# Online appendix to "The United States of Europe: A gravity model evaluation of the four freedoms"

# A Theory and simulations

## A.1 Structural gravity interpretation of EU effects

Adapting the Head and Mayer (2014) structural gravity equations to encompass panel data, we obtain the following formula for exports of $i$ to $n$ in year $t$:

$$X_{nit} = \frac{Y_{it}}{\Omega_{it}} \frac{X_{nt}}{\Phi_{nt}} \phi_{nit}, \tag{A.1}$$

where $Y_{it} = \sum_n X_{nit}$ is the value of production, $X_{nt} = \sum_i X_{nit}$ is the value of the importer's expenditure on all source countries, $\phi_{nit} = \tau_{nit}^{-\epsilon}$, and $\Omega_{it}$ and $\Phi_{nt}$ are "multilateral resistance" terms defined as

$$\Phi_{nt} = \sum_{\ell} \frac{\phi_{n\ell t} Y_{\ell t}}{\Omega_{\ell t}} \quad \text{and} \quad \Omega_{it} = \sum_{\ell} \frac{\phi_{\ell i t} X_{\ell t}}{\Phi_{\ell t}}. \tag{A.2}$$

Defining $\alpha_{it} \equiv \ln Y_{it} - \ln \Omega_{it}$ and $\gamma_{nt} \equiv \ln X_{nt} - \ln \Phi_{nt}$, we can re-express the gravity equation in a way that is closer to estimated version:

$$X_{nit} = \exp(\alpha_{it} + \gamma_{nt} - \epsilon \ln \tau_{nit}), \quad \text{with } \tau_{nit} = (1 + \text{tar}_{nit})(1 + \text{ntb}_{nit})(1 + \text{frt}_{nit}), \tag{A.3}$$

where we assume that the three types of trade costs, tariffs (tar), non-tariff barriers (ntb) and freight costs (frt), can be expressed in *ad valorem* equivalents. In this decomposition, the final component of trade costs, $\text{frt}_{nit}$, does not depend on national borders or EU membership.[1] We refer to this as freight but formally it is the part of trade costs that depends on distance and analogous variables. Parameterizing freight costs as a linear combination of determinants, $\mathbf{D}'_{nit}$, we can write

$$-\epsilon \ln \tau_{nit} = -\epsilon[\ln(1 + \text{tar}_{nit}) + \ln(1 + \text{ntb}_{nit})] + \mathbf{D}'_{nit}\boldsymbol{\delta}. \tag{A.4}$$

Tariffs are given by $\text{cet}_t$ the common external tariff on imports from non-members and $\text{pref}_t$ on imports from members. The rest of the world charges $\text{row}_t$ on imports from all origins. NTBs are $\nu_t$ when the exporter is not a member but a lower $\rho_t$ applies to members. Meanwhile, in the rest of the world, trade incurs NTBs of $\kappa_t$.

The tariff and NTB terms in square brackets in equation (A.4) can now be expressed as a linear combination involving indicators for whether this is a flow inside the EU, an import of an EU country from third countries, or an import from a non-EU country:

$$\begin{aligned}
\ln(1 + \text{tar}_{nit}) &= \ln\left(\frac{1 + \text{pref}_t}{1 + \text{cet}_t}\right) \times \text{EU}_{nit} + \ln(1 + \text{cet}_t) \times \text{EU}_{nt} + \ln(1 + \text{row}_t) \times (1 - \text{EU}_{nt}), \\
\ln(1 + \text{ntb}_{nit}) &= \ln\left(\frac{1 + \rho_t}{1 + \nu_t}\right) \times \text{EU}_{nit} + \ln(1 + \nu_t) \times \text{EU}_{nt} + \ln(1 + \kappa_t) \times (1 - \text{EU}_{nt}). \qquad \text{(A.5)}
\end{aligned}$$

[1] Any border or EU-related effect on freight costs will be captured here in the ntb.

In the second equation, $(1+\rho_t)/(1+\nu_t)$ quantifies the success of the regional integration agreement at reducing non-tariff barriers. In the 1960s, it measures elimination of quantitative restrictions between EU members whereas in the late 1980s it corresponds to elements of the Single European Act such as removal of frontier barriers and standardization of technical requirements.

Plugging the equations for tariffs and NTBs in (A.5) into (A.4) and then the result into (A.3), we see that the coefficient on the "both EU" dummy in equation (**??**) is

$$\beta_t = \epsilon \ln[(1+\text{cet}_t)(1+\nu_t)] - \epsilon \ln[(1+\text{pref}_t)(1+\rho_t)]. \tag{A.6}$$

We should note that the destination-time fixed effect used in the modern estimation of structural gravity therefore has structural interpretation $\gamma_{nt} - \epsilon([\ln(1+\text{cet}_t) + \ln(1+\nu_t)]\text{EU}_{nt} + [\ln(1+\text{row}_t) + \ln(1+\kappa_t)](1-\text{EU}_{nt}))$, since the terms added to $\gamma_{nt}$ only vary across destination-time.

## A.2 General equilibrium gravity—with tariffs

We consider the class of single factor models that satisfy R3′ in Arkolakis et al. (2012). In these models country $i$'s share the market in $n$ is given by

$$\lambda_{ni} \equiv \frac{X_{ni}}{X_n} = \frac{w_i^{-\epsilon} A_i \phi_{ni}}{\Phi_n} \quad \text{where} \quad \Phi_n = \sum_\ell w_\ell^{-\epsilon} A_\ell \phi_{n\ell} \tag{A.7}$$

In this equation $w_i$ are endogenous wages and $A_i$ is an exogenous "ability" of each exporting country. To allow expenditures, $X_n$, to exceed the value of production $w_n L_n$, we add a per-capita borrowing of $b_n$ which is determined outside the model. Prior to the formation of the EU, its members charged import tariffs on each other, so we wish to consider lost tariff revenue as part of the welfare evaluation. Tariffs are assumed to apply to the CIF value of imports, that is $X_{ni}/(1+\text{tar}_{ni})$. Summing tariffs collected from all source countries and dividing by expenditure,

$$\pi_n = \sum_i \frac{\text{tar}_{ni}}{1+\text{tar}_{ni}} \lambda_{ni}. \tag{A.8}$$

The combined effect of these adjustments implies

$$X_n = w_n L_n (1+b_n)/(1-\pi_n) \neq w_n L_n = Y_n.$$

Bilateral trade flows are given by $\lambda_{ni} X_n$. Plugging in their respective determinants, yields

$$X_{ni} = \frac{w_i^{-\epsilon} A_i \phi_{ni} w_n L_n}{\Phi_n} \frac{1+b_n}{1-\pi_n}. \tag{A.9}$$

Market clearing states that worker income equals total sales including transport costs but excluding tariffs (as there are no other factors and no intermediate inputs).

$$w_i L_i = \sum_n \frac{X_{ni}}{1+\text{tar}_{ni}} = w_i^{-\epsilon} A_i \sum_n \frac{\phi_{ni} w_n L_n}{(1+\text{tar}_{ni})\Phi_n} \frac{1+b_n}{1-\pi_n} \tag{A.10}$$

Solving for wages

$$w_i = \left(\frac{A_i \Omega_i}{L_i}\right)^{1/(1+\epsilon)} \quad \text{where} \quad \Omega_i = \sum_n \frac{\phi_{ni} w_n L_n}{(1+\text{tar}_{ni})\Phi_n} \frac{1+b_n}{1-\pi_n}. \tag{A.11}$$

The primitives in this formulation are $A_i$, $L_i$, $b_n$, the four determinants of $\tau_{ni}$ and $\epsilon$. The endogenous variables are $X_{ni}$, $\pi_n$, and $w_i$. The solution algorithm works by guessing $w_i = 1$, obtaining $\Phi_i$, then $\Omega_i$, then $w_i$, and iterating until wages stop changing. Then one plugs the equilibrium (fixed point) wages back into the gravity equation to obtain trade flows $X_{ni}$.

The level of welfare is given by real consumption, $C_n = X_n / P_n$ where $P_n = \Phi_n^{-1/\epsilon}$.[2] Costinot and Rodriguez-Clare (2014, equation (41)) show that in all models consistent with structural gravity—equation (A.1)—the change in real consumption brought about by any change in tariffs or non-tariff barriers can be calculated through the formula

$$\hat{C}_n = \left(\frac{1-\pi_n}{1-\pi'_n}\right) \hat{\lambda}_{nn}^{-1/\epsilon}. \tag{A.12}$$

The sufficient statistics are the familiar share of expenditure procured at home, $\hat{\lambda}_{nn}$, and $\pi_n$, tariff revenue as a share of total expenditure.

## A.3 Welfare gains using CIF trade flows

Begin with the definition of CIF trade flows, i.e. tariff inclusive flows divided by the relevant *ad valorem* adjustment $1 + \text{tar}_{ni}$:

$$X_{ni}^{\text{CIF}} \equiv \frac{X_{ni}}{1+\text{tar}_{ni}} = \frac{\lambda_{ni} X_n}{1+\text{tar}_{ni}}.$$

The share of bilateral trade in expenditures, when valued CIF is now

$$\lambda_{ni}^{\text{CIF}} \equiv \frac{X_{ni}^{\text{CIF}}}{X_n^{\text{CIF}}} = \frac{\lambda_{ni}(X_n^{\text{CIF}} + T_n)}{X_n^{\text{CIF}}(1+\text{tar}_{ni})} = \lambda_{ni} \left(\frac{1+\overline{\text{tar}}_n}{1+\text{tar}_{ni}}\right), \tag{A.13}$$

where

$$\overline{\text{tar}}_n \equiv \frac{T_n}{X_n^{\text{CIF}}} = \frac{\sum_i \text{tar}_{ni} X_{ni}^{\text{CIF}}}{X_n^{\text{CIF}}}, \tag{A.14}$$

is the ratio or tariff revenue to the CIF value of expenditures. This is not a conventional number to measure but fortunately it is easy to relate to the trade-weighted tariff,

$$\text{tartw}_n \equiv T_n / \sum_{i \neq n} X_{ni}^{\text{CIF}},$$

through the formula:

$$\overline{\text{tar}}_n = (1 - \lambda_{nn}^{\text{CIF}})\text{tartw}_n.$$

[2]Recall that $\epsilon = \sigma - 1$ in the Armington or Krugman models and $\theta$ in Eaton and Kortum (2002).

From (A.12), we know that real consumption changes from trade liberalization depend on two endogenous variables: i) the proportional change in the share of expenditure spent domestically, $\lambda_{nn}$, and ii) the fraction of tariff-inclusive expenditure allocated to tariffs, denoted $\pi_n$.

Regarding $\lambda_{nn}$, we can set $\text{tar}_{nn} = 0$ in (A.13), and rearrange, to obtain

$$\lambda_{nn} = \frac{\lambda_{nn}^{\text{CIF}}}{1 + \overline{\text{tar}}_n} \qquad \text{and} \qquad \hat{\lambda}_{nn} = \hat{\lambda}_{nn}^{\text{CIF}} \frac{1 + \overline{\text{tar}}_n}{1 + \overline{\text{tar}}_n'}.$$

For $\pi_n$, we can see from the definition of $\pi_n$ combined with (A.14) that

$$1 - \pi_n = 1/(1 + \overline{\text{tar}}_n).$$

Real consumption changes from the Costinot and Rodriguez-Clare (2014) equation (A.12) can now be re-formulated entirely in terms of CIF-measured variables:

$$\hat{C}_n = \left( \frac{1 + \overline{\text{tar}}_n'}{1 + \overline{\text{tar}}_n} \right) \hat{\lambda}_{nn}^{-1/\epsilon} = (\hat{\lambda}_{nn}^{\text{CIF}})^{-1/\epsilon} \left( \frac{1 + \overline{\text{tar}}_n'}{1 + \overline{\text{tar}}_n} \right)^{1+1/\epsilon}. \tag{A.15}$$

The advantage of this approach is that obtaining tariff-inclusive import flows is not easy whereas DOTS provides CIF import flows. Furthermore, $\text{tartw}_n$ is readily available.

### A.3.1 Welfare and EU trade effects

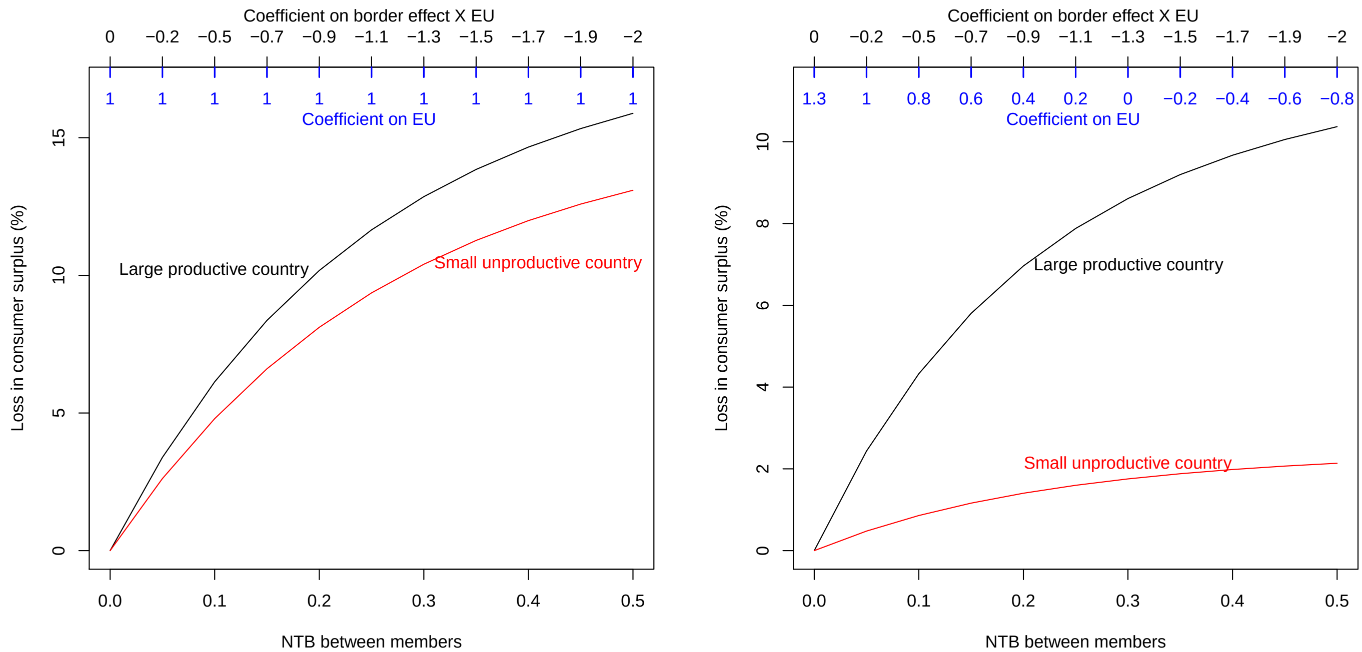
Equation (A.15) implies that welfare increases when changes in trade costs decrease $\lambda_{nnt}^{\text{CIF}}$. Even though internal trade costs are assumed to be unaffected by EU membership, $\lambda_{nnt}^{\text{CIF}}$ relates to $\kappa$ and $\rho$ via the multilateral resistance indicators $\Omega_{it}$ and $\Phi_{nt}$. A sufficient condition for EU integration to raise welfare is that $\kappa_t$ is non-increasing and $\rho_t$ declines as consequence of the agreement.

Recognizing that equation (2) is usually estimated with trade measured in CIF value, the structural interpretation of the border effects changes to be

$$\begin{aligned}
\beta_t^{\text{CET}} &= -(\epsilon + 1) \ln(1 + \text{cet}_t) - \epsilon \ln(1 + \nu_t) \\
\beta_t^{\text{ROW}} &= -(\epsilon + 1) \ln(1 + \text{row}_t) - \epsilon \ln(1 + \kappa_t) \\
\beta_t^{\text{EUB}} &= -(\epsilon + 1) \ln(1 + \text{pref}_t) - \epsilon \ln(1 + \rho_t).
\end{aligned} \tag{A.16}$$

Figure A.1 shows how welfare relates to estimated gravity coefficients in response to underlying variation in non-tariff barriers. The figures come from a simulated version of the model, and computes changes in welfare for two countries (a large productive one in black and a small unproductive one in red) for different levels of NTBs (on the lower horizontal axis). Panel (a) increases MFN and preferential NTBs proportionately such that their relative levels stay the same. As depicted inside the upper horizontal axis, this implies standard gravity would estimate the same EU coefficient for all levels of NTBs. On the contrary, the EU border effect interaction, obtained from equation (A.16), tracks the co-movement of welfare and preferential NTBs.

Figure A.1: Welfare




(a) Constant relative NTBs

(b) Changing EU NTBs only

# B Data and empirics

Additional information on the construction of the data with a complete set of data citations, links, and access dates can be found in the README.pdf file at Head and Mayer (2021), the ICSPR repository for this paper. The data manipulation for this project generally uses R packages on a CRAN with the important exception of the authors package Head (2021) available at Github/ckhead.

## B.1 Distance data and other gravity variables

For the cross-sectional regressions, we primarily use CES-distances, made available in the CEPII gravity database (`http://www.cepii.fr/cepii/en/bdd_modele/presentation.asp?id=8`), which is also the source for most bilateral right-hand-side covariates.

For state to state distances we used the measure developed in Head and Mayer (2010). The calculation starts with obtaining county-level latitudes, longitudes, population, and land areas, such as those available at `https://www2.census.gov/geo/docs/maps-data/data/gazetteer/2020_Gazetteer/2020_Gaz_counties_national.zip`. County-to-county distances are calculated using the great circle formula. Then following the formula in Head and Mayer (2010) one calculates interstate distances by combining every combination of county-to-county distances as a CES index with $\theta = 1$ (a population-weighted harmonic mean). Since a state's distance to itself puts weight on each county's distance to self, we follow the Head and Mayer (2010) justification for using the following area-based formula for that: $d_{ii} = 0.667\sqrt{\text{area}_i/\pi}$.

We obtain similar results with the Hinz (2017) satellite-based inter- and intra-area distances, downloadable and documented at `https://github.com/julianhinz/gravity.distances`.

## B.2 Trade in goods

In order to be able to cover the longest possible time period and the largest possible set of countries, we use in this paper data for trade in overall goods. The two main sources of bilateral trade data are the International Monetary Fund (2020) DOTS data (downloaded 1948–2018 data) and United Nations (2020a) Comtrade data (downloaded 1962 to 2019 data). Those two sources sum the bilateral value of trade for all available years and are mostly similar, but not identical in ways that turns out to be important.

There are mirror flows in those datasets. One partner declares a flow as FOB exports, when the other declares it as CIF imports (a very limited number of countries report imports FOB). We give priority to the imports valued in CIF since this is the relevant value on which the tariff should be imposed and also the one we use in our theoretical developments.

For some countries with very large ports (Belgium and Netherlands are of particular interest for us), the two sources start to diverge in the 1990s, when the IMF DOTS source gets quite a lot larger than the UN Comtrade one. We conjecture that the UN source is doing a better job at the allocation of re-exports of goods that only transit through those countries (the legal units that have to declare trade might also be using different concepts, i.e. customs vs BOP residence principles). This is particularly important in our case because those re-exports are likely to be inside the EU and potentially bias upwards the EU integration estimates. Furthermore, since the self-trade is computed as production value - export value, this overestimate of exports results in negative self-trade for the latest years. We use Comtrade as the course for bilateral trade when available and use DOTs as the second choice source.

### B.2.1 Self-trade in goods

The computation of self-trade for overall trade in goods is paradoxically more complex that when using data at the industry level. This is because the overall production value of a country restricted to tradeable goods is not a standard statistic collected by official institutes.

The first step is to generate a panel of country-year goods production values. We follow the United Nations ISIC revision 3 classifications because that was what was in use for the data sets we obtained.
`https://ilostat.ilo.org/resources/concepts-and-definitions/classification-e`
The industries we refer to as goods comprise A (Agriculture, hunting and forestry), B (Fishing), C (Mining and quarrying), D (Manufacturing).[3]

[3]For any extension of our data using revision 4, note that B (Fishing) was subsumed into A, so Mining became B, and manufacturing became C.

Because GDP have the longest time series for the most countries, they are the starting point. We combine Feenstra et al. (2015), accessed via Zeileis (2019) in R to obtain read GDP data, which we converting real to nominal GDPs using the GDP price level index. We supplement this with additional nominal GDP data from World Bank (2020b). Let us denote GDP with $Y$. When subscripted, it refers to *value-added* in the corresponding industry (ISIC rev 3) or industries. Thus $Y_{AB}$ is value added in Agriculture, hunting, forestry and fishing. At risk of confusion, we denote production as $Q$, but $Q$ is the *value* of production.

The goal is to obtain $Q_{ABCD}$ for each country $i$. OECD SNA provides data to calculate $Q_{AB}$, $Q_C$ and $Q_D$. UNIDO provides manufacturing output $Q^u_D$. Unfortunately the coverage in the OECD and UNIDO data is somewhat limited. Therefore, we bring in the United Nations (2020c) data to obtain $Y_{AB}$ and $Y_{CDE}$ and $Y_D$ for a larger set of countries and years. Making the assumption that $Y_E$ is stable as share of GDP, we remove $D$ and $E$ to get $Y_C$ (value added in mining). Going back to the OECD SNA data we obtain $z_{AB} = Q_{AB}/Y_{AB}$ and $z_C = Q_C/Y_C$ as the relevant output to value-added ratios. We assume these are fairly stable and can be used for extrapolation.

With the OECD SNA data output to GDP shares directly for sectors A, B, and C. For the large set of country-years without the OECD data, we convert the UNAMA value added data into output to GDP ratios and fill in the missing gaps with interpolation. Thus the ABC output to GDP ratio is given by

$$x^u_{ABC} = \begin{cases} (Q_A + Q_B + Q_C)/Y & \text{when there is OECD data on outputs} \\ (Y_{AB} z_{AB} + Y_C z_C)/Y & \text{rely on UNAMA VA data and average } z \end{cases} \tag{B.1}$$

As the UNIDO manufacturing output data is less complete than GDP data, we also obtain $x^u_D = Q^u/Y$ as the manufacturing output total GDP ratio. Assuming these $x$ ratios are more stable over time than the underlying output, we interpolate them to fill in the missing country-year observations.

$$Q^{ABCD} = \begin{cases} x^u_{ABC} Y + Q^u_D & \text{UNIDO mnfg. data available.} \\ x^u_{ABC} Y + Q_D & \text{no UNIDO but OECD mnfg. data available.} \\ x^u_{ABC} Y + x^u_D Y & \text{only interpolated output to GDP ratios available.} \end{cases} \tag{B.2}$$

Once we have data on production of goods, we subtract aggregate exports (to other countries). The remainder is exports to self.

$$X_{ii} = Q_{ABCDi} - \sum_{n \neq i} X_{ni} \tag{B.3}$$

The $X_{ni}$ bilateral trade values (in goods) come from Comtrade (downloaded via API) when possible and IMF DOTS (bulk download) for earlier years and other cases when Comtrade data were not available.

### B.2.2 Trade between states in the US

Trade between US States comes from Bureau of Transportation Statistics (2017) Commodity Flow Survey. The 1997 data was obtain from Bureau of Transportation Statistics (1997).

## B.3 Migration

The World Bank (2020a) Global Bilateral Migration Databank provides a decadal bilateral matrix from 1960 to 2000. The United Nations (2020b) Global Migration Database, provides data starting in 1990 and has data at 5 years intervals until 2015. When both datasets are available, inspection of the data led us to privilege the UN data. Both sources provide estimates of stocks based on national censuses as primary source. They use country of birth as the preferred indication of country of origin. The UN clarifies that they used country of citizenship instead of country of birth for 20% of the countries.

The state to state migration, again defined by comparing the current residence to the place of birth comes from a combination of U.S. Census Bureau (2015) American Community Survey and the U.S. Census Bureau (2000) Decennial Census. We downloaded the XLS files from the links provided in the data References at the end of this appendix.

Finally, Table B.1 lists the papers and elasticities used to calibrate $\epsilon$ for migration flows.

Table B.1: Recent preferred estimates of the elasticity of migration with respect to the retention rate $(1-\tau)$, ordered by publication year

| Author | Country | $\epsilon$ estimate |
|---|---|---|
| Kleven et al. (2013) | Europe (foreign soccer players) | 0.99 |
| Kleven et al. (2014) | Denmark (top earning foreigners) | 1.63 |
| Akcigit et al. (2016) | 8 countries (top inventors) | 1.04 |
| Suárez Serrato and Zidar (2016) | USA (all workers) | 1.21 |
| Moretti and Wilson (2017) | USA (star scientists) | 1.81 |
| Fajgelbaum et al. (2018) | USA (all workers) | 1.73 |
| Bryan and Morten (2019) | Indonesia (representative survey) | 3.18 |
| Bryan and Morten (2019) | USA (representative survey) | 2.69 |
| Tombe and Zhu (2019) | China (census) | 1.50 |
| Caliendo et al. (2020) | CEECs (EU Labor Force Survey) | 0.50 |
| Muñoz (2020) | EU-LFS (foreigners) | 2.10 |
| **Median estimate** | | **1.63** |

## B.4 Trade in services

Bilateral trade in services is available as part of the World Input-Output Database (WIOD) by Timmer et al. (2016), which is documented in Timmer et al. (2015). They use data from Eurostat, the OECD, and the UN. While the underlying sources have data that goes as far back as 1985, they contain only international service flows. Our method requires intranational flows as well, the construction of which involves combine service value added data with the trade data (as discussed in our section for trade in goods). This is done in WIOD (as well as the USITC ITPD-E database which became available more recently), which covers 28 EU countries and 15 other major countries in the world for the period from 2000 to 2014.

As data in travel or transport services do not fit the trade models as naturally, we restrict trade flows to the set of commercial services that the Treaty of Rome and later

EU legislation were probably targeting and where comparison with goods flows is most relevant. We follow Mayer et al. (2019), who followed the Head et al. (2009) procedure for isolating tradable services. They start from an aggregate code for "Other services", 981 in EBOPS 2002 classification, which is just All services minus Transport and Travel. They then subtract government services, defined as codes 895 (Education), 896 (Health), and 291 (Government NIE). The WIOD uses a different activity classification system (ISIC revision 4). To reach a similar definition of commercial services, we sum the following WIOD Industry Code values: J58, J59_J60, J61, J62_J63, K64, K65, K66, M69_M70, M71, M72, M73, M74_M75, N.

## B.5 Capital (mergers & acquisitions)

The source of our data is SDC Platinum, which is the data source for several influential papers in the finance literature: Ahern et al. (2015), Serdar Dinc and Erel (2013), Erel et al. (2012). We extract all completed transactions that were announced in a given year from 1985 to 2018. Prior to 1985, the SDC data becomes very thin. In the interface we select

1. US targets and Non-US M&A targets
2. M&A transactions for majority/remaining interest.
    - Disclosed value
    - Undisclosed value
    - Completed transactions (did not keep the "unconditionals")

We calculate two bilateral flow measures. The first is the value of transactions (in millions of US dollars), which is available for 40% of transactions. The second is the count of transactions. About 23% of the transactions are cross-border, and this is true of the subset of transactions where values were reported.[4] Cross-border transactions tend to be slightly larger, accounting for 28% of the value of all M&A transactions.[5]

## B.6 Price data

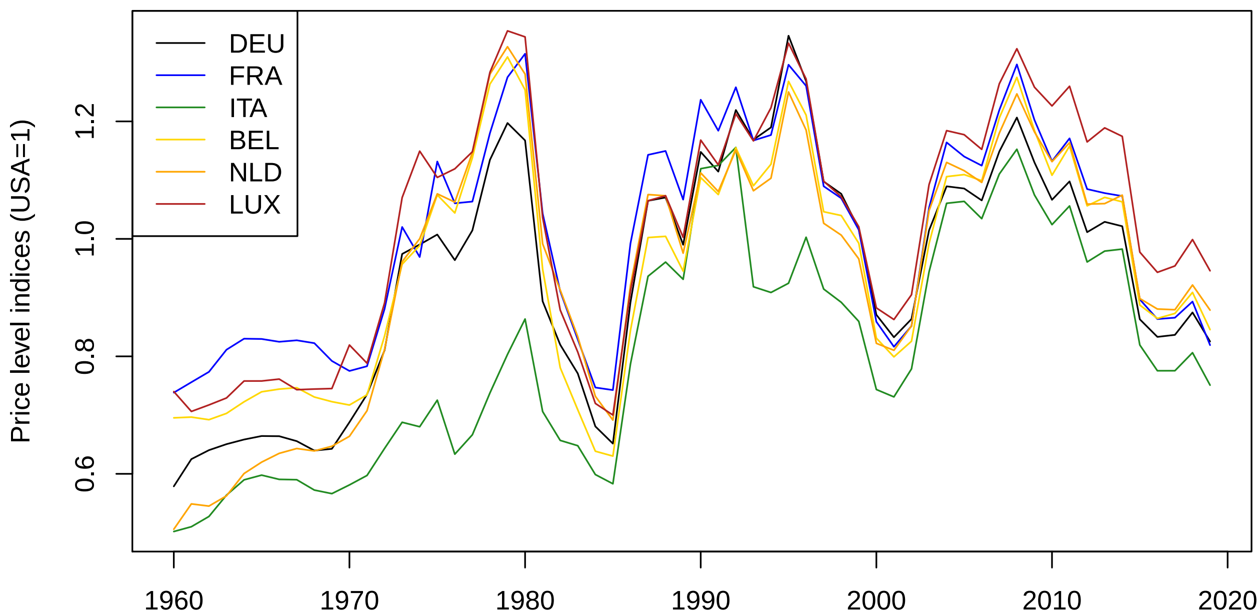
The analysis of price convergence brings together several sets of data. The first are the purchasing power parities (PPP) estimated jointly by Eurostat and the OECD and available for download at `https://stats.oecd.org/`. Dividing PPPs by nominal exchange rates (both expressed in terms of US dollars) yields the price level index (PLI). Details on data construction are available at `https://www.oecd.org/sdd/prices-ppp/eurostat-oecdmethodologicalmanualonpurchasingpowerparitiesppps.htm`. The PLI are calculated such that all price levels are relative to the US in a given year. In 2018 the PLI in the EU range from 0.42 (Bulgaria) to 1.07 (Denmark).

Figure B.1 shows PLI for the EU6 over the whole span for which data are available.

[4] Ahern et al. (2015) report 24% in their 1985–2008 data set.

[5] Erel et al. (2012) report 29% in their data.

Figure B.1: Price levels in the six original EU members 1960–2019




The regional price parities (RPP) calculated at the state level come from the US Bureau of Economic Analysis (BEA), which reports them starting in 2008 at `https://www.bea.gov/data/prices-inflation/regional-price-parities-state-and-metro-area`. Price levels are expressed as a percentage of the overall national level. In 2018 the RPP in the US range from 0.85 (Arkansas) to 1.18 (Hawaii), about half the range within the EU.

Real personal incomes in the US are also provided by the BEA (download at `https://apps.bea.gov/regional/downloadzip.cfm`) and are calculated by dividing state-level personal incomes by the corresponding RPPs. For the EU counterpart we used Penn World Tables 9.1, downloaded via the "pwt9" package in R. Real income per capita is constructed as the ratio $y$ =cgdpo/pop. As the US data are real incomes, we use real Gross National Income (GNI) per capita instead of GDP per capita from 1990 forward, the year when GNI becomes available in the World Development Indicators. Specifically, from 1990 forward we multiplying $y$ by the ratio of the series NY.GNP.PCAP.PP.CD to NY.GDP.PCAP.PP.CD.

The US "first 6" and "first 15" in figures 5 and 7 are based on order of entry taken from `https://en.wikipedia.org/wiki/List_of_states_and_territories_of_the_United_States`.

We use data from Goldberg and Verboven (2005), Sosvilla-Rivero and Gil-Pareja (2012), supplemented with European Commission Car price reports. The raw EU commission data are archived at `https://ec.europa.eu/competition/sectors/motor_vehicles/prices/report.html`. It is reported in local currency units both pre and post taxes (but both prices are not always available for a given country year.)

US price dispersion for cars is calculated from public use micro data of the Consumer Expenditure Survey collected by the US Bureau of Labor Statistics and available for download at `https://www.bls.gov/cex/pumd_data.htm#stata`. The variable we use is NETPURX, defined as "Net purchase price after discount, trade-in, or rebate, including destination fee." It is not clear from this definition whether prices exclude sales taxes or not. The data are self-reported so this might vary across respondents.

When disaggregated to the state level, the number of observations for low population states is sometimes too small to be reliable. Therefore we pool data into two periods, 2010 to 2012 and 2013 to 2015 to improve the spatial coverage of the survey.

# C Gravity in goods regressions

Figure C.1: Intra-EU gravity coefficients for trade in goods - shares

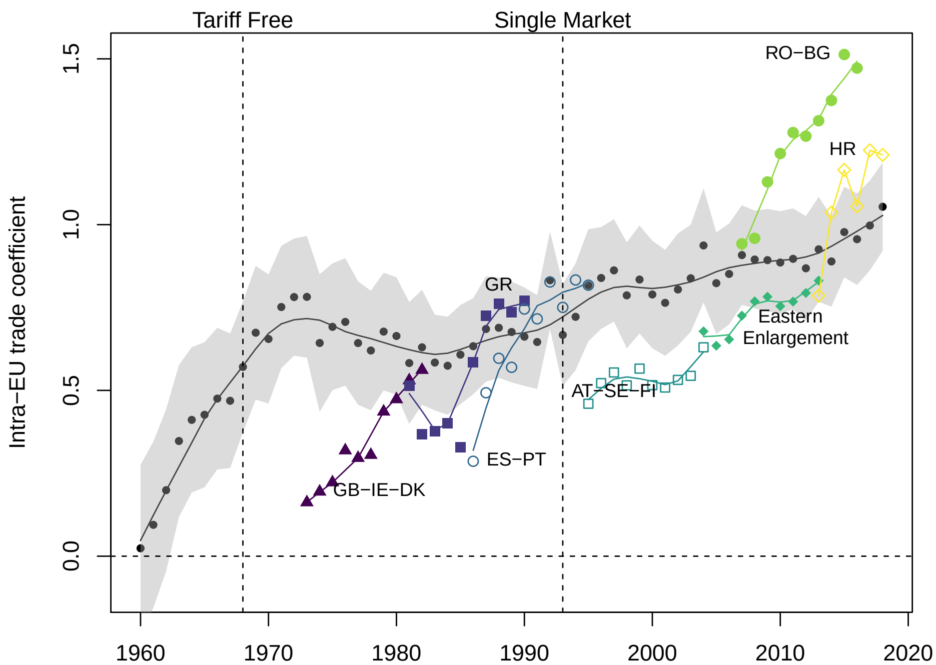



Figure C.1 plots the time-varying EU coefficient and its confidence interval starting in 1960, from a standard structural gravity estimation (i.e. not including trade internal to nations). The plot also includes ten years of post-accession coefficients for groups of countries that entered the EU since 1973. This is an updated version of figure 2 in Mayer et al. (2019). The dashed vertical line in 1968 shows the point at which tariffs ceased to be collected on intra-EU trade. We see in the years leading up to this and in the first few years afterwards, the EU appears to make rapid progress towards integration. The EU effect stops rising in the early 1970s and progress does not resume until the early 1990s when the Single Market Programme is fully implemented. The continued progress after 1992 in goods integration seen in figure C.1 depends on the specification of the left-hand side variable. Here we use trade shares $X_{nit}/X_{nt}$; appendix figure C.2, based on a specification with $X_{nit}$ as the dependent variable, shows EU effects for the original six members remaining very stable.[6] A robust finding across both specifications is that the

[6]Head and Mayer (2014) explain that such differences are the consequence of different weightings in the

new entrants (from the UK in 1973 to Croatia in 2013) make rapid integration gains in the years following accession. This echoes the pattern of integration progress depicted for the original members, suggesting that it takes roughly 10 years to reap the bulk of the benefits of EU integration.

Figure C.2: Intra-EU gravity coefficients for trade in goods - levels

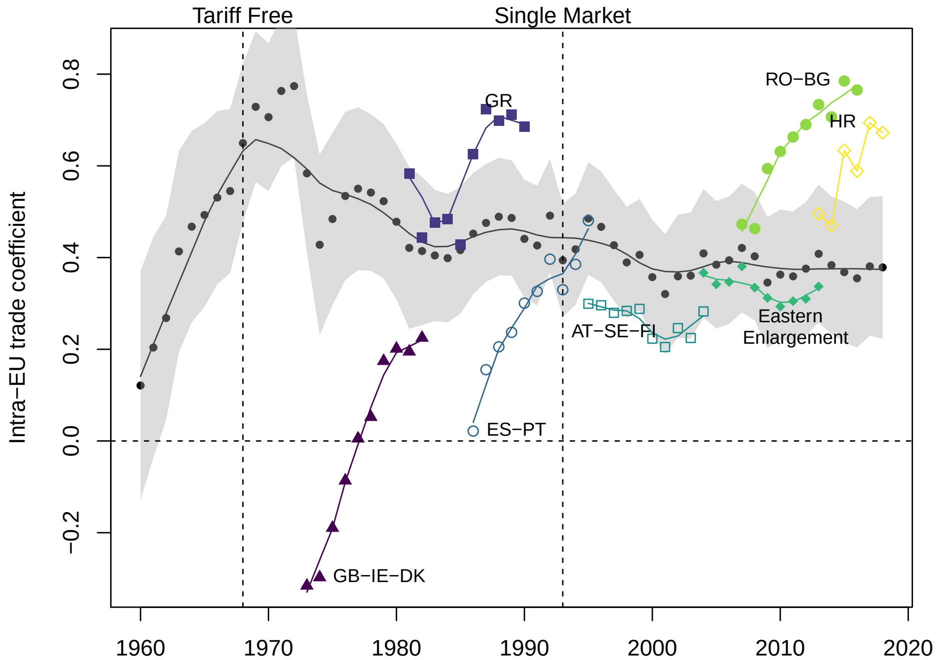



Figure figure C.3 contains the regression coefficients needed to compute the ad-valorem equivalents of figure 1 in the main text, with same color codes: blue is the intra-EU level of integration, red is EU imports from third countries, and black is all imports of non-EU countries The black line in figure C.3 replicates the coefficient from figure C.1.[7] The purple coefficients is the simple difference between blue and red, and corresponds to the supplement of trade integration taking place inside the EU. It therefore corresponds to the same comparison as the standard gravity estimates in the black line, and tracks it quite closely.[8] As for the standard gravity results, we find that the time pattern of those purple and black points are flatter when trade is expressed in levels (figure C.4) than when expressed in expenditure shares (figure C.3). The decomposition made possible by the use of internal flows however is interesting. It reveals that the EU to EU progress is steady in both cases, but that the difference in results comes from a steeper substitution of domestic towards ROW goods when measured in levels.

Table C.1 provides the other coefficients from the regressions used in the figures C.1 and C.3) in columns 3 (not using internal flows) and 4 (using internal flows) respectively.

objective function according to flow size. The levels specification puts greater weight on larger flows.

[7]To avoid cluttering figure C.3, the black line comes from the same regression as in figure C.1, but run without the set of EU accession dummies.

[8]The fact that purple and black points are not identical comes from differences in the other estimated coefficients in the two regressions.

Figure C.3: Evaluating EU with border effect coefficients for trade in goods - shares

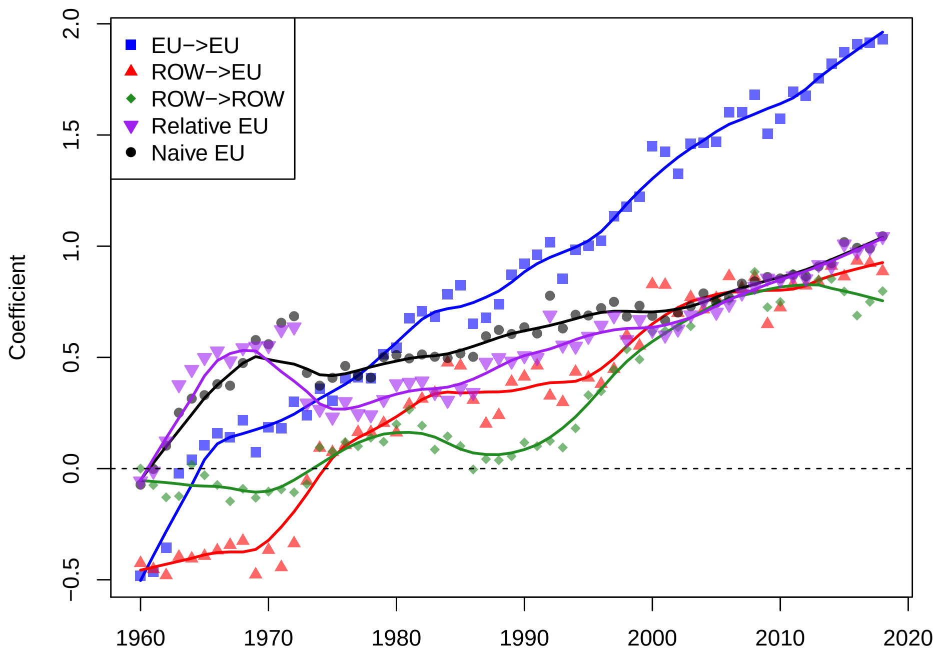



Figure C.4: Evaluating EU with border effect coefficients for trade in goods - levels

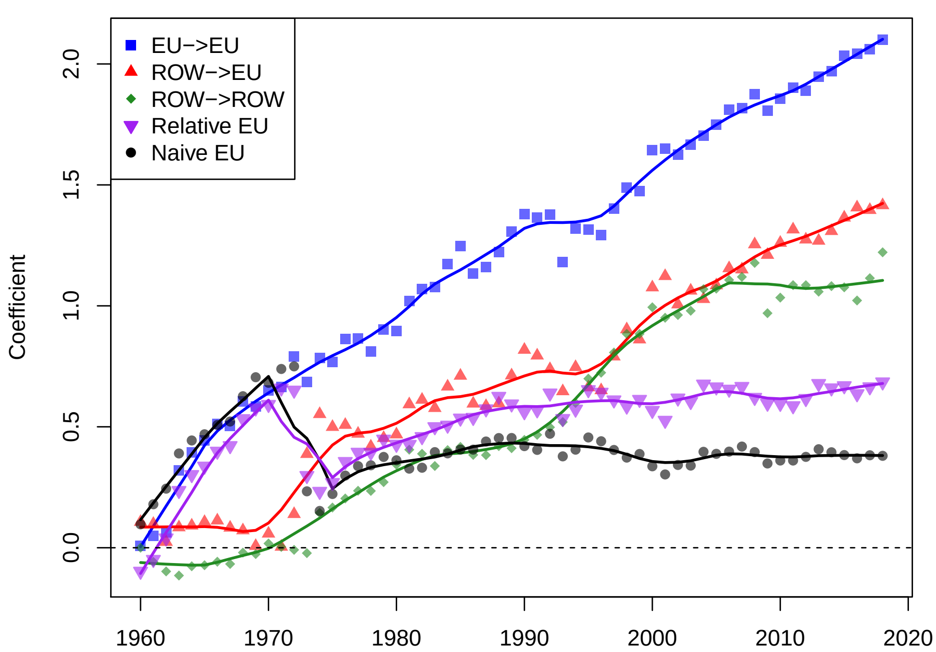


Table C.1: Gravity in goods coefficients - shares

| Model: | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| EC/EU | $0.732^a$ | | | |
| | (0.047) | | | |
| Border EU ($i \neq n$, $i, n \in$ EU) | | $1.42^a$ | | |
| | | (0.055) | | |
| Border ROWEU ($i \neq n$, $n \in$ EU) | | $0.492^a$ | | |
| | | (0.066) | | |
| Both GATT/WTO | $0.134^a$ | $0.455^a$ | $0.151^a$ | $0.233^a$ |
| | (0.039) | (0.036) | (0.039) | (0.035) |
| FTA | $0.098^a$ | $0.346^a$ | $0.108^a$ | $0.181^a$ |
| | (0.024) | (0.031) | (0.024) | (0.032) |
| EEE | $0.369^a$ | $0.641^a$ | $0.425^a$ | $0.263^a$ |
| | (0.069) | (0.071) | (0.071) | (0.085) |
| EU-CHE | 0.081 | $0.946^a$ | $0.178^c$ | $0.571^a$ |
| | (0.089) | (0.200) | (0.091) | (0.139) |
| EU-TUR | $0.269^b$ | $1.41^a$ | $0.335^a$ | $1.09^a$ |
| | (0.124) | (0.150) | (0.123) | (0.116) |
| Observations | 1,108,846 | 1,116,608 | 1,108,846 | 1,116,608 |

Note: Dependent variable is the share of expenditure of $n$ spent on $i$ goods (in value). Method is PPML with origin and destination fixed effects in each regression. Standard errors in (), significance levels: 1% ($a$), 5% ($b$), and 10% ($c$).

Columns 1 and 2 follow the same logic, but with simple EU dummies (not interacted with time). We find consistently positive and significant effects for GATT/WTO effects, as well as for the dummy for regional agreements other than EU and for the major agreements that the EU has with its neighbors. A noticeable effect of introducing internal trade is to increase the effect of all those agreements. This pattern is replicated when considering levels in Table C.2. A difference is the absence of effect of WTO and other FTAs when using PPML in levels without internal trade, a pattern already present in Mayer et al. (2019).

Table C.2: Gravity in goods coefficients - levels

| Model: | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| EC/EU | $0.391^a$ | | | |
| | (0.054) | | | |
| Border EU ($i \neq n$, $i, n \in$ EU) | | $1.69^a$ | | |
| | | (0.069) | | |
| Border ROWEU ($i \neq n$, $n \in$ EU) | | $0.835^a$ | | |
| | | (0.082) | | |
| Both GATT/WTO | -0.072 | $0.560^a$ | -0.074 | $0.250^a$ |
| | (0.066) | (0.054) | (0.066) | (0.047) |
| FTA | 0.008 | $0.448^a$ | 0.006 | $0.192^a$ |
| | (0.050) | (0.062) | (0.050) | (0.047) |
| EEE | $0.196^b$ | $0.659^a$ | $0.189^b$ | 0.059 |
| | (0.086) | (0.080) | (0.090) | (0.078) |
| EU-CHE | $-0.242^b$ | $1.05^a$ | $-0.250^b$ | $0.488^a$ |
| | (0.116) | (0.221) | (0.122) | (0.157) |
| EU-TUR | 0.159 | $1.13^a$ | 0.147 | $0.730^a$ |
| | (0.098) | (0.084) | (0.101) | (0.082) |
| Observations | 1,108,854 | 1,116,616 | 1,108,854 | 1,116,616 |

Note: Dependent variable is the flow of goods (in value). Method is PPML with origin and destination fixed effects in each regression. Standard errors in (), significance levels: 1% ($a$), 5% ($b$), and 10% ($c$).

## C.1 Additional results, EU/US comparison, goods

Table C.3 reports results of the regressions underlying the first row of Table 1 in the main text that compares EU to US integration. The first striking result in that table is that the effect of distance is very similar for both regions. The picture is different for border effects though. In 1997, crossing one of the EU15 national borders reduces trade by 74%, when the figure for the USA was "only" 50%. Twenty years later, for the same set of countries, we estimate a EU15 border impediment of 52% (47% for all 28 members in 2017), and a US state border effect of 45%. Past work shows that the absolute levels of state border effects should be taken with caution. The first caveat to this cross-sectional analysis is that it is sensitive to the measure of distance (unlike the panel regressions where dyadic fixed effects subsume distance). There are biases that lead to overestimation of internal distances relative to state to state distances (see Hillberry and Hummels (2003), Head and Mayer (2010), and Hinz (2017)). Table C.4 reports supplementary regressions using different distance measures, including the actual distance measure preferred by Hillberry and Hummels (2003).

The second caveat, also from Hillberry and Hummels (2003), is that the absolute level of the US states' border effects are biased upwards due to the behavior of wholesale trade. A third concern is that the data collection procedure for CFS is quite different from international trade.

Table C.3: Border effects: EU vs US

| Region | EU15 | US50 | EU15 | EU28 | US50 |
|---|---|---|---|---|---|
| Year | 1997 | 1997 | 2017 | 2017 | 2017 |
| Model: | (1) | (2) | (3) | (4) | (5) |
| Border ($i \neq n$ ) | -0.865$^a$ | -0.545$^a$ | -0.593$^b$ | -0.382 | -0.463$^a$ |
| | (0.278) | (0.102) | (0.248) | (0.254) | (0.120) |
| $\ln$(CES distance) | -1.1$^a$ | -1.05$^a$ | -1.06$^a$ | -1.19$^a$ | -1.16$^a$ |
| | (0.102) | (0.054) | (0.109) | (0.105) | (0.059) |
| Common language | 0.667$^a$ | | 0.404$^b$ | 0.588$^b$ | |
| | (0.100) | | (0.184) | (0.262) | |
| Tariff equivalent of border | 18.76 | 11.44 | 12.5 | 7.9 | 9.64 |
| Observations | 225 | 2,181 | 222 | 779 | 2,285 |

Note: Dependent variable is the share of $i$ of total expenditure of $n$. Method is PPML with origin and destination fixed effects in each regression. Standard errors in (), significance levels: 1% ($a$), 5% ($b$), and 10% ($c$).

Table C.4: Border effects: EU vs US, alternative distance measures

| Region | EU15 | US50 | EU28 | US50 | EU28 | US50 | US50 |
|---|---|---|---|---|---|---|---|
| Year | 1997 | 1997 | 2017 | 2017 | 2017 | 2017 | 2017 |
| Model: | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| Border ($i \neq n$ ) | -1.62$^a$ | -1.21$^a$ | -0.902$^a$ | -1.2$^a$ | -0.467$^b$ | -0.637$^a$ | -0.168 |
| | (0.242) | (0.089) | (0.201) | (0.109) | (0.225) | (0.103) | (0.108) |
| ln(AVG distance) | -1.19$^a$ | -1.2$^a$ | -1.48$^a$ | -1.32$^a$ | | | |
| | (0.092) | (0.067) | (0.093) | (0.076) | | | |
| ln(Hinz distance) | | | | | -1.39$^a$ | -1.23$^a$ | |
| | | | | | (0.082) | (0.061) | |
| ln(actual distance) | | | | | | | -1.23$^a$ |
| | | | | | | | (0.049) |
| Common language | 0.871$^a$ | | 0.444$^c$ | | 0.238 | | |
| | (0.177) | | (0.229) | | (0.237) | | |
| Observations | 225 | 2,181 | 779 | 2,285 | 779 | 2,285 | 2,285 |

Note: Dependent variable is the shares of $n$ expenditure spent on goods form $i$. Method is PPML with origin and destination fixed effects in each regression. Standard errors in (), significance levels: 1% ($a$), 5% ($b$), and 10% ($c$).

Table C.5: Border effects: EU vs US - levels

| Region | EU15 | US50 | EU15 | EU28 | US50 |
|---|---|---|---|---|---|
| Year | 1997 | 1997 | 2017 | 2017 | 2017 |
| Model: | (1) | (2) | (3) | (4) | (5) |
| Border ($i \neq n$ ) | -1.33$^a$ | -0.698$^a$ | -0.840$^a$ | -0.655$^a$ | -0.596$^a$ |
| | (0.204) | (0.100) | (0.141) | (0.167) | (0.125) |
| ln(CES distance) | -0.892$^a$ | -0.858$^a$ | -0.907$^a$ | -1.01$^a$ | -0.986$^a$ |
| | (0.055) | (0.074) | (0.042) | (0.037) | (0.079) |
| Common language | 0.674$^a$ | | 0.365 | 0.329 | |
| | (0.058) | | (0.236) | (0.233) | |
| Tariff equivalent of border | 30.23 | 14.88 | 18.18 | 13.9 | 12.59 |
| Observations | 225 | 2,181 | 222 | 779 | 2,285 |

Note: Dependent variable is the level of $i$'s export to $n$. Method is PPML with origin and destination fixed effects in each regression. Standard errors in (), significance levels: 1% ($a$), 5% ($b$), and 10% ($c$).

Table C.6: Border effects: EU vs US, alternative distance measures - levels

| Region | EU15 | US50 | EU28 | US50 | EU28 | US50 | US50 |
|---|---|---|---|---|---|---|---|
| Year | 1997 | 1997 | 2017 | 2017 | 2017 | 2017 | 2017 |
| Model: | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| Border ($i \neq n$ ) | -1.94$^{a}$ | -1.25$^{a}$ | -1.14$^{a}$ | -1.25$^{a}$ | -0.838$^{a}$ | -0.807$^{a}$ | -0.210$^{b}$ |
| | (0.181) | (0.070) | (0.183) | (0.096) | (0.172) | (0.120) | (0.102) |
| $\ln$(AVG distance) | -0.992$^{a}$ | -1.01$^{a}$ | -1.27$^{a}$ | -1.14$^{a}$ | | | |
| | (0.087) | (0.088) | (0.053) | (0.096) | | | |
| $\ln$(Hinz distance) | | | | | -1.16$^{a}$ | -1.06$^{a}$ | |
| | | | | | (0.053) | (0.091) | |
| $\ln$(actual distance) | | | | | | | -1.13$^{a}$ |
| | | | | | | | (0.059) |
| Common language | 0.902$^{a}$ | | 0.269 | | 0.104 | | |
| | (0.152) | | (0.237) | | (0.229) | | |
| Observations | 225 | 2,181 | 779 | 2,285 | 779 | 2,285 | 2,285 |

Note: Dependent variable is the flow of goods (in value). Method is PPML with origin and destination fixed effects in each regression. Standard errors in (), significance levels: 1% ($a$), 5% ($b$), and 10% ($c$).

# D Gravity migration regressions

## D.1 Gravity migration coefficients

Figure D.1: Intra-EU gravity coefficients for migration

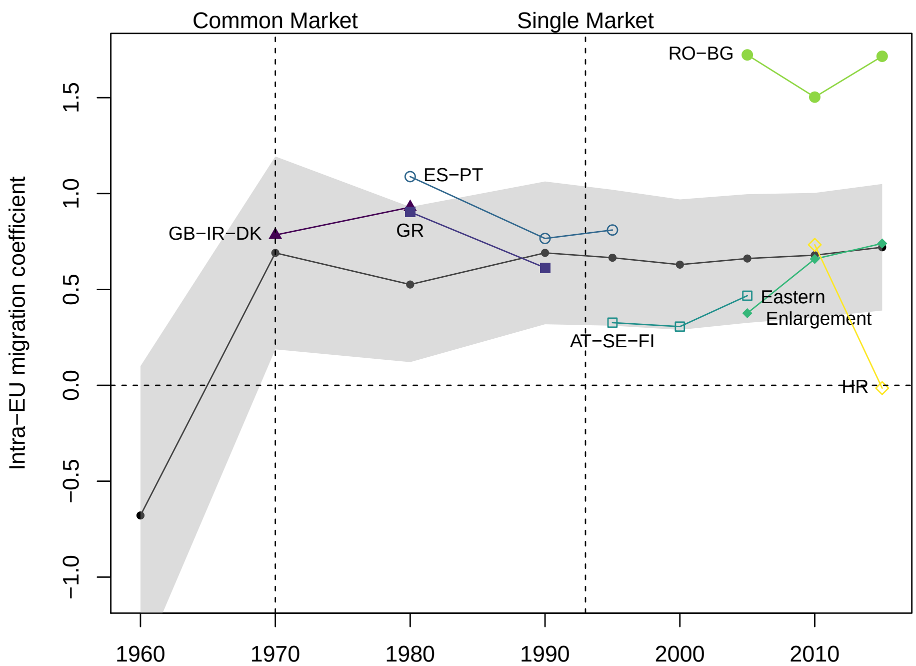


Figure D.2: Evaluating EU with border effect coefficients for migration

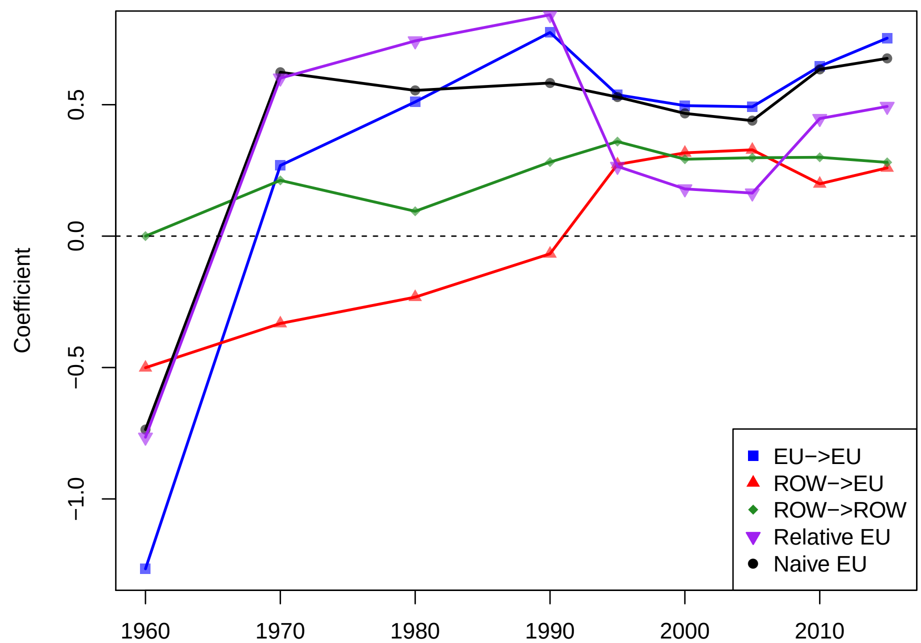



Table D.1: Gravity in migration coefficients

| Model: | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| EC/EU | 0.535[a] | | | |
| | (0.089) | | | |
| Border EU ($i \neq n$, $i, n \in$ EU) | | 0.453[a] | | |
| | | (0.113) | | |
| Border ROWEU ($i \neq n$, $n \in$ EU) | | -0.020 | | |
| | | (0.142) | | |
| Both GATT/WTO | 0.210[a] | 0.268[a] | 0.231[a] | 0.190[a] |
| | (0.060) | (0.053) | (0.059) | (0.053) |
| FTA | -0.124[a] | 0.014 | -0.115[a] | -0.047 |
| | (0.040) | (0.048) | (0.040) | (0.059) |
| EEE | 0.452[b] | 0.722[a] | 0.474[b] | 0.555[a] |
| | (0.188) | (0.152) | (0.189) | (0.170) |
| EU-CHE | 0.114 | 0.533[a] | 0.158 | 0.396[b] |
| | (0.153) | (0.151) | (0.155) | (0.165) |
| EU-TUR | 0.111 | 0.135 | 0.149 | 0.042 |
| | (0.242) | (0.177) | (0.241) | (0.181) |
| Observations | 171,130 | 172,921 | 171,130 | 172,921 |

Note: Dependent variable is the share of people born in each origin country that allocates to each destination. Method is PPML with origin and destination fixed effects in each regression. Standard errors in (), significance levels: 1% ($a$), 5% ($b$), and 10% ($c$).

Table D.2: Border effects for migration: EU vs US

| Region | EU15 | US50 | EU15 | EU28 | US50 |
|---|---|---|---|---|---|
| Year | 2000 | 2000 | 2015 | 2015 | 2015 |
| Model: | (1) | (2) | (3) | (4) | (5) |
| Border ($i \neq n$ ) | -5.18$^{a}$ | -1.96$^{a}$ | -5.18$^{a}$ | -4.91$^{a}$ | -2.07$^{a}$ |
| | (0.578) | (0.075) | (0.459) | (0.366) | (0.079) |
| $\ln$(CES distance) | -0.877$^{a}$ | -0.992$^{a}$ | -0.617$^{a}$ | -0.926$^{a}$ | -0.954$^{a}$ |
| | (0.310) | (0.026) | (0.217) | (0.167) | (0.027) |
| Common language | 1.49$^{a}$ | | 1.39$^{a}$ | 1.69$^{a}$ | |
| | (0.217) | | (0.225) | (0.224) | |
| Tax equivalent of border | 95.84 | 69.94 | 95.84 | 95.07 | 71.93 |
| Observations | 225 | 2,500 | 225 | 764 | 2,500 |

Note: Dependent variable is the share of destination $n$ in the stock of people born in $i$. Method is PPML with origin and destination fixed effects in each regression. Standard errors in (), significance levels: 1% ($a$), 5% ($b$), and 10% ($c$).

## D.2 Results using flows instead of shares

Figure D.3: Intra-EU gravity coefficients for migration

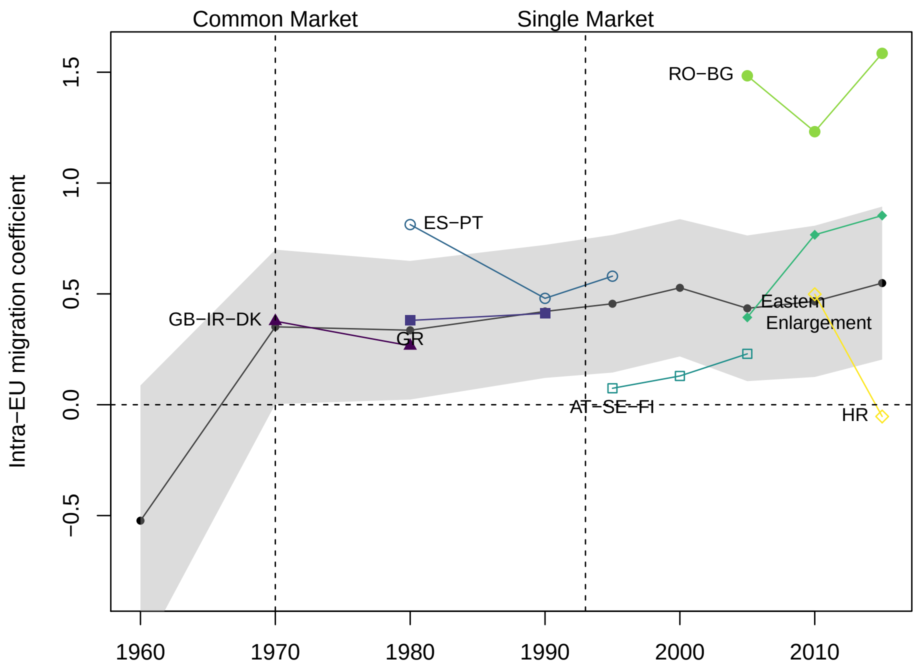


Figure D.4: Evaluating EU with border effect coefficients for migration

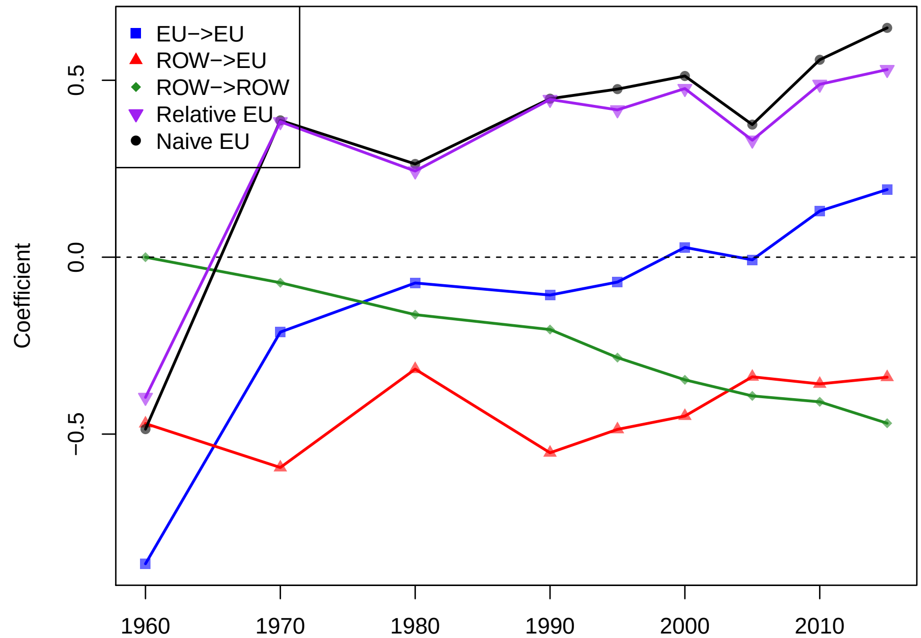



Table D.3: Border effects for migration: EU vs US

| Region | EU15 | US50 | EU15 | EU28 | US50 |
|---|---|---|---|---|---|
| Year | 1997 | 1997 | 2017 | 2017 | 2017 |
| Model: | (1) | (2) | (3) | (4) | (5) |
| Border ($i \neq n$ ) | -5.01[a] | -2.27[a] | -4.97[a] | -4.72[a] | -2.32[a] |
| | (0.386) | (0.091) | (0.276) | (0.302) | (0.091) |
| ln(CES distance) | -0.719[a] | -0.813[a] | -0.541[a] | -0.800[a] | -0.784[a] |
| | (0.199) | (0.033) | (0.132) | (0.136) | (0.032) |
| Common language | 1.04[a] | | 1.04[a] | 1.22[a] | |
| | (0.289) | | (0.274) | (0.280) | |
| Tax equivalent of border | 95.38 | 75.18 | 95.25 | 94.48 | 75.98 |
| Observations | 225 | 2,500 | 225 | 764 | 2,500 |

Note: Dependent variable is the bilateral number of migrants. Method is PPML with origin and destination fixed effects in each regression. Standard errors in (), significance levels: 1% ($a$), 5% ($b$), and 10% ($c$).

# E Gravity services regressions

Figure E.1: Evaluating EU with border effect coefficients for services

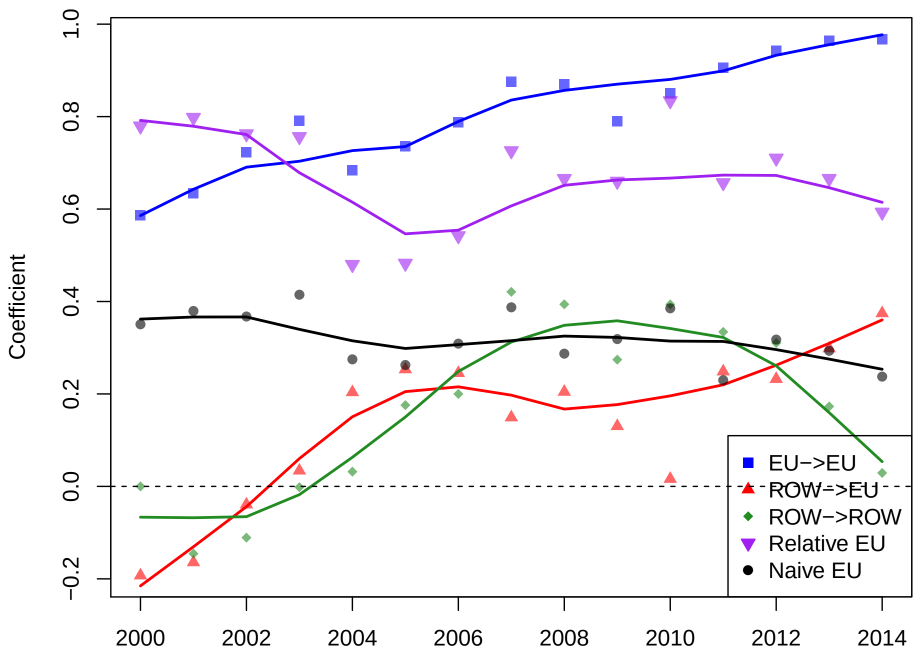


Table E.1: Gravity in services coefficients

| Model: | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| EC/EU | 0.352$^a$ | | | |
| | (0.127) | | | |
| Border EU ($i \neq n$, $i, n \in$ EU) | | 0.979$^a$ | | |
| | | (0.092) | | |
| Border ROWEU ($i \neq n$, $n \in$ EU) | | 0.087 | | |
| | | (0.224) | | |
| Both GATT/WTO | 0.301 | 0.144$^b$ | 0.296 | 0.039 |
| | (0.225) | (0.062) | (0.229) | (0.063) |
| FTA | 0.072 | 0.442$^a$ | 0.075 | 0.393$^a$ |
| | (0.083) | (0.148) | (0.084) | (0.143) |
| EEE | 0.408$^c$ | 1.21$^a$ | 0.410$^c$ | 0.910$^a$ |
| | (0.234) | (0.256) | (0.235) | (0.250) |
| EU-CHE | -0.017 | 0.394$^b$ | -0.024 | 0.100 |
| | (0.140) | (0.171) | (0.145) | (0.166) |
| EU-TUR | -1.12$^a$ | -1.16$^a$ | -1.13$^a$ | -1.47$^a$ |
| | (0.279) | (0.315) | (0.278) | (0.303) |
| Observations | 27,090 | 27,735 | 27,090 | 27,735 |

Note: Dependent variable is the share of the origin country in the total expenditure of destination. Method is PPML with origin-time, destination-time and dyadic fixed effects in each regression. Standard errors in (), significance levels: 1% ($a$), 5% ($b$), and 10% ($c$).

# F Gravity M&A regressions

Table F.1: Border effects: EU vs US

| Region | EU15 | US50 | EU15 | EU28 | US50 |
|---|---|---|---|---|---|
| Year | 1995–8 | 1995–8 | 2015–8 | 2015–8 | 2015–8 |
| Model: | (1) | (2) | (3) | (4) | (5) |
| Border ($i \neq n$ ) | -1.35$^{b}$ | -0.792$^{b}$ | -0.314 | -1.18$^{a}$ | -1.51$^{a}$ |
| | (0.594) | (0.332) | (0.533) | (0.370) | (0.353) |
| $\ln$(CES distance) | -1.13$^{a}$ | -0.586$^{a}$ | -1.23$^{a}$ | -1.19$^{a}$ | -0.349$^{a}$ |
| | (0.242) | (0.094) | (0.210) | (0.143) | (0.087) |
| Common language | 0.495 | | 0.219 | 0.647$^{c}$ | |
| | (0.562) | | (0.368) | (0.350) | |
| Tax equivalent of border | 29.54 | 18.54 | 7.81 | 26.35 | 32.27 |
| Observations | 225 | 2,500 | 225 | 784 | 2,500 |

Note: Dependent variable is the share of $i$ as purchaser of total transactions of $n$. Method is PPML with origin and destination fixed effects in each regression. Standard errors in (), significance levels: 1% ($a$), 5% ($b$), and 10% ($c$).

Table F.2: Border effects: EU vs US

| Region | EU15 | US50 | EU15 | EU28 | US50 |
|---|---|---|---|---|---|
| Year | 1995–8 | 1995–8 | 2015–8 | 2015–8 | 2015–8 |
| Model: | (1) | (2) | (3) | (4) | (5) |
| Border ($i \neq n$ ) | -1.28$^a$ | -1.24$^a$ | -2.01$^a$ | -2.56$^a$ | -1.48$^a$ |
| | (0.318) | (0.119) | (0.294) | (0.253) | (0.124) |
| $\ln$(CES distance) | -1.07$^a$ | -0.552$^a$ | -0.781$^a$ | -0.711$^a$ | -0.507$^a$ |
| | (0.150) | (0.028) | (0.121) | (0.099) | (0.030) |
| Common language | 0.561$^a$ | | 0.968$^a$ | 1.49$^a$ | |
| | (0.178) | | (0.144) | (0.157) | |
| Tax equivalent of border | 28.29 | 27.52 | 40.59 | 48.48 | 31.78 |
| Observations | 225 | 2,500 | 225 | 784 | 2,500 |

Note: Dependent variable is the share of $i$ as purchaser of total transaction counts of $n$. Method is PPML with origin and destination fixed effects in each regression. Standard errors in (), significance levels: 1% ($a$), 5% ($b$), and 10% ($c$).

# G Gravity capital regressions

Figure G.1: Evaluating EU with border effect coefficients for capital

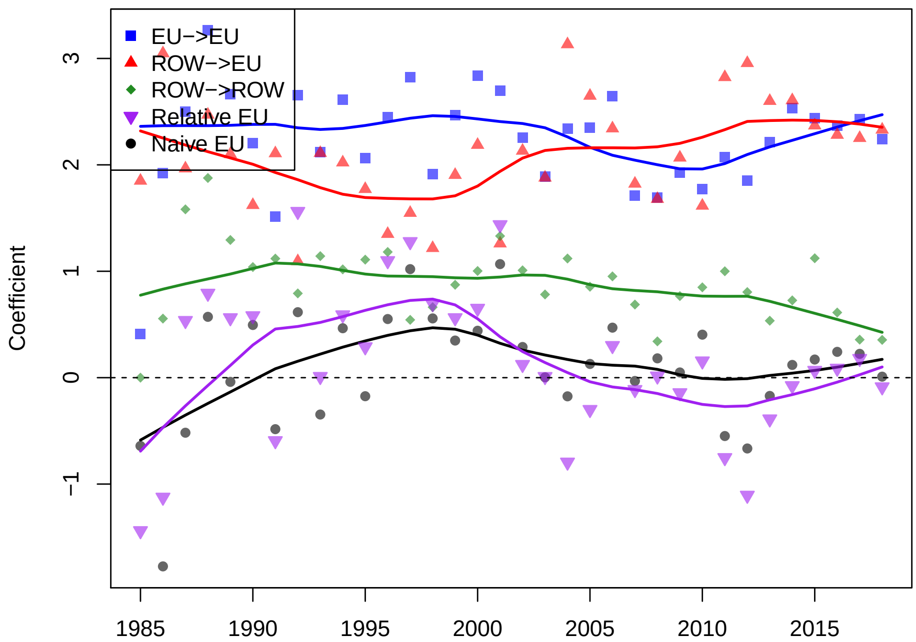


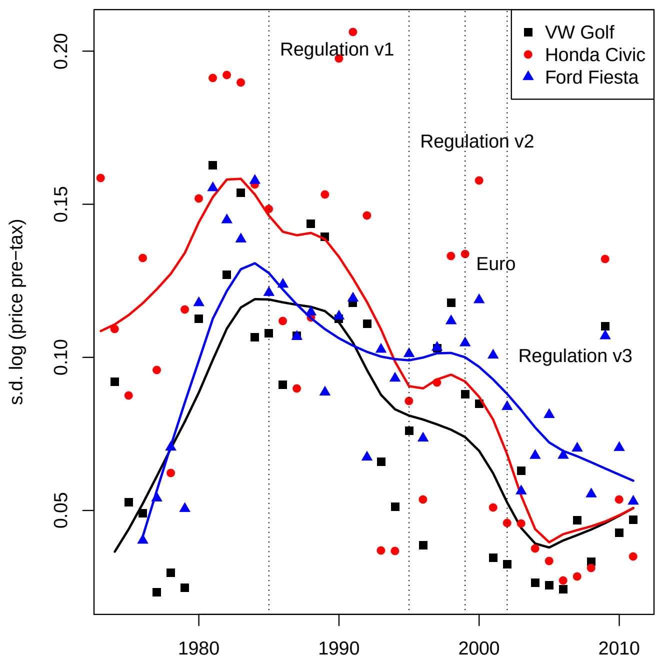
Table G.1: Gravity in capital coefficients - value shares

| Model: | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| EC/EU | 0.149 | | | |
| | (0.238) | | | |
| Border EU ($i \neq n, i, n \in$ EU) | | $1.25^a$ | | |
| | | (0.276) | | |
| Border ROWEU ($i \neq n, n \in$ EU) | | $1.04^a$ | | |
| | | (0.347) | | |
| Both GATT/WTO | 0.865 | $-0.560^a$ | 0.832 | $-0.495^b$ |
| | (0.610) | (0.209) | (0.610) | (0.208) |
| FTA | 0.116 | 0.083 | 0.097 | 0.106 |
| | (0.118) | (0.118) | (0.118) | (0.118) |
| EEE | 0.046 | -0.348 | 0.075 | -0.256 |
| | (0.489) | (0.400) | (0.490) | (0.384) |
| EU-CHE | -0.351 | $-0.659^b$ | -0.511 | $-0.793^a$ |
| | (0.298) | (0.258) | (0.312) | (0.269) |
| EU-TUR | $-0.971^c$ | $-1.67^b$ | $-1.07^b$ | $-2.02^a$ |
| | (0.518) | (0.658) | (0.527) | (0.604) |
| Observations | 17,908 | 19,788 | 17,908 | 19,788 |

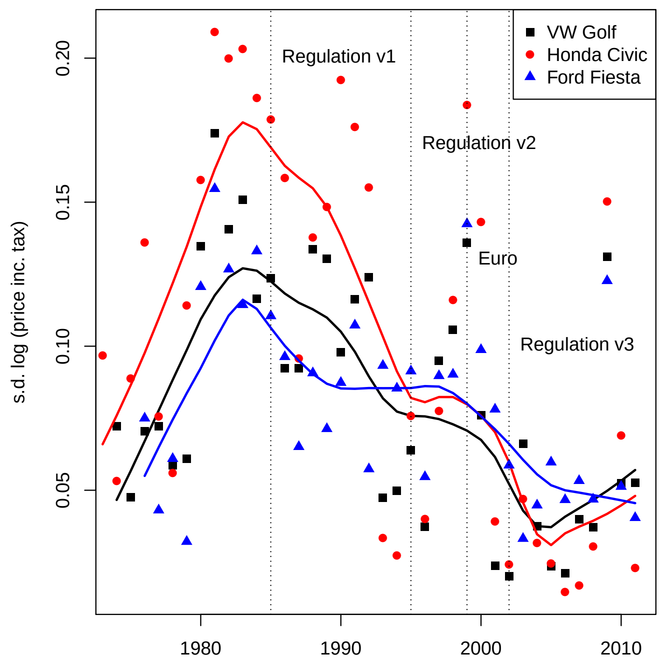
Note: Dependent variable is the share of bilateral transactions with the total in the destination being the denominator. Method is PPML with origin-time, destination-time and dyadic fixed effects in each regression. The EU and ROW coefficients in columns (3) and (4) are diplayed in figures (G.1) and (**??**). Standard errors in (), significance levels: 1% ($a$), 5% ($b$), and 10% ($c$).

# H Price dispersion graphs

Figure H.1: Car price differentials (model level, big 5)

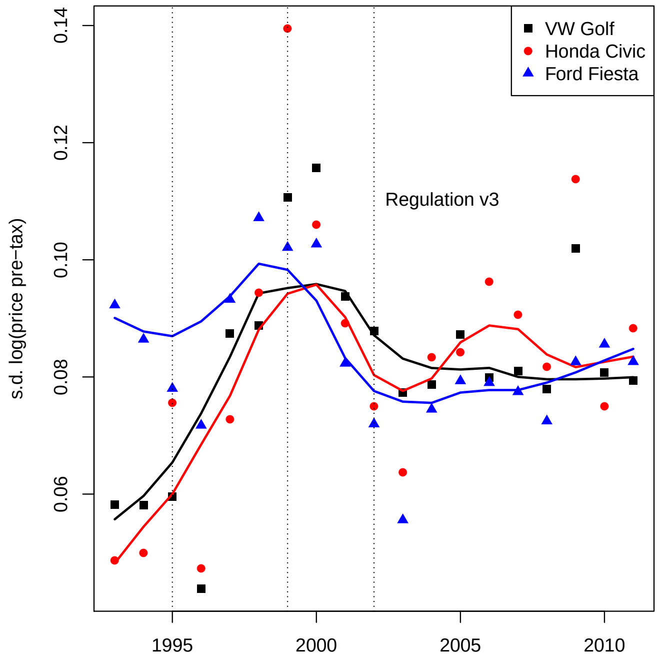



(a) Excluding tax

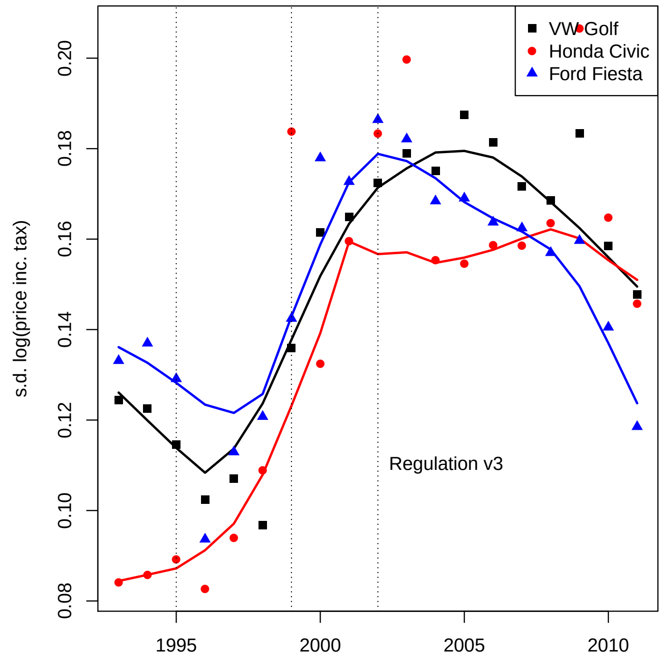



(b) Including tax

Figure H.2: Car price differentials (model level, EU15)

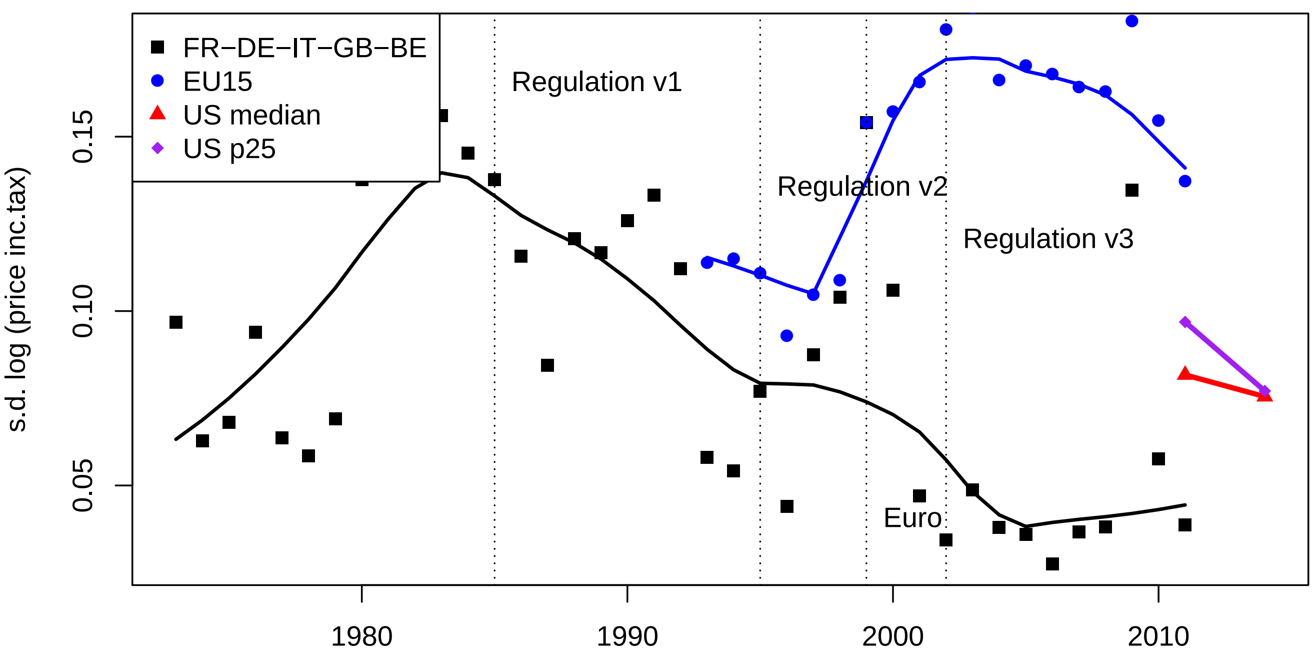



(a) Excluding tax




(b) Including tax

Figure H.3: Car price differentials



# References


Ahern, K. R., D. Daminelli, and C. Fracassi (2015). Lost in translation? The effect of cultural values on mergers around the world. *Journal of Financial Economics 117*(1), 165–189.

Akcigit, U., S. Baslandze, and S. Stantcheva (2016, October). Taxation and the international mobility of inventors. *American Economic Review 106*(10), 2930–81.

Arkolakis, C., A. Costinot, and A. Rodriguez-Clare (2012). New trade models, same old gains? *American Economic Review 102*(1), 94–130.

Bryan, G. and M. Morten (2019). The aggregate productivity effects of internal migration: Evidence from indonesia. *Journal of Political Economy 127*(5), 2229–2268.

Bureau of Transportation Statistics (1997). Commodity Flow Survey. `https://www.bts.gov/archive/publications/commodity_flow_survey/1997/states/index`. Accessed: 2001-08-15.

Bureau of Transportation Statistics (2017). Geographic Area Series: Shipment Characteristics by Origin Geography by Destination Geography. `https://www.census.gov/data/tables/2017/econ/cfs/aff-2017.html` Series #CF1700A20. Accessed: 2020-08-05.

Caliendo, L., F. Parro, L. D. Opromolla, and A. Sforza (2020). Goods and factor market integration: A quantitative assessment of the eu enlargement.

Costinot, A. and A. Rodriguez-Clare (2014). Trade theory with numbers: Quantifying the consequences of globalization. In E. Helpman (Ed.), *Handbook of international economics*, Volume 4. Elsevier.

Eaton, J. and S. Kortum (2002). Technology, geography, and trade. *Econometrica 70*(5), 1741–1779.

Erel, I., R. C. Liao, and M. S. Weisbach (2012). Determinants of cross-border mergers and acquisitions. *The Journal of Finance 67*(3), 1045–1082.

Fajgelbaum, P. D., E. Morales, J. C. Suárez Serrato, and O. Zidar (2018, 09). State Taxes and Spatial Misallocation. *The Review of Economic Studies 86*(1), 333–376.

Feenstra, R. C., R. Inklaar, and M. P. Timmer (2015). The next generation of the penn world table. *American Economic Review 105*(10), 3150–3182.

Goldberg, P. K. and F. Verboven (2005). Market integration and convergence to the law of one price: evidence from the European car market. *Journal of international Economics 65*(1), 49–73.

Head, C. K. (2021, Apr). ckhead/headr: Headr free4.

Head, K. and T. Mayer (2010). Illusory border effects: Distance mismeasurement inflates estimates of home bias in trade. In S. Brakman and van Bergeijk (Eds.), *The gravity model in international trade: Advances and applications*. Cambridge University Press.

Head, K. and T. Mayer (2014). Gravity equations: Workhorse,toolkit, and cookbook. In G. Gopinath, E. Helpman, and K. Rogoff (Eds.), *Handbook of international economics*, Volume 4, pp. 131–196. Elsevier.

Head, K. and T. Mayer (2021). Data and code for: The United States of Europe: A gravity model evaluation of the four freedoms. Inter-university Consortium for Political and Social Research [distributor], DOI: `http://doi.org/10.3886/E133281V1`.

Head, K., T. Mayer, and J. Ries (2009). How remote is the offshoring threat? *European Economic Review 53*(4), 429–444.

Hillberry, R. and D. Hummels (2003). Intranational home bias: Some explanations. *Review of Economics and Statistics 85*(4), 1089–1092.

Hinz, J. (2017). The view from space: Theory-based time-varying distances in the gravity model. Kiel Working Paper 2059, Kiel Institute for the World Economy.

International Monetary Fund (2020). The Direction of Trade Statistics. `https://data.imf.org/?sk=388DFA60-1D26-4ADE-B505-A05A558D9A42&sId=1479329334655`. Accessed: 2020-04-01.

Kleven, H. J., C. Landais, and E. Saez (2013, August). Taxation and international migration of superstars: Evidence from the European football market. *American Economic Review 103*(5), 1892–1924.

Kleven, H. J., C. Landais, E. Saez, and E. Schultz (2014, 12). Migration and wage effects of taxing top earners: Evidence from the foreigners' tax scheme in Denmark. *The Quarterly Journal of Economics 129*(1), 333–378.

Mayer, T., V. Vicard, and S. Zignago (2019, 05). The cost of non-Europe, revisited*. *Economic Policy 34*(98), 145–199.

Moretti, E. and D. J. Wilson (2017, July). The effect of state taxes on the geographical location of top earners: Evidence from star scientists. *American Economic Review 107*(7), 1858–1903.

Muñoz, M. (2020). Do European top earners react to labour taxation through migration.

Serdar Dinc, I. and I. Erel (2013). Economic nationalism in mergers and acquisitions. *The Journal of Finance 68*(6), 2471–2514.

Sosvilla-Rivero, S. and S. Gil-Pareja (2012). Convergence in car prices among European countries. *Applied Economics 44*(25), 3247–3254.

Suárez Serrato, J. C. and O. Zidar (2016, September). Who benefits from state corporate tax cuts? a local labor markets approach with heterogeneous firms. *American Economic Review 106*(9), 2582–2624.

Timmer, M. P., E. Dietzenbacher, B. Los, R. Stehrer, and G. J. De Vries (2015). An illustrated user guide to the world input–output database: the case of global automotive production. *Review of International Economics 23*(3), 575–605.

Timmer, M. P., E. Dietzenbacher, B. Los, R. Stehrer, and G. J. De Vries (2016). World Input-Output Database. `http://www.wiod.org/protected3/data16/wiot_ROW/wiot_stata_Nov16.zip`. Accessed: 2017-05-03.

Tombe, T. and X. Zhu (2019). Trade, migration, and productivity: A quantitative analysis of china. *American Economic Review 109*(5), 1843–72.

United Nations (2020a). Comtrade Database. `https://comtrade.un.org/data/`. Accessed: 2020-07-20.

United Nations (2020b). Global Migration Database. `https://www.un.org/en/development/desa/population/migration/data/estimates2/data/UN_MigrantStockByOriginAndDestination_2015.xlsx`. Accessed: 2020-04-24.

United Nations (2020c). National Accounts–Analysis of Main Aggregates . `https://unstats.un.org/unsd/amaapi/api/file/2`. Accessed: 2020-05-16.

U.S. Census Bureau (2000). Decennial Census. `https://www2.census.gov/programs-surveys/demo/tables/geographic-mobility/2000/place-of-birth-decennial/`. Accessed: 2020-04-24.

U.S. Census Bureau (2015). American Community Survey. `https://www2.census.gov/programs-surveys/demo/tables/geographic-mobility/2015/place-of-birth-acs-2015/`. Accessed: 2020-04-24.

World Bank (2020a). Global Bilateral Migration Databank. `https://databank.worldbank.org/source/global-bilateral-migration`. Accessed: 2020-04-25.

World Bank (2020b). World Development Indicators: GDP in current dollars. `http://data.worldbank.org/indicator/NY.GDP.MKTP.CD`. Accessed: 2020-10-05 via WDI package in R.

Zeileis, A. (2019). *pwt9: Penn World Table (Version 9.x)*. R package version 9.1-0.