Dennis Novy, Attila Rátfai, Ádám Reiff, Robert Stehrer, participants at the ETSG 2009 Conference, the 2nd Conference of GIST, participants of internal seminars at the central bank of Austria, the Vienna Institute for International Economic Studies, and the Johannes Kepler University Linz. This paper was written while I was a visiting researcher at the Research Department of the central bank of Hungary (Magyar Nemzeti Bank) and later a Marie Curie early-stage researcher in the project

Globalization, Investment and Services Trade (GIST) at the Johannes Kepler University Linz. I gratefully acknowledge the financial support.

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Appendix: Figures and Tables

Table 6: Industry-level descriptive statistics

NACE industry	% share in total bilateral exports[1]	% share in total gross output[1]	σ	θ average[2]	No. of obs in balanced panel
17 Textiles	3.2	2.5	7.3	1.8	1862
18 Wearing apparel	2.1	1.5	5.7	2.7	1232
19 Leather, luggage, footwear, etc.	1.1	0.8	7.2	2.0	1022
20 Wood, excl. furniture	2.2	3.3	3.7	7.6	2898
21 Pulp, paper products	4.6	4.4	4.4	4.6	2744
22 Publishing, printing	1.3	7.4	5.1	6.9	3024
24 Chemical products	15.0	11.6	7.1	1.9	1876
25 Rubber and plastic products	1.0	0.8	5.2	2.6	280
26 Other non-metallic mineral prods	3.1	6.1	3.0	22.5	3024
27 Basic metals	8.0	4.8	3.5	5.8	1260
28 Fabricated metal products	4.8	12.1	4.9	4.9	3066
29 Machinery and equipment	13.9	14.7	7.2	2.0	2856
30 Office machinery and computers	0.9	0.4	10.9	1.5	350
31 Electrical machinery and apparatus	7.0	6.7	6.0	2.3	2814
32 Radio, tv and communication equip.	5.4	3.1	5.9	2.3	1456
33 Medical, precision and optical instr.	2.6	2.8	6.6	2.3	1974
34 Motor, vehicles, trailers	16.7	10.8	7.3	1.8	1274
35 Other transport equipment	4.2	3.3	7.5	2.3	1526
36 Furniture, manufacturing n.e.c.	2.9	3.0	4.1	5.1	1652

Notes: Own calculations based on Eurostat and OECD data. σ is based on estimates from Hummels (2001a). Statistics refer to the database of 19 industries (2-digit NACE), country pairs formed by 22 EU countries and 7 years between 2000-2006. Detailed description of the database is in Section 2.2. [1] Total is the sum of the 22 EU countries in the database. [2] Simple averages across country pairs.

Figure 4: Trade restrictiveness by industry ($\ln \theta$, normalized to year 2000)

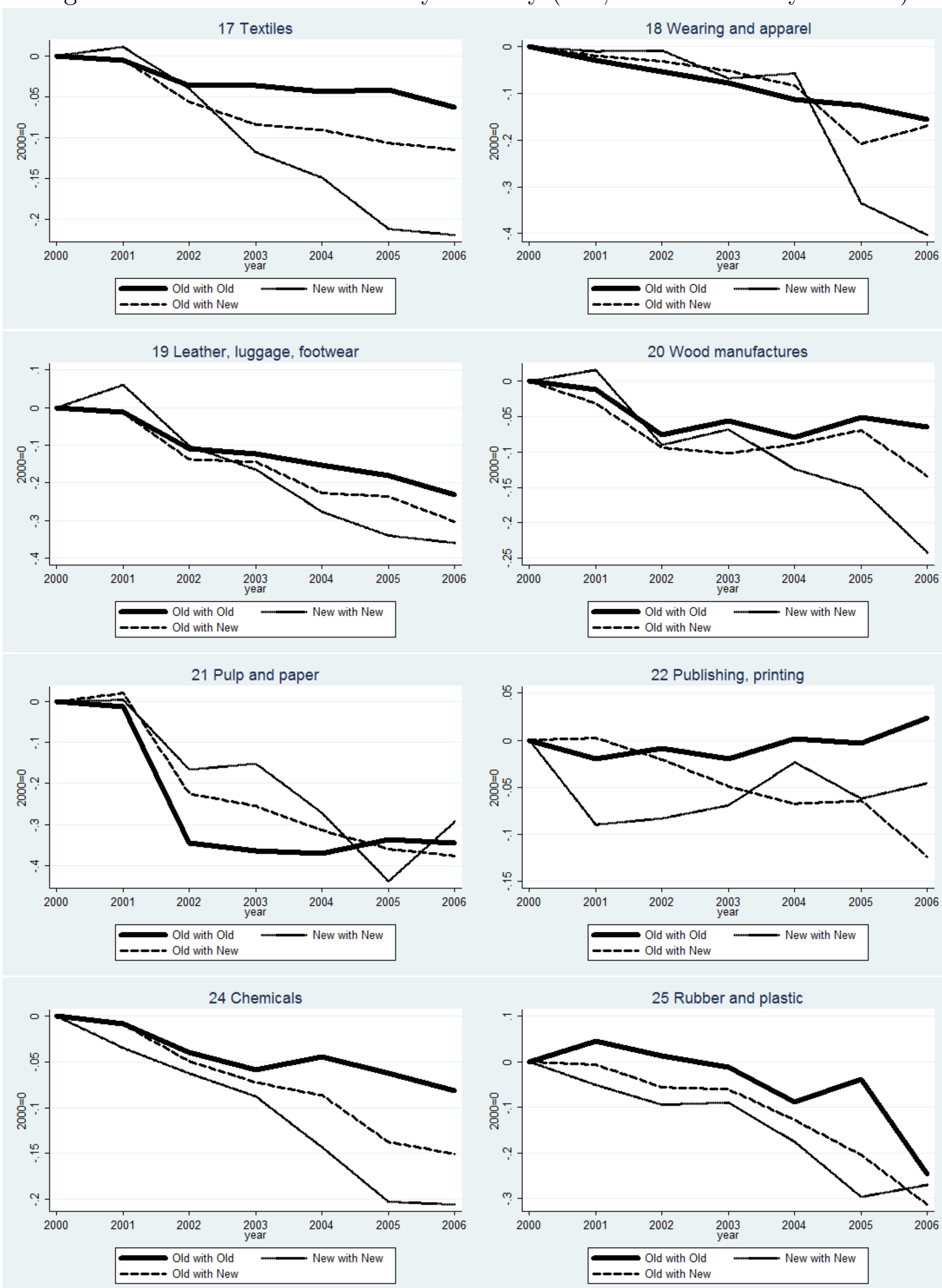

Figure 5: Trade restrictiveness by industry (continued)

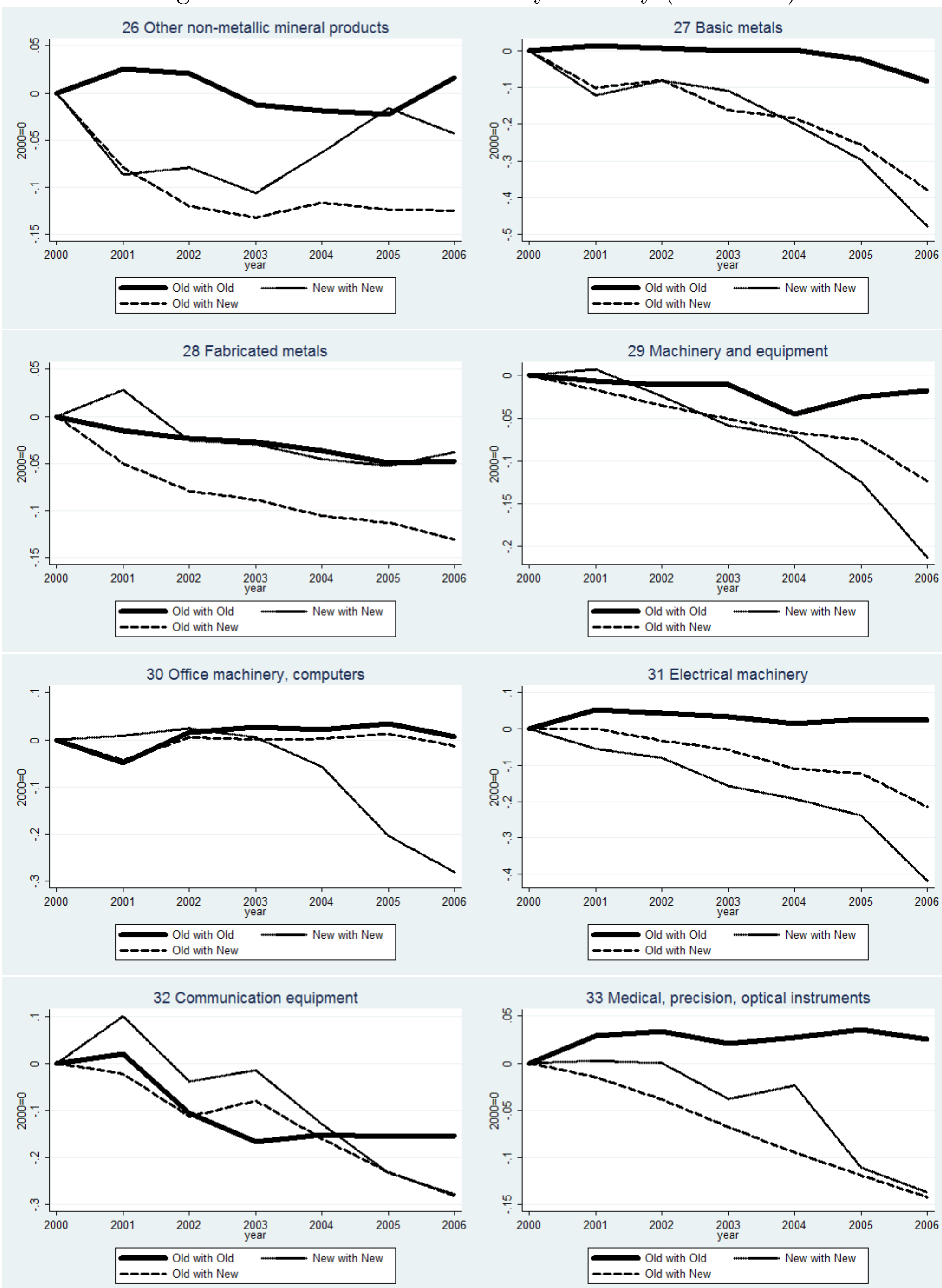

Figure 6: Trade restrictiveness by industry (continued)

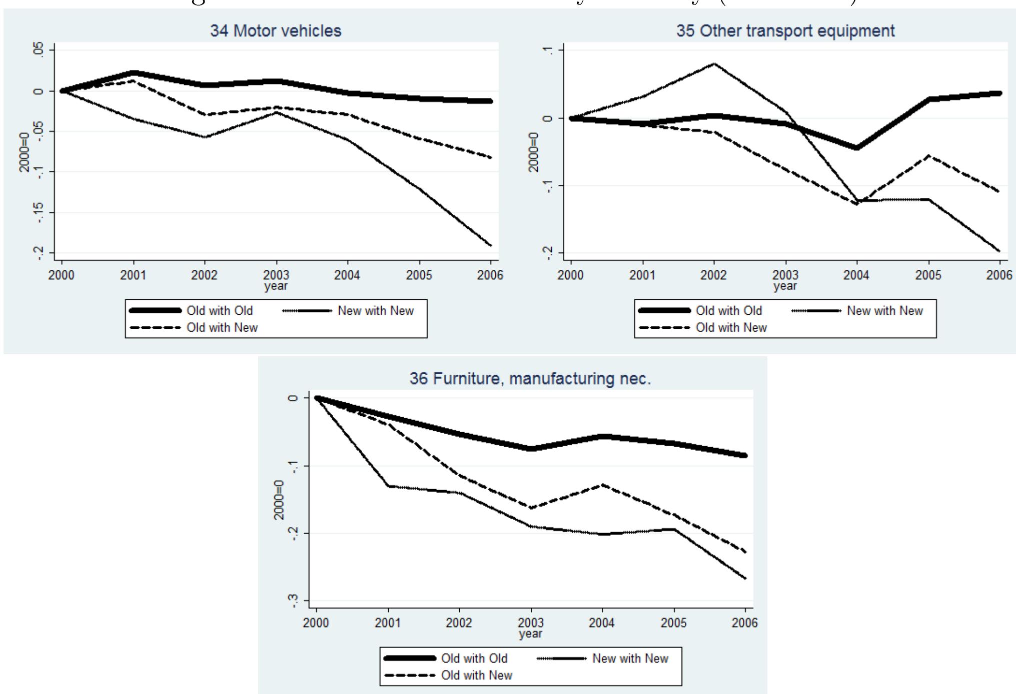

Table 7: Country-level descriptive statistics

exporter	% share in total bilateral exports[1]	% share in total gross output[1]	θ average[2]	No. of observations in balanced panel
Austria	3.8	2.4	4.9	1722
Belgium	4.1	1.8	4.6	1281
Czech Republic	2.5	1.6	4.7	1883
Germany	27.2	27.3	2.8	2065
Denmark	1.5	1.3	4.9	1701
Estonia	0.2	0.1	5.8	1379
Spain	6.6	7.9	5.0	2058
Finland	2.0	2.2	5.4	1988
France	14.0	14.2	4.1	2002
Hungary	1.8	1.0	5.7	1736
Ireland	0.7	0.9	9.6	1015
Italy	11.4	17.2	4.3	2086
Lithuania	0.2	0.1	7.0	1512
Luxembourg	0.1	0.1	11.6	672
Latvia	0.1	0.1	7.5	1176
Netherlands	6.8	3.5	4.0	1799
Poland	3.3	2.2	4.2	1995
Portugal	1.6	1.2	7.7	1820
Sweden	3.6	3.5	4.5	1841
Slovenia	0.4	0.3	6.2	1505
Slovakia	0.7	0.3	7.4	1190
United Kingdom	7.5	11.1	4.5	1764

Notes: Own calculations based on Eurostat and OECD data. Statistics refer to the database of 19 industries (2-digit NACE), country pairs formed by 22 EU countries and 7 years between 2000-2006. Detailed description of the database is in Section 2.2. [1] Total is the sum of the 22 EU countries in the database. [2] Simple averages across industries and importers.

Table 8: Waiting hours at borders raw data by border

origin country	destination country	number of crossing points[1]	average hours (2000-2002)[2]
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

Source: International Road Union (IRU). [1] Number of crossing points with waiting time data per border. [2] Simple averages across years and crossing points.

Table 9: Regression statistics of transport mode choice MNLs

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

Notes: Maximum Likelihood estimation summary statistics for the industry-specific transport mode choice Multinomial Logits. Modal choice alternatives are land (base category), air and sea. The regression specification is described in Section 5.1.2. Unit of observation is country pair (EU exporter, non-EU importer) and 6-digit product. Sub-industries are 4-digit NACE industries.

Table 10: Median values of estimates from transport mode choice MNLs

	mode=air		mode=sea	
Regressor	median coefficient	median p-value	median coefficient	median 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	

Notes: 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. Regressors are described in Section 5.1.2. Unit of observation is a country pair (EU exporter, non-EU importer) and 6-digit product.

Table 11: Summary statistics of the in-sample predicted and true modal choice probabilities

Variable	Number of observations	Mean	St.dev.	Min	Max
Projected share					
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 share					
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

Notes: 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, as described in Section 5.1.

Table 12: 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	

Notes: 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, as described in Section 5.1. 4-digit and 2-digit industry (true and predicted) modal shares are weighted averages of product-level (true and predicted, respectively) modal choice probabilities with trade value weights.

Table 13: Out-of-sample projections of intra-EU modal shares by industry[1]

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

Notes: Out of sample projections are based on the transport mode choice Multinomial Logit estimations, described in Section 5.1. Out-of-sample projections are made for intra-EU country pairs and 6-digit products. Industry-level modal share projections are weighted averages of product-level projected choice probabilities with trade value weights. [1] Reported modal shares are averages across country pairs.

Table 14: Out-of-sample projections of intra-EU modal shares by country[1]

country	if exporter			if importer		
	air	land	sea	air	land	sea
Austria	0.17	0.75	0.08	0.16	0.69	0.14
Belgium	0.12	0.76	0.12	0.15	0.64	0.21
Czech Republic	0.10	0.90	0.00	0.13	0.74	0.12
Germany	0.14	0.62	0.23	0.14	0.70	0.16
Denmark	0.15	0.57	0.29	0.17	0.61	0.22
Estonia	0.14	0.58	0.28	0.17	0.61	0.22
Spain	0.19	0.53	0.28	0.18	0.63	0.19
Finland	0.17	0.49	0.33	0.19	0.59	0.21
France	0.19	0.66	0.15	0.16	0.67	0.17
Hungary	0.11	0.89	0.00	0.15	0.71	0.14
Ireland	0.42	0.10	0.48	0.20	0.60	0.20
Italy	0.17	0.58	0.25	0.17	0.65	0.18
Lithuania	0.12	0.73	0.15	0.16	0.64	0.21
Luxembourg	0.12	0.82	0.06	0.20	0.62	0.19
Latvia	0.14	0.74	0.12	0.15	0.64	0.21
Netherlands	0.16	0.70	0.14	0.15	0.64	0.21
Poland	0.10	0.80	0.10	0.13	0.69	0.18
Portugal	0.21	0.58	0.21	0.22	0.57	0.22
Sweden	0.23	0.45	0.33	0.18	0.61	0.21
Slovenia	0.08	0.88	0.03	0.15	0.61	0.23
Slovakia	0.05	0.95	0.00	0.12	0.75	0.13
United Kingdom	0.32	0.20	0.48	0.17	0.66	0.18
Mean	0.16	0.65	0.19	0.16	0.65	0.19

Notes: Out of sample projections are based on the transport mode choice Multinomial Logit estimations, described in Section 5.1. Out-of-sample projections are made for intra-EU country pairs and 6-digit products. Industry-level modal share projections are weighted averages of product-level projected choice probabilities with trade value weights. [1] Reported modal shares are averages across industries and trade partners.

Table 15: Alternative classifications for treatment sensitivity

Industry	SHPA	sensitive=1	FDIVA	sensitive=1
17 Textiles	0.023	1	0.382	0
18 Wearing apparel	0.000	0	0.170	0
19 Leather, luggage, footwear, etc.	0.000	0	0.305	0
20 Wood, excl. furniture	0.000	0	0.764	1
21 Pulp, paper products	0.000	0	0.674	1
22 Publishing, printing	0.017	0	0.165	0
24 Chemical products	0.000	0	1.060	1
25 Rubber and plastic prods	0.697	1	0.670	1
26 Other non-metallic mineral prods	0.004	0	0.593	0
27 Basic metals	0.000	0	0.878	1
28 Fabricated metal prods	0.147	1	0.297	0
29 Machinery and equipment	0.191	1	0.438	0
30 Office machinery and computers	0.321	1	1.923	1
31 Electrical machinery and apparatus	0.479	1	0.482	0
32 Radio, tv and communication equip.	0.410	1	0.800	1
33 Medical, precision and optical instr.	0.034	1	0.695	1
34 Motor vehicles, trailers, semi-trailers	0.141	1	1.140	1
35 Other transport equipment	0.201	1	2.262	1
36 Furniture, manufacturing n.e.c.	0.019	0	0.105	0

Notes: Own calculation, based on Eurostat, OECD and WIIW data. SHPA is the share of parts and accessories in intra-EU trade within the industry. FDIVA is the ratio of inward FDI stock to value added in the new countries by industry.

Table 16: Results with parts and accessories share as treatment sensitivity

	w/o treatment intensity			with treatment intensity		
	whole sample	land	non-land	whole sample	land	non-land
Treatment	-0.029***	-0.021**	-0.031**			
	[0.007]	[0.008]	[0.014]			
Treatment x Sensitive	-0.011*	-0.011	-0.003			
	[0.006]	[0.007]	[0.014]			
Treatment intensity				0.002	0.001	0.008
				[0.002]	[0.002]	[0.005]
Treatment intensity x Sensitive				0.004**	0.005**	-0.002
				[0.002]	[0.002]	[0.006]
GDP per capita gap	0.195***	0.184***	0.211***	0.360***	0.301***	0.336***
	[0.031]	[0.039]	[0.043]	[0.050]	[0.062]	[0.061]
Country pair - industry effects	yes	yes	yes	yes	yes	yes
Industry - year effects	yes	yes	yes	yes	yes	yes
Number of observations	36190	23856	12334	25578	16408	9170
Number of groups, of which:	5170	3408	1762	3654	2344	1310
- treatment, of which:	2998	2360	638	1482	1296	186
– sensitive	1400	1019	381	676	566	110
Adjusted within R^2	0.26	0.29	0.21	0.31	0.35	0.26

Notes: Estimates for equations (4) and (5) on a panel of country pairs and industries in period 2000-2006. Land and non-land refer to subsamples defined on transport mode propensities, described in Section 5. Dependent variable is the log of the Novy index. Industry treatment sensitivity is based on the share of parts and accessories within the industry in intra-EU trade. Treatment is being an old-new or new-new country pair after 2004. Treatment intensity is the decline in border waiting time between countries (described in Section 3.4). Cluster-robust standard errors (with country pair clusters) are in brackets. * significant at 10%; ** at 5%; *** at 1%.

Table 17: Results with FDI intensity as treatment sensitivity

	w/o treatment intensity			with treatment intensity		
	whole sample	land	non-land	whole sample	land	non-land
Treatment	-0.028***	-0.016**	-0.041***			
	[0.007]	[0.008]	[0.012]			
Treatment x Sensitive	-0.015**	-0.024***	0.018			
	[0.007]	[0.008]	[0.014]			
Treatment intensity				0.003	0.002	0.009**
				[0.002]	[0.002]	[0.004]
Treatment intensity x Sensitive				0.003	0.004**	-0.005
				[0.002]	[0.002]	[0.004]
GDP per capita gap	0.196***	0.186***	0.210***	0.360***	0.301***	0.338***
	[0.031]	[0.039]	[0.044]	[0.050]	[0.062]	[0.061]
Country pair - industry effects	yes	yes	yes	yes	yes	yes
Industry - year effects	yes	yes	yes	yes	yes	yes
Number of observations	36190	23856	12334	25578	16408	9170
Number of groups, of which:	5170	3408	1762	3654	2344	1310
- treatment, of which:	2998	2360	638	1482	1296	186
– sensitive	1256	945	311	652	551	101
Adjusted within R^2	0.26	0.29	0.21	0.31	0.35	0.26

Notes: Estimates for equations (4) and (5) on a panel of country pairs and industries in period 2000-2006. Land and non-land refer to subsamples defined on transport mode propensities, described in Section 5. Dependent variable is the log of the Novy index. Industry treatment sensitivity is based on the ratio of inward FDI stock to value added in new countries within the industry. Treatment is being an old-new or new-new country pair after 2004. Treatment intensity is the decline in border waiting time between countries (described in Section 3.4). Cluster-robust standard errors (with country pair clusters) are in brackets. * significant at 10%; ** at 5%; *** at 1%.

Table 18: Days to trade and customs quality raw data

country	Doing Business Survey		Executive Opinion Survey	
	days to export	days to import	customs business impact[1]	import customs efficiency[1]
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

Notes: Source of Doing Business data is Djankov, Freund and Pham (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). [1] Scores range between 1 and 7. Original scores reversed, here larger reflects worse evaluation.

Table 19: Estimates with alternative treatment intensities

Variable	Number of borders	Days to trade	Customs burden
Treatment intensity	0.016***	0.002	0.007***
	[0.005]	[0.001]	[0.002]
Treatment intensity x Sensitive	0.010	0.006***	0.007***
	[0.006]	[0.001]	[0.002]
GDP per capita gap	0.235***	0.239***	0.215***
	[0.032]	[0.037]	[0.036]
Country pair - industry effects	yes	yes	yes
Industry - year effects	yes	yes	yes
Number of observations	29316	28210	29316
Number of groups, of which:	4188	4030	4188
- treatment, of which:	2402	2362	2402
– sensitive	952	938	952
Adjusted within R^2	0.26	0.28	0.26

Notes: Estimates for equations (4) and (5) on a panel of country pairs and industries in period 2000-2006. Dependent variable is the log of the Novy index. Treatment is being an old-new or new-new country pair after 2004. Industry treatment sensitivity is based on Hummels (2001b). Treatment intensity is either the change in the number of borders between countries (described in Section 3.4), the approximate change in the days to export/import in the two countries or a survey-based measure on the change in the burden related to the customs procedure in the two countries (the latter two described in Section 6.2). Cluster-robust standard errors (with country pair clusters) are in brackets. * significant at 10%; ** at 5%; *** at 1%.

Table 20: Estimates with alternative treatment intensities, land vs. non-land transport

Variable	Number of borders		Days to trade		Customs burden	
	land	non-land	land	non-land	land	non-land
Treatment intensity	0.013**	0.026**	0.001	0.000	0.005**	0.008*
	[0.006]	[0.010]	[0.002]	[0.003]	[0.002]	[0.005]
Treatment intensity x Sensitive	0.009	-0.002	0.003**	0.007**	0.004**	0.007
	[0.006]	[0.011]	[0.001]	[0.003]	[0.002]	[0.005]
GDP per capita gap	0.201***	0.252***	0.207***	0.280***	0.199***	0.229***
	[0.040]	[0.047]	[0.045]	[0.053]	[0.046]	[0.052]
Country pair - industry effects	yes	yes	yes	yes	yes	yes
Industry - year effects	yes	yes	yes	yes	yes	yes
Number of observations	19495	9821	18725	9485	19495	9821
Number of groups, of which:	2785	1403	2675	1355	2785	1403
- treatment, of which:	1889	513	1852	510	1889	513
– sensitive	652	300	640	298	652	300
Adjusted within R^2	0.29	0.21	0.32	0.22	0.29	0.21

Notes: Estimates for equations (4) and (5) on a panel of country pairs and industries in period 2000-2006. Land and non-land refer to subsamples defined on transport mode propensities, described in Section 5. Dependent variable is the log of the Novy index. Treatment is being an old-new or new-new country pair after 2004. Industry treatment sensitivity is based on Hummels (2001b). Treatment intensity is either the change in the number of borders between countries (described in Section 3.4), the approximate change in the days to export/import in the two countries or a survey-based measure on the change in the burden related to the customs procedure in the two countries (the latter two described in Section 6.2). Cluster-robust standard errors (with country pair clusters) are in brackets. * significant at 10%; ** at 5%; *** at 1%.

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