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Border Effects without Borders

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Border Effects without Borders^{*}

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Abstract

Over the last 20 years the border-effect literature repeatedly documented the trade-reducing effect of inter- and intra-national borders. Thereby, the sheer size and persistence of observed border effects from the beginning raised doubts on the genuine effect of the underlying political borders. However, when so-called “border effects” result either from statistical artefacts or from differences in fundamentals, why should their spatial dimension then inevitably coincide with the geography of present or past political borders? This paper identifies a discontinuous trade reduction along a geographic dimension that neither existing nor defunct political borders can explain. Trade between the East and the West of Japan is 23.1% - 51.3% lower than trade within both country parts. Including a rich set of explanatory variables, suggests that recent agglomeration trends, reflected by the contemporaneous structure of Japan’s business and social networks, rather than cultural differences, shaped by long-lasting historical shocks, can explain the east-west bias in intra-Japanese trade.

JEL-Classification: F14, F15, F12

Keywords: Border effect, gravity equation, intra-national trade, Japan

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1 Introduction

Beginning with the seminal contribution of [McCallum \(1995\)](#), a large and still growing literature on the trade-reducing effects of inter- and intra-national borders has emerged¹. Within the literature three competing explanations for the trade-inhibiting effect of borders in terms of “political barriers”, “statistical artefacts”, or “fundamentals” exist. Thereby, [Wei \(1996\)](#), [Hillberry \(1999\)](#) as well as [Head and Mayer \(2000\)](#) show that the trade reducing effect of international borders can not be explained through tariffs, quotas, exchange rate variability, transaction costs, or regulatory differences. [Chen \(2004\)](#) confirms the irrelevance of non-tariff barriers, but also finds that border effects are increased through technical barriers to trade and product-specific information cost. Alternatively, [Head and Mayer \(2002\)](#) as well as [Hillberry and Hummels \(2008\)](#) show that border effects are inflated by the mismeasurement of internal distances, while the role of aggregation bias in explaining the trade-reducing effect of intra-national borders is highlighted by [Hillberry \(2002\)](#) and [Hillberry and Hummels \(2003, 2008\)](#). Evidence in favour of the “fundamentals” hypothesis is provided by [Combes, Lafourcade, and Mayer \(2005\)](#); [Garmendia, Llano, Minondo, and Requena \(2012\)](#) as well as by [Nitsch and Wolf \(2013\)](#), who stress the importance of business and social networks. The role of cultural affinity and limited trust is highlighted by [Felbermayr and Gröschl \(2014\)](#). Thus, the overall evidence in favour of an explanation in terms of “political barriers” seems fairly limited. However, when political borders are not the main cause behind observed border effects, why should the geography of discontinuous trade barriers then inevitably coincide with the shape of present *or* past political borders?

This paper – to the best of my knowledge – is the first to identify a discrete spatial barrier to trade that is related neither to present nor to past political borders. In particular, it is shown that inter-prefectural trade flows between the East and the West of Japan are by 23.1% to 51.3% lower than comparable trade flows within both country parts. Although this trade reduction may seem moderate compared to a drop in international trade of 80.8%, which [Anderson and van Wincoop \(2003\)](#) report for trade between Canadian provinces and U.S. states, it is substantial and much larger than the persistent reductions of 20.5% or 12.8% in contemporaneous intra-national trade across the former border between the GDR (East-Germany) and the FRG (West-Germany) in [Nitsch and Wolf \(2013\)](#) or across the historical border between the Union and the

¹For evidence on international borders see among others [Wei \(1996\)](#); [Helliwell \(1998\)](#); [Hillberry \(1999\)](#); [Head and Mayer \(2000\)](#); [Nitsch \(2000\)](#); [Anderson and van Wincoop \(2003\)](#) and [Chen \(2004\)](#). Evidence on the intra-national home bias is provided for example by [Wolf \(2000\)](#); [Hillberry and Hummels \(2003\)](#); [Combes, Lafourcade, and Mayer \(2005\)](#); [Millimet and Osang \(2007\)](#) as well as [Yilmazkuday \(2012\)](#), while [Nitsch and Wolf \(2013\)](#) as well as [Felbermayr and Gröschl \(2014\)](#) emphasise the importance of defunct historical borders at the sub-national level.

Confederacy during the American Secession in [Felbermayr and Gröschl \(2014\)](#). The intra-Japanese East-West border effect represents an *ad valorem* tariff equivalent of about 13.4% to 43.4%, and although the average (real) consumption gains from a *hypothetical* elimination of the intra-Japanese East-West border effect would fall into a moderate range from 1.2% to 2.8%, there are substantial distributional consequences associated with such a *counterfactual* scenario: As trade would be diverted away from the periphery and from large trading hubs, prefectures like Hokkaidô, Okinawa, Tôkyô or Ôsaka would lose, while prefectures such as Gifu or Shiga, which are located close to the intra-Japanese East-West “border” would benefit.²

In order to identify *and* explain a *unique* barrier to trade along a specific geographic dimension, that is not predetermine by some existing *or* defunct political border, the analysis proceeds in three steps. At first an intra-Japanese barrier to East-West trade is identified and explored. Guided by the Japanese terms: *Kantô* (関東) and *Kansai* (関西), referring to Japan’s two major agglomeration areas, which – if literally translated – are located in the *east* (東) *tô* or the *west* (西) *sai* of a *barrier* or *toll gate* (関) *kan*, the sample of 47 Japanese prefectures is divided into 23 East and 24 West-Japanese prefectures.³ Already from a visual inspection of Japan’s internal trade integration matrix it becomes clear that average trade integration measured by the Head-Ries Index (cf. [Head and Ries, 2001](#)) is more than five to six times as high within the East or the West than between both country parts. Simple gravity regressions, which additionally account for the trade-inhibiting effect of bilateral transportation cost, confirm this pattern: Without including an East-West “border” dummy bilateral trade flows within the East and the West are underestimated in 61.8% and 61.1% of all cases, while East-West and West-East trade is underestimated in only 32.1% and 35.5% of all constellations. Finally, including an intra-Japanese East-West “border” dummy into a gravity equation with exporter- and importer-specific fixed effects for bilateral trade between prefectures, results in a robust, statistically significant, and economically meaningful intra-Japanese East-West border effect, which is associated with a reduction of 23.1% to 51.3% in East-West trade.

The result is robust to employing alternative methodologies (in particular a PPML-model, cf. [Santos Silva and Tenreyro, 2006, 2010](#)), measuring trade flows either in quantities or in values (cf. [Combes, Lafourcade, and Mayer, 2005](#); [Nitsch and Wolf, 2013](#)), or drawing on sectoral rather than aggregate bilateral trade data (cf. [Chen, 2004](#)). The intra-Japanese East-West

²For the importance of market access for regional development see [Redding and Sturm \(2008\)](#), who exploit the division of Germany after the Second World War and the reunification of East and West Germany in 1990 as a natural experiment.

³The Kantô area includes Japan’s capital Tôkyô as well as Japan’s largest harbour Yokohama. The population in 2010 amounted to 42.6 million people. The Kansai area includes Japans second largest citiy Ôsaka, the former capital Kyôto, and Japan’s second largest harbour Kobe. There was an overall population of 22.7 million people in 2010. Both agglomeration areas together account for almost the half of Japan’s total population.

border effect can be identified across all waves (2000, 2005, 2010) of the National Commodity Flow Survey (NCFS), and when employing the Japanese Commodity Flow Statistic (CFS) as alternative data source, it moreover is possible to identify a slight increase over the decade from 2000 to 2012. The effect tends to be stronger and more robust in secondary sectors (e.g. machinery, chemicals, or manufacturing) than in primary sectors (e.g. agriculture, forest, or minerals). However, when distinguishing between homogeneous and differentiated products (cf. [Rauch, 1999](#)), no systematic correlation between the share of differentiated products and the size of the intra-Japanese East-West border effect can be identified, suggesting that neither local preferences nor limited trust offer a convincing explanation for the East-West border effect. Differentiating between four transport modes (by road, rail, sea and air) moreover reveals that the intra-Japanese East-West border effect can not be attributed to the geographic organisation of Japan’s major railway company.

In a second step it is ensured that the intra-Japanese East-West border effect does not result from statistical artefacts. To verify the intra-Japanese border effect’s unique east-west dimension, several million placebo regressions are conducted. Starting from an allocation with 23 East- and 24 West-Japanese prefectures a step-by-step randomisation of the prefecture samples is associated with gradually declining border effects, which in most cases turn insignificant once the East-West separation of prefectures is sufficiently disintegrated. To see whether alternative prefecture allocations can be associated with “border effects” of comparable or even larger size a simple heuristic search algorithm which aims to maximise the *hypothetical* intra-Japanese border effect is defined. Reassuringly, all local maxima identified by the algorithm closely resemble the baseline east-west allocation and display a clear east-west division. Finally, another million of placebos allows for more than just one *hypothetical* border. Holding the baseline intra-Japanese East-West border fixed, the sub-samples of 23 East- and 24 West-Japanese prefectures are again sub-divided according to a million randomly chosen borderlines. Unlike the intra-Japanese East-West border effect, the *hypothetical* “border effects” within both sub-samples are small and in most cases statistically indistinguishable from zero. Together, all the placebo regressions suggest that there is a *single* intra-Japanese border effect with an *unique* east-west dimension.

To rule out mismeasurement in transportation costs as a potential cause behind the intra-Japanese East-West border effect, alternative transport cost measures are taken into account. Since, the National Commodity Flow Survey (NCFS) provides detailed information on unit transport cost per ton and kilometre the *exact* transportation cost account for both distance-related (i.e. gas, tolls, etc.) and time-related (i.e. salaries, insurance, etc.) expenditures.

Thereby, it makes little difference, whether unit transport cost are multiplied by greater-circle distance, real-road distance (cf. [Ozimek and Miles, 2011](#)), or a population-weighted average over bilateral distances measured at the sub-prefecture level (cf. [Mayer and Zignago, 2011](#)). Finally, the results are also robust to the inclusion of real-road travel time or discrete distance intervals as in [Eaton and Kortum \(2002\)](#).

In search for an explanation of the intra-Japanese East-West border effect, a rich set of (additional) explanatory variables is taken into account in a third and final step. Among others, controls for business (cf. [Combes, Lafourcade, and Mayer, 2005](#)), social (cf. [Head and Ries, 1998](#); [Millimet and Osang, 2007](#)), and coethnic (cf. [Rauch and Trindade, 2002](#)) networks, as well as proxies for bilateral trust (cf. [Guiso, Sapienza, and Zingales, 2009](#)), cultural proximity (cf. [Falck, Heblich, Lameli, and Südekum, 2012](#)), and defunct political borders (cf. [Nitsch and Wolf, 2013](#); [Felbermayr and Gröschl, 2014](#)) are considered. From this comprehensive list two competing explanations in terms of “history” versus “agglomeration” can be identified.

As recently argued by several authors (cf. [Nitsch and Wolf, 2013](#); [Felbermayr and Gröschl, 2014](#)), historical borders, which shaped cultural difference that still matter today, tend to cast long-lasting shadows on contemporaneous trade patterns. Although, there is no *direct* evidence that the intra-Japanese East-West effect can be explained by (defunct) political borders between feudal domains in pre-modern Japan, it is possible to infer differences in cultural proximity between Japanese prefectures from historical dialect data. As argued by [Falck, Heblich, Lameli, and Südekum \(2012\)](#), a region’s dialectical footprint thereby can be understood as a comprehensive summary measure reflecting the evolutionary process of past interactions with other regions. Computing a cultural proximity index from historical dialect data in the Linguistic Atlas of Japan (LAJ) indeed reveals substantial inter-prefectural differences. However, rather than between the East and the West, these differences unfold between Japan’s core and its periphery. In line with this finding, it can be shown that the trade-enhancing effect of cultural proximity is stronger between rather than within the East and the West, which rules out history-based explanations of the intra-Japanese East-West border effect.

Further evidence for the more recent nature of the intra-Japanese east-west bias comes from the trade-creating effects of (contemporaneous) business and migration networks, which are stronger within the East and the West than between both country parts. An intuitive explanation for this dual structure in terms of post-war agglomeration trends thereby is offered by [Tabuchi \(1988\)](#) and [Fujita and Tabuchi \(1997\)](#), who show that the “Tôkyô-Ôsaka bipolar growth pattern” during Japan’s post-war recovery period led to a subsequent wave of massive rural-to-urban migration. Accounting for the impact of *past* migration networks on Japan’s

contemporaneous East-West trade, confirms that the capability of migration networks to explain the intra-Japanese East-West effect gradually improves as networks from the 1950s until today are taken into account. The intra-Japanese East-West border effect thus can be explained by the trade-creating and self-reinforcing effects of business and social networks, originating from the Tōkyō-Ōsaka bipolar nature of post-war agglomeration processes.

This paper contributes to a growing literature arguing that observed trade reductions along existing or defunct political borders can be explained through a spatial heterogeneity in the trade-enhancing effect of business and migration networks to both sides of the respective border (cf. Combes, Lafourcade, and Mayer, 2005; Garmendia, Llano, Minondo, and Requena, 2012; Nitsch and Wolf, 2013). Thereby, it challenges the view that differences in network structures inevitably have to coincide with the geography of political and/or administrative borders. This simple, yet intuitive insight may hold beyond the illustrative example of Japan, for which it is shown that business and migration networks, that are disproportionately well integrated within East and the West are associated with a discrete drop in intra-Japanese East-West trade. The paper connects to previous work on intra-Japanese migration by Tabuchi (1988) and Fujita and Tabuchi (1997) (see Fujita, Mori, Henderson, and Kanemoto (2004) for a summary). Recent studies on intra-Japanese business networks include (among others) Bernard, Moxnes, and Yukiko (2014) as well as Carvalho, Makoto, and Yukiko (2014).

The paper is structured as follows: Section 2 introduces the National Commodity Flow Survey (NCFS) and the Japanese Commodity Flow Statistic (CFS) before discussing the theoretical foundation and implementation of a standard gravity approach. Section 3 identifies and explores the intra-Japanese East-West border effect. The sensitivity analysis is covered in Section 4. An explanation for the intra-Japanese East-West border effect is offered in Section 5. Section 6 finally concludes.

2 Setup

Subsection 2.1 introduces the National Commodity Flow Survey (NCFS) [*Zenkoku Kamotsu Jun Ryūdō Chōsa*] as main data source. Theory and implementation are covered in the Subsections 2.2 and 2.3, respectively.

2.1 Data

Data on intra-Japanese trade flows are obtained from the National Commodity Flow Survey (NCFS) [*Zenkoku Kamotsu Jun Ryūdō Chōsa*] compiled by the Ministry of Land, Infrastructure, Tourism and Transport (MLIT). The NCFS reports trade flows (measured in metric tons)

between *and* within all 47 Japanese prefectures at a five-year base since 1970. Bilateral commodity flows thereby are inferred from two separate surveys: a one-year survey (1YS) with information on aggregated commodity flows per year, and a complementing three-day survey (3DS), which provides comparable information for the shorter time span of three days at more detailed levels of disaggregation.⁴ Figure 9 in the Appendix summarizes the structure of the raw data, which is publicly available for the years 2000, 2005, and 2010. Exploiting this rich data structure, three data sets at different levels of aggregation can be constructed. The resulting data sets (at the lowest level of aggregation) comprise 46,389 observations (= 47 exporters × 47 importers × 7 sectors × 3 years), 450,636 observations (47 exporters × 47 importers × 68 sub-sectors × 3 years) and 185,556 observations (= 47 exporters × 47 importers × 7 sectors × 4 transport modes × 3 years), respectively. The NCFS moreover holds detailed information on prefecture-pair-specific unit transport costs (per metric ton and kilometre). Exploiting this valuable information, it is possible, to compute the actual bilateral transport cost as the product of (greater-circle) distance between the capitals of any prefecture pair times the unit transport costs (per metric ton and kilometre) of connecting both cities.⁵ As a result, *generalised* transport cost account for both distance-related (i.e. gas, tolls, etc.) and time-related (i.e. salaries, insurance, etc.) transport cost.

If necessary, the NCFS is complement by data from the Commodity Flow Statistic (CFS) [*Kamotsu Chiiki Ryûdô Chôsa*], which also is reported by Ministry of Land, Infrastructure, Tourism and Transport (MLIT). The CFS provides information on the intra-Japanese transport volume at a yearly basis form 2000 to 2012. Commodity flows are disaggregated by industry and transport mode such that two data sets with 689,208 observations (= 47 exporters × 47 importers × 8 sectors × 3 transport modes × 13 years) and 918,944 observations (= 47 exporters × 47 importers × 32 industries × 13 years) can be constructed. Figure 10 in the Appendix illustrates the structure of the raw data.

To economise on space, a more detailed discussion of the data is delegated to the Appendix. Detailed summary statistics can be found in Table 6, which also lists all data sources used in this study.

⁴Both surveys cover the same sample of 21,349 (21,045; 25,349) representative Japanese firms for 2010 (2005; 2000), which corresponds to a response rate of 34% (31%; 38%) for 2010 (2005; 2000).

⁵Following the literature (cf. Anderson and van Wincoop, 2003; Baier and Bergstrand, 2009), intra-prefecture distance is approximated by a quarter of the distance to the closest neighbouring prefecture. In Subsection 4.2 alternative, more flexible distance specifications are considered.

2.2 Theory

To account for the rich structure of the NCFS and the CFS, a multi-sector version of an – otherwise standard – Armington model (cf. [Arkolakis, Costinot, and Rodriguez-Clare, 2012](#); [Costinot and Rodriguez-Clare, 2015](#)) is adopted. In each prefecture $i, j = 1, \dots, n$ a representative household aims to maximise aggregate consumption

$$C_j = \prod_{s=1}^S C_{j,s}^{\beta_{j,s}} \quad \text{with} \quad \beta_{j,s} > 0 \quad \text{and} \quad \sum_{s=1}^S \beta_{j,s} = 1. \quad (1)$$

Thereby, total consumption of sector s ' varieties in prefecture j takes the form:

$$C_{j,s} = \left[\sum_{i=1}^n (\psi_{ij} C_{ij,s})^{(\sigma_s-1)/\sigma_s} \right]^{\sigma_s/(\sigma_s-1)}. \quad (2)$$

with $\sigma_s > 1$ denoting the elasticity of substitution between different varieties within the same sector s , and $\psi_{ij} > 0$ being an exogenous preference parameter. As in the single-sector Armington model (cf. [Anderson, 1979](#); [Anderson and van Wincoop, 2003](#)), there is a sole producer for each variety, such that $C_{ij,s}$ denotes prefecture j 's consumption of prefecture i 's sector s variety. Solving for the optimal level of demand $C_{ij,s}$ yields

$$C_{ij,s} = \left(\frac{\psi_{ij} P_{ij,s}}{P_{j,s}} \right)^{-\sigma_s} \frac{\beta_{j,s} E_j}{P_{j,s}}, \quad (3)$$

in which

$$P_{j,s} \equiv \left[\sum_{i=1}^n (\psi_{ij} P_{ij,s})^{1-\sigma_s} \right]^{1/(1-\sigma_s)} \quad (4)$$

is prefecture j 's ideal price index for sector s , $P_{ij,s}$ refers to the price of prefecture i 's sector s variety in prefecture j , and $\beta_{j,s} E_j$ denotes prefectures j 's total expenditure on goods from sector s . In order to sell one unit of sector s ' variety in prefecture j , firms from prefecture i must ship $\tau_{ij,s} \geq 1$ units, with $\tau_{ii,s} = 1$. For there to be no arbitrage opportunities, the price of sector s ' variety produced in i and sold to j must be equal to $P_{ij,s} = \tau_{ij,s} P_{ii,s} = \tau_{ij,s} w_i = \tau_{ij,s} Y_i / L_i$. Thereby, perfect competition implies $P_{ii,s} = w_i$, while $w_i = Y_i / L_i$ follows from full employment, with Y_i as prefecture i 's aggregate income and L_i as prefecture i 's total labour endowment. Combining $P_{ij,s} = \tau_{ij,s} Y_i / L_i$ with Eqs. (3) and (4), it is possible to derive the sector-level

volume $C_{ij,s}$ and value $X_{ij,s}$ of bilateral trade from prefecture i to prefecture j as:

$$\begin{aligned} C_{ij,s} &= \frac{(\tau_{ij,s} Y_i)^{-\sigma_s} (L_i / \psi_{ij})^{\sigma_s}}{\sum_{l=1}^n (\tau_{lj,s} Y_l)^{1-\sigma_s} (L_l / \psi_{lj})^{\sigma_s-1}} \beta_{j,s} E_j, \\ X_{ij,s} &= \frac{(\tau_{ij,s} Y_i)^{1-\sigma_s} (L_i / \psi_{ij})^{\sigma_s-1}}{\sum_{l=1}^n (\tau_{lj,s} Y_l)^{1-\sigma_s} (L_l / \psi_{lj})^{\sigma_s-1}} \beta_{j,s} E_j. \end{aligned} \quad (5)$$

Exploiting the fact that for $\sigma_s = \sigma$ and $\tau_{ij,s} = \tau_{ij}$ the multi-sector Armington model is isomorphic to a (standard) single-sector Armington model, two analogous gravity equations for aggregate bilateral trade flows can be obtained from aggregating up Eq. (5)

$$\begin{aligned} C_{ij} &= \sum_{s=1}^S C_{ij,s} = \frac{(\tau_{ij} Y_i)^{-\sigma} (L_i / \psi_{ij})^{\sigma}}{\sum_{l=1}^n (\tau_{lj} Y_l)^{1-\sigma} (L_l / \psi_{lj})^{\sigma-1}} E_j, \\ X_{ij} &= \sum_{s=1}^S X_{ij,s} = \frac{(\tau_{ij} Y_i)^{1-\sigma} (L_i / \psi_{ij})^{\sigma-1}}{\sum_{l=1}^n (\tau_{lj} Y_l)^{1-\sigma} (L_l / \psi_{lj})^{\sigma-1}} E_j. \end{aligned} \quad (6)$$

In the following Eq. (6) is adapted as baseline specification. While, Eq. (5) serves as theoretical foundation, whenever the analysis requires a more disaggregated view on sector-level bilateral trade flows.

2.3 Implementation

In the literature on intra-national trade two different approaches to utilise shipment data measured in quantities (rather than in values) exist.⁶ Combes, Lafourcade, and Mayer (2005) use a monopolistic competition framework à la Dixit-Stiglitz-Krugman (cf. Dixit and Stiglitz, 1977; Krugman, 1980) to derive a demand function, which allows to estimate the intra-national trade volume (measured in metric tons) consistently for France. Alternatively, Nitsch and Wolf (2013) aggregate up industry-level trade volumes for Germany, using unit-values from the German foreign trade statistic as time-varying weights, to obtain intra-national trade flows measured in values.⁷ In the following, *both* approaches are used to consistently estimate intra-Japanese trade in quantities *and* values based on Eqs. (5) and (6).

Bilateral resistance $\tau_{ij,s} \cdot \psi_{ij}$ is specified as follows:

$$\tau_{ij,s} \cdot \psi_{ij} = \text{Trans}_{ij,s}^{\delta_{1s}} \cdot e^{\delta_2 \text{Bord}_{ij} + \delta_3 \text{Adj}_{ij} + \delta_4 \text{Pref}_{ij} + \delta_5 \text{Reg}_{ij} + \delta_6 \text{Sea}_{ij}}. \quad (7)$$

⁶The US commodity flow survey (cf. Wolf, 2000; Hillberry, 2002; Hillberry and Hummels, 2003; Millimet and Osang, 2007; Yilmazkuday, 2012; Coughlin and Novy, 2013; Felbermayr and Gröschl, 2014) provides information on both the volume and the value of intra-national trade. Poncet (2003, 2005) uses provincial input-output (IO) tables to derive intra-national trade flows for China. For the case of Japan comparable IO tables only exist at the aggregated level of 9 main regions (cf. Okubo, 2004), but not at the more disaggregated level of the 47 prefectures covered by the Japanese commodity flow survey.

⁷Requena and Llano (2010) apply a similar strategy to their Spanish data, using unit-prices derived from detailed industry-level surveys as weights for the aggregation.

Thereby, Bord_{ij} is a binary indicator variable, which takes a value of $\text{Bord}_{ij} = 0$ if both prefectures in the pair $i \times j$ either belong to East- or West-Japan and a value of $\text{Bord}_{ij} = 1$ if one prefecture is located in the East while the other prefecture is located in the West of Japan. The parameter δ_2 consequently captures one plus the tariff equivalent of trading across a (hypothetical) intra-Japanese East-West border, which will be specified in more detail below. Bilateral transport costs are captured by $\ln \text{Trans}_{ij,s}$, and Adj_{ij} is a binary indicator variable, taking a value of $\text{Adj}_{ij} = 1$ if prefectures i and j share a common border and a value of $\text{Adj}_{ij} = 0$ otherwise. Finally, the indicator variables Pref_{ij} , Reg_{ij} , and Sea_{ij} account for all trade flows across prefectural, regional, or sea borders, thereby controlling for the intra-national home bias and the existence of administrative as well as geographic borders inside Japan.

Two major issues concerning the use of shipment data have been identified in the existing literature (cf. [Combes, Lafourcade, and Mayer, 2005](#); [Nitsch and Wolf, 2013](#)). First, a certain fraction of shipments enter or leave Japan via ports ($> 99\%$ in 2010) and hubs of air cargo ($< 1\%$ in 2010). Since Japan's external trade is channelled through these ports, intra-national shipments in general are biased towards coastal prefectures and in particular towards those hosting large port facilities (e.g. located in the bays of Tôkyô, Ôsaka, and Ise). To account for these and other unobservable demand or supply shifters in Eqs. (5) and (6), (sector-level) importer- and exporter-specific fixed effects are included in the empirical analysis. Second, single transactions often are reflected by multiple records in the shipment data due to the unloading and reloading of shipments at warehouses, ports, and railway freight terminals. Notably, [Hillberry and Hummels \(2003\)](#) show that the underlying hub and spoke distribution patterns translate into comparatively short distances for shipments that originate from wholesalers rather than from manufactures. In the empirical analysis, the over-representation of short-distance shipments (i.e. the intra-national home bias), is captured by additional fixed effects, which account for (short-distance) trade, that does not cross intra-Japanese prefecture, region, or sea borders.

Following standard practice, Eq. (7) is substituted into Eq. (5) or (6), which subsequently are log-linearised and then estimated in an ordinary least squares (OLS) gravity regression with exporter- and importer-specific fixed effects (cf. [Head and Mayer, 2015](#)). However, to avoid potentially large biases of OLS estimates in the presence of heteroscedasticity and many zero observations (both relevant concerns at higher levels of disaggregation), Eqs. (5) and (6) are also estimated in their multiplicative forms, using the pseudo Poisson maximum-likelihood (PPML) estimator proposed by [Santos Silva and Tenreyro \(2006, 2010\)](#).

3 Results

Section 3 is structured as follows: Subsection 3.1 explores the National Commodity Flow Survey (NCFS), which then in Subsection 3.2 is used to identify a unique, spatial barrier to intra-Japanese trade. Subsection 3.3 finally explores how the intra-Japanese East-West border effect varies by year, industry or transport mode.

3.1 Exploring the National Commodity Flow Survey

To the best of my knowledge, this paper is the first to estimates intra-Japanese trade flows based on the National Commodity Flow Survey (NCFS). To assess the representativeness of the dataset, a standard gravity equation is estimated in varying specifications along the lines of Section 2.3. Thereby, different trade flow statistics (quantities vs. values), different trade cost measures (distance vs. actual transport cost), and different estimation techniques (OLS vs. PPML) are used.⁸ Table 1 summarises the results for the year 2010.

Table 1: *Exploring the National Commodity Flow Survey*

| Dependent variable: Aggregated exports from prefecture i to prefecture j | | | | | | | | |
|--|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| Year: | 2010 | | | | | | | |
| Survey: | 1YS | | 3DS | | 1YS | | 3DS | |
| Unit: | Quantities | | Values | | Quantities | | Values | |
| Model: | OLS | PPML | OLS | PPML | OLS | PPML | OLS | PPML |
| Specification: | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Coefficients: | | | | | | | | |
| \ln distance $_{ij}$ | -1.2786*** (.0465) | -0.7625*** (.0614) | -1.1954*** (.0611) | -0.5614*** (.0920) | | | | |
| \ln transport cost $_{ij}$ | | | | | -0.6761*** (.0425) | -0.6037*** (.0512) | -0.8685*** (.0471) | -0.3843*** (.0642) |
| Adjacency $_{ij}$ | 0.4167*** (.0893) | 0.5401*** (.1042) | 0.5600** (.1126) | 0.7781*** (.1578) | 1.1110*** (.0874) | 0.9595*** (.1235) | 1.1241*** (.1044) | 1.1325*** (.1703) |
| Prefecture border dummy $_{ij}$ | -1.2813*** (.3112) | -1.4772*** (.1645) | -2.6314*** (.3910) | -2.8812*** (.2751) | -3.4264*** (.2374) | -2.5204*** (.1283) | -4.2655*** (.3141) | -3.7588*** (.1878) |
| Region border dummy $_{ij}$ | -0.1393 (.0845) | -0.3027** (.1313) | -0.0527 (.1025) | -0.2924* (.1558) | -0.8263*** (.0817) | -0.6788*** (.1287) | -0.5700*** (.0943) | -0.5559** (.1591) |
| Sea border dummy $_{ij}$ | -0.3799*** (.0896) | -0.341*** (.1016) | -0.5476*** (.1168) | -0.5894*** (.1236) | -0.6231*** (.0885) | -0.3514*** (.0995) | -0.6712*** (.1086) | -0.6214*** (.1264) |
| Fixed effects: 7 | | | | | | | | |
| Exporter (i) | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Importer (j) | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Summary statistics: | | | | | | | | |
| Number of observations | 2,207 | 2,209 | 2,199 | 2,209 | 2,207 | 2,209 | 2,199 | 2,209 |
| (Pseudo) R^2 | .8331 | .9602 | .7772 | .9780 | .8115 | .9572 | .7863 | .9767 |

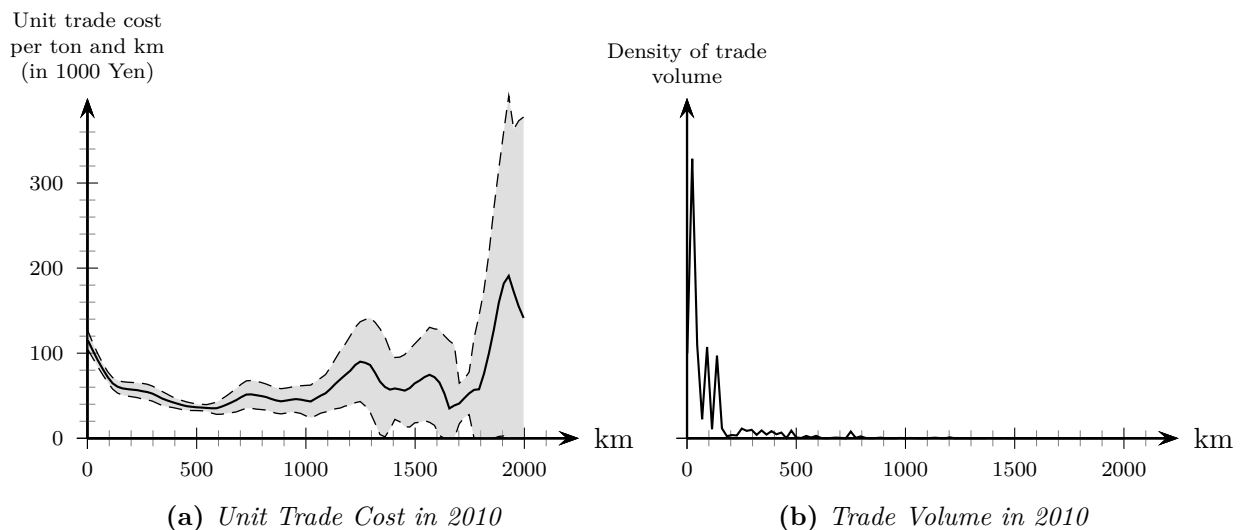
Robust standard errors; significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

In the specifications (1) to (4) distance is chosen as a proxy for bilateral trade cost. The coefficients for distance and adjacency take values, which are comparable to the mean estimates

⁸To compute the trade volume in values, trade flows are aggregated up from the industry level using unit-values from Japan's Foreign Trade Statistic as weights (cf. Nitsch and Wolf, 2013). For this purpose 6-digit HS-codes from the Japanese Foreign Trade Statistic are matched to the 68 (4-digit) industries reported in the National Commodity Flow Survey. All details regarding the matching are included in a Technical Supplement, which is available from the author upon request.

of typical gravity variables, reported in the meta-analysis by [Head and Mayer \(2015\)](#).⁹ As usual distance estimates under OLS thereby are upward biased relative to PPML (cf. [Santos Silva and Tenreyro, 2006](#); [Head and Mayer, 2015](#)). Finally, the estimates for the intra-national home bias are similar to those for the US (cf. [Wolf, 2000](#); [Millimet and Osang, 2007](#); [Yilmazkuday, 2012](#)). Specifications (5) to (8) repeat the analysis, using actual transport cost instead of the unweighted distance as a proxy for bilateral trade cost. As a striking result the proxies for short-distance trade, which is restricted to single or neighbouring prefectures as well as to single regions and islands, deliver estimates of larger (absolute) size for these specifications. At the same time, the trade reducing effect of actual transport costs seems to be smaller than the effect of unweighted distance. To understand these differences, [Figure 1a](#) explores the link between unit trade cost and (unweighted) distance.¹⁰

Figure 1: *Unit Trade Cost and Trade Volumes over Distance*



As evident from [Figure 1a](#) unit trade cost fall substantially within the first 500 kilometres, which according to [Figure 1b](#) account for more than 95% of the intra-Japanese trade volume in 2010.¹¹ Unweighted distance as a proxy for bilateral trade cost ignores this decline of unit transport costs over increasing distances. As a consequence, the implied reduction of short-

⁹[Head and Mayer \(2015\)](#) report typical gravity estimates, based on a comparison of 2,508 usable estimates from more than 150 published papers. Thereby the mean estimates for distance and adjacency in a structural gravity setting take values of -1.14 and 0.52 , respectively. See also [Disdier and Head \(2008\)](#).

¹⁰[Figure 1a](#) uses an (Epanechnikov) kernel regression estimator to provide a non-parametric estimate of the relationship between the distance of shipments and the respective unit trade cost in 2010. As in [Hillberry and Hummels \(2008\)](#) $n = 100$ points are computed, allowing the estimator to calculate and employ the optimal bandwidth. The solid line in [Figure 1a](#) refers to the estimate, dashed lines indicate the 99%-confidence interval. [Figure 1b](#) presents an (Epanechnikov) kernel density (with optimal bandwidth) of the 2010 trade volume (measured in quantities).

¹¹Further evidence in favour of long-haul economies in the Japanese transportation sector comes from [Yoko, Mun, Yoshihiko, and Sung \(2012\)](#), who use the 2005 wave of the NCFs to structurally estimate a cost function for (on-road) transportation services.

distance trade flows is picked up other proxies for short-distance trade and mitigates the trade-enhancing effect among neighbouring prefectures as well as within single prefectures, regions, or islands.

Taking stock, the National Commodity Flow Survey (NCFS) generates estimates which are comparable to typical results from the gravity literature. Thereby, it is possible to avoid the notorious measurement error, usually resulting from the use of unweighted distance as a proxy for bilateral trade cost by using actual, bilateral transport cost instead.

3.2 Identifying the Intra-Japanese East-West Border Effect

The NCFS covers 47 Japanese prefectures grouped in 9 administrative regions. Except for the Prefecture Okinawa all prefectures are depicted in Figure 2, which presents a division into two blocks with 23 East- and 24 West-Japanese prefectures, arranged around Japan's two major agglomeration areas *Kantô* and *Kansai*.¹² Interestingly, the terms *Kantô* (関東) and *Kansai* (関西) thereby literally refer to two areas in the east (東) and west (西) of a barrier (関), and it will be shown, that this East-West barrier matters in a crucial way for the contemporaneous pattern of intra-national trade in Japan.

To enable a first visual inspection of the intra-Japanese trade pattern, Table 2 reports measures of bilateral trade integration for all 47×47 Japanese prefecture pairs. Thereby, trade integration is measured through the Head-Ries Index (HRI) (cf. Head and Ries, 2001)

$$\hat{\phi}_{ij} = \hat{\phi}_{ji} = \sqrt{\frac{C_{ij}C_{ji}}{C_{ii}C_{jj}}} \in [0, 1] \quad \text{with} \quad \phi_{ij} \equiv \tau_{ij}^{-\sigma}, \quad (8)$$

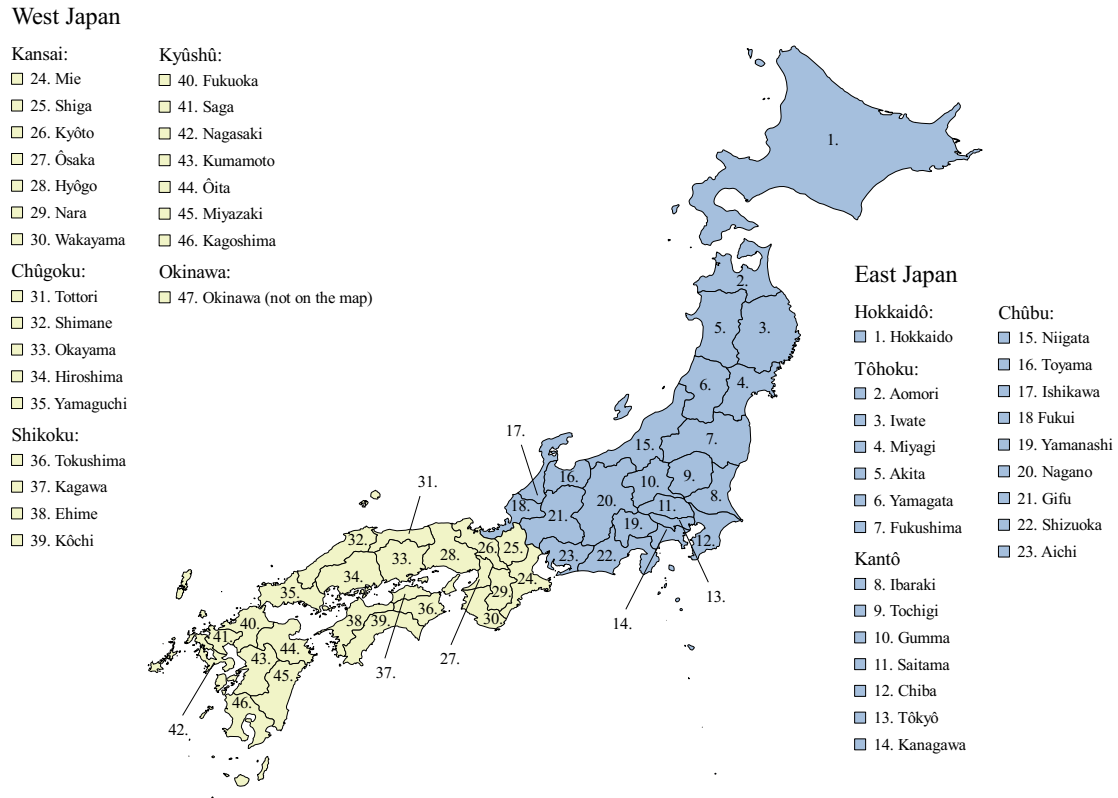
which exploits the Independence of Irrelevant Alternatives (IIA) property (cf. Anderson, DePalma, and Thisse, 1992) of gravity equation (6) to evaluate the overall level of bilateral trade integration between any two prefectures under the assumptions of symmetry in bilateral trade cost ($\tau_{ij} = \tau_{ji}$) and frictionless intra-prefectural trade ($\tau_{ii} = \tau_{jj} = 1$).¹³ Note, that by construction the bilateral-trade-integration matrix in Table 2 is symmetric and entries at the main diagonal take a value of one due to $\hat{\phi}_{ii} = 1$.¹⁴ Since the ordering of prefectures, starting with 1. Hokkaidô in the far northeast (upper-left corner) and ending with 47. Okinawa in the extreme

¹²The Prefectures of Hokkaidô and Okinawa form two own regions. Both prefectures/regions differ from mainland Japan in various ways and have own historic, ethnic, and cultural backgrounds. The Ryûkyû Islands (today forming the Prefecture Okinawa) for the first time came under Japanese influence in 1609, official annexation followed in 1879. Hokkaidô's colonisation started gradually with a substantial acceleration of settlement efforts in the second half of the 19th century.

¹³See Head and Mayer (2015) for a more detailed discussion and further applications.

¹⁴Note, that in Table 2 zeros are (vastly) overreported due to the rounding of index numbers with a value below 0.5%. Indeed, the one-year survey (1YS) for 2010 features only 2 zero-trade-flows out of an overall number of $47 \times 47 = 2,209$ trade flows.

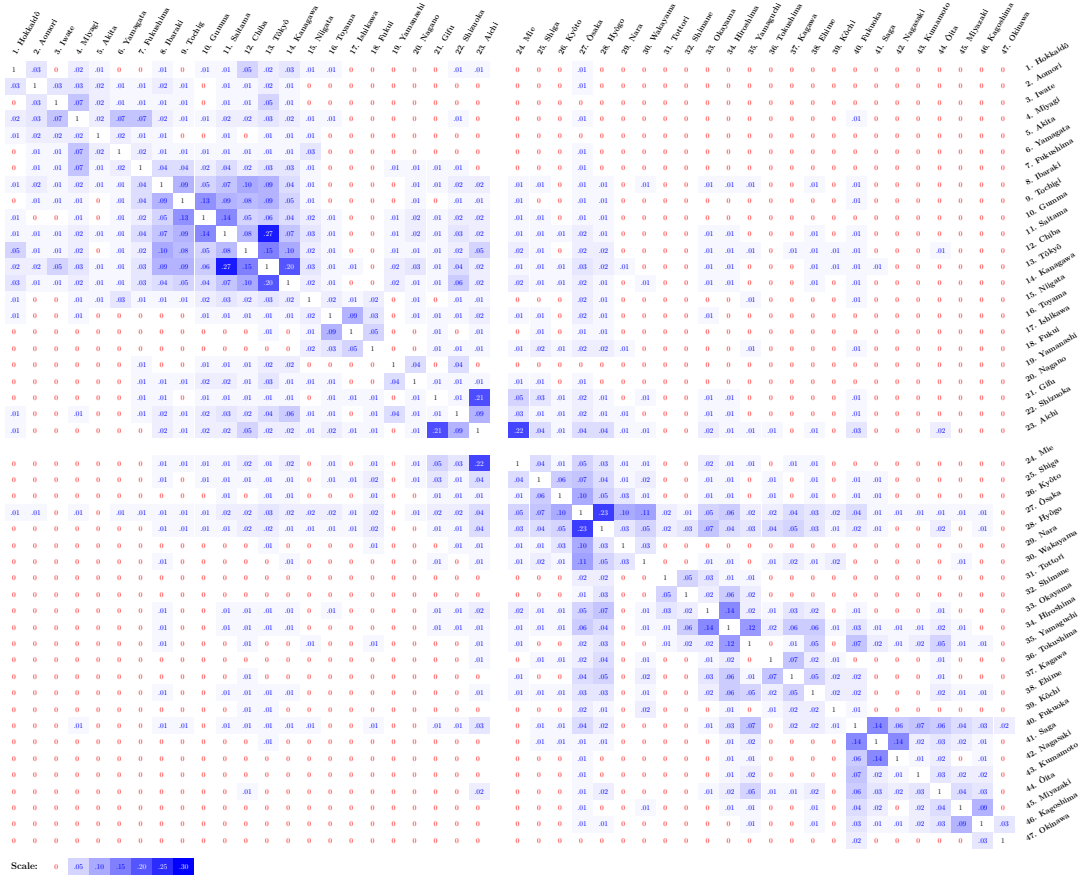
Figure 2: *Regions and Prefectures of Japan*



southwest (lower-right corner), is the same as in Figure 2, geography shines through in Table 2 and entries with longer (horizontal or vertical) distances to the main diagonal usually refer to trade integration between prefectures which are also geographically more distant. Exploiting this structure, it is possible to dissect Table 2 into four quadrants. Thereby the upper-left and the lower-right quadrants in Table 2 capture intra-East and intra-West trade, respectively, while the symmetric, off-diagonal quadrants refer to trade between the East and the West. Comparing trade integration across the quadrants in Table 2, reveals a surprisingly stark East-West pattern in Japan's intra-national trade: prefecture pairs within the East and the West are on average five to six times as well integrated as prefectures pairs featuring one prefecture from the East and another prefecture from the West of Japan.

Of course, this finding is anything but a surprise. Prefectures from the East and the West are usually separated by larger distances than prefectures which both originate from the same country part. As a consequence, East-West trade should be (relatively) costlier and therefore also less intense. The relevant question, thus, is not whether there is (comparatively) less East-West trade, but rather to what extent this pattern persists, once bilateral transport cost are taken into account. If the lack of East-West trade in Table 2 can be fully explained through higher

Table 2: *Bilateral Trade Integration Between Japanese Prefecture*



bilateral East-West trade cost, no systematic geographic variation should be left in the residuals ($C_{ij} - \hat{C}_{ij}$ or $X_{ij} - \hat{X}_{ij}$, respectively) from Table 1. Table 3 plots the share of East-East, West-West, East-West and West-East prefecture pairs for which the actual trade flow C_{ij} or X_{ij} is underestimated by \hat{C}_{ij} or \hat{X}_{ij} , respectively. According to Table 3, a gravity model, that

Table 3: *The Share of Prefecture Pairs with Underestimated Trade Flows*

| Specification | East-East | West-West | East-West | West-East | All |
|---------------|-----------|-----------|-----------|-----------|--------|
| (1) | 50.85% | 56.42% | 45.65% | 45.83% | 49.75% |
| (3) | 52.93% | 54.61% | 48.01% | 48.01% | 50.09% |
| (5) | 61.81% | 61.11% | 32.07% | 35.51% | 47.62% |
| (7) | 58.41% | 58.33% | 42.39% | 41.30% | 50.11% |

Residuals are computed based on the specifications (1), (3), (5) and (7) in Table 1.

explicitly takes into account bilateral trade cost, systematically underestimates (overestimates) *actual* bilateral trade flows within (between) the East and the West. Notably, the East-West bias is most pronounced in the *preferred* specifications (5) and (7), which account for unit transport costs that are falling over longer distances (cf. Section 3.1).

To assess in a next step the *average* impact of the division into East- and West-Japan on trade between rather than within both blocks on a more throughout basis, Eqs. (5) and (6) are re-estimated, taking into account the East-West border dummy introduced in Section 2.3. Table 4 presents the benchmark results for 2010. Thereby, in Columns (1) and (2) aggregate trade flows from the one-year survey (1YS), measured in metric tons, are used for the estimation. Under OLS, cross-border trade is 51.3% ($e^{-0.719} - 1$) smaller than trade within both blocks. This reduction may seem small compared to a drop of 80.8%, which Anderson and van Wincoop (2003) report for trade among Canada provinces and U.S. states, which crosses the international border between both countries.¹⁵ However, the drop in intra-Japanese East-West trade is substantial and much larger than the persistent reductions of 20.5% or 12.8% in contemporaneous intra-national trade across the former border between the GDR (East-Germany) and the FRG (West-Germany) in Nitsch and Wolf (2013) or across the historical border between the Union and the Confederacy during the American Secession in Felbermayr and Gröschl (2014).¹⁶

Table 4: *Baseline East-West Border Effect*

| Dependent variable: Exports from prefecture i to prefecture j | | | | | | | |
|---|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| Year: | 2010 | | | | | | |
| Survey: | 1YS | | | 3DS | | | |
| Data: | Aggregated | | Aggregated | | | Sectoral | |
| Unit: | Quantities | | Quantities | | Values | Quantities | |
| Model: | OLS-FE | PPML-FE | OLS-FE | PPML-FE | OLS-FE | PPML-FE | PPML-FE |
| Specification: | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| Coefficients: | | | | | | | |
| East-West border dummy $_{ij}$ | -0.7188*** (.0487) | -0.3956*** (.1130) | -0.5395*** (.0542) | -0.3601*** (.1173) | -0.5661*** (.0619) | -0.2631* (.1392) | -0.3255*** (.0498) |
| \ln transport cost $_{ij}$ | -0.5238*** (.0426) | -0.5494*** (.0599) | -0.9521*** (.0451) | -0.5607*** (.0671) | -0.7487*** (.0495) | -0.3476*** (.0760) | -0.6162*** (.0652) |
| Adjacency $_{ij}$ | 1.0743*** (.0895) | 0.9449*** (.1302) | 0.9790*** (.0938) | 1.0404*** (.1484) | 1.0952*** (.1059) | 1.1127*** (.1670) | 1.0236*** (.1483) |
| Prefecture border dummy $_{ij}$ | -3.6356*** (.2396) | -2.5786*** (.1248) | -3.0865*** (.2664) | -2.6566*** (.1617) | -4.4296*** (.3154) | -3.7919*** (.1879) | -2.6565*** (.4265) |
| Region border dummy $_{ij}$ | -0.5619*** (.0846) | -0.5330*** (.1244) | -0.4389*** (.0862) | -0.3574** (.1393) | -0.3615*** (.0981) | -0.4687*** (.1582) | -0.4978*** (.0618) |
| Sea border dummy $_{ij}$ | -0.5937*** (.0856) | -0.3590*** (.0972) | -0.4950*** (.0715) | -0.4128*** (.0732) | -0.6490*** (.1079) | -0.6127*** (.1265) | -0.5512*** (.1083) |
| Fixed effects: | | | | | | | |
| Exporter (i) | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ |
| Importer (j) | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ |
| Exporter \times Sector ($i \times s$) | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✓ |
| Importer \times Sector ($j \times s$) | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✓ |
| Summary statistics: | | | | | | | |
| Number of observations | 2,207 | 2,209 | 2,199 | 2,209 | 2,199 | 2,209 | 109,104 |
| (Pseudo) R^2 | .8287 | .9367 | .8914 | .9494 | .7944 | .9766 | .8839 |

Robust standard errors (in Specification (7) clustered at the industry level); significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

¹⁵See Table 2 in Anderson and van Wincoop (2003), OLS in 1993: $e^{-1.65} - 1$.

¹⁶See Table 1a in Nitsch and Wolf (2013), pooled OLS in 2004: $e^{-0.229} - 1$, as well as Table 2 in Felbermayr and Gröschl (2014), OLS in 1993: $e^{-0.137} - 1$.

In Columns (3) to (7) disaggregated industry-level trade flows from the three-day survey (3DS) are used. Across all specifications the East-West border effect has the expected sign, a comparable magnitude, and is highly significant. Whether industry-level trade flows in Columns (3)-(4) or (5)-(6) thereby are aggregated up in terms of quantities (cf. Combes, Lafourcade, and Mayer, 2005) or values (cf. Nitsch and Wolf, 2013) does not make a big difference for the estimation results. Finally, to ensure that results do not depend on the mode of aggregation, Column (7) presents an estimate for the East-West border effect at the level of 68 two-digit sectors (cf. Chen, 2004; Anderson and Yotov, 2010; Felbermayr and Gröschl, 2014). This practice has the advantage that all price terms in the sector-level gravity equations from Eq. (5) can be fully absorbed through exporter \times sector- and importer \times sector-specific fixed effects, which in addition control for varying transport cost across different industries (cf. Chen and Novy, 2011).¹⁷ Taking into account a considerable amount of zeros in bilateral trade flows at the disaggregated industry-level, PPML is the preferred estimation technique. The obtained estimate closely resembles the PPML estimates for aggregate trade flows in the columns (4) and (6) and implies a reduction in East-West trade of 27.8% ($e^{-0.326} - 1$).

Computing the tariff equivalent of the intra-Japanese East-West border effect, requires knowledge of the trade cost elasticity $\sigma - 1$, which, according to Hertel, Hummels, Ivanic, and Keeney (2007), can be estimated directly from gravity equation (5), given that the NCFs provides detailed information on bilateral trade cost (per ton and kilometre).¹⁸ Following the approach of Hertel, Hummels, Ivanic, and Keeney (2007), Eq. (7) is re-specified as follows: To approximate for $\tau_{ij,s}$ one plus the *ad valorem* freight rate $\tau_{ij,s} = 1 + \text{Freight}_{ij,s}$ is used, while ψ_{ij} is assumed to have the following function form:

$$\psi_{ij} = \text{Dist}_{ij}^{\mu_1} e^{\mu_2 \text{Bord}_{ij} + \mu_3 \text{Adj}_{ij} + \mu_4 \text{Pref}_{ij} + \mu_5 \text{Reg}_{ij} + \mu_6 \text{Sea}_{ij}}, \quad (9)$$

with Dist_{ij} denoting bilateral (greater circle) distance and the remaining variables being defined as in Eq. (7). To obtain an estimate for $\sigma_s - 1$, $\tau_{ij,s}$ and ψ_{ij} are substituted into $X_{ij,s}$ from Eq. (5), which subsequently is log-linearised and then estimated in an OLS gravity regression with sector \times exporter- and sector \times importer-specific fixed effects. Table 7 in the Appendix presents the results for the years 2000, 2005, and 2010. Depending on the sector, σ_s varies from 2.03 for “manufacturing” in 2010 to 4.79 for “miscellaneous products” in 2005, which is in line with

¹⁷Anderson and Yotov (2010) estimate a structural gravity equation at the sector-level and argue that this practice reduces the aggregation bias. For a more detailed discussion of the aggregation bias in structural gravity equations see Anderson and van Wincoop (2004).

¹⁸Eaton and Kortum (2002) offer multiple ways to estimate the trade cost elasticity from a gravity model akin to Eq. (6) when information on bilateral trade costs is not available. A refinement of Eaton and Kortum’s preferred method is provided by Simonovska and Waugh (2014). Hillberry and Hummels (2013) review the literature.

the findings of [Yilmazkuday \(2012\)](#), who computes elasticities of substitution for trade within the US, that range from 1.61 to 5.99 with an average value of 3.01. Pooling over all sectors implies for each year an average trade cost elasticity of about $\sigma - 1 \approx 1.56$, which is a somewhat smaller value than the mean or the preferred estimate of 3.19 or 4.51 that [Head and Mayer \(2015\)](#) report in their meta study.¹⁹ Finally, applying a trade cost elasticity of 1.56, 3.19, or 4.51 to the corresponding point estimate for the intra-Japanese East-West border effect from Specification (5) in Table 4, implies a tariff equivalent of 43.4%, 19.0%, or 13.4%, respectively.

Following [Arkolakis, Costinot, and Rodriguez-Clare \(2012\)](#), it is moreover possible to quantify how the distribution of prefecture-level real consumption is shaped through the intra-Japanese East-West border effect.²⁰ Thereby changes in prefecture-level real consumption \hat{C}_j in response to a certain (intra-national) trade shock:

$$\hat{C}_j = \hat{\lambda}_{jj}^{\frac{1}{1-\sigma}} \quad \text{with} \quad \lambda_{jj} \equiv \frac{X_{jj}}{\sum_l X_{lj,s}}, \quad (10)$$

are proportional to changes in the respective prefecture's domestic expenditure share λ_{jj} .²¹

While in Figure 3a the prefecture-level gains in per capita consumption from intra-Japanese trade are plotted, Figure 3b illustrates how these consumption gains would change in a *counterfactual* equilibrium without the intra-Japanese East-West border effect.²² Depending on the applied trade cost elasticity (1.56 vs. 3.19 or 4.51), the average consumption gains from inter-prefectural trade in Japan range from 25.1% to 11.4%, or 7.9%. The *counterfactual* increase in the economy-wide real consumption level associated with a *hypothetical* elimination of the intra-Japanese East-West border effect would amount to 2.8%, 1.7%, or 1.2%, respectively. Although these *average* changes seem modest, there are substantial distributional consequences associated with the counterfactual experiment from Figure 3b: As one might expect, prefectures close to (and in particular in the west of) the intra-Japanese East-West border would benefit

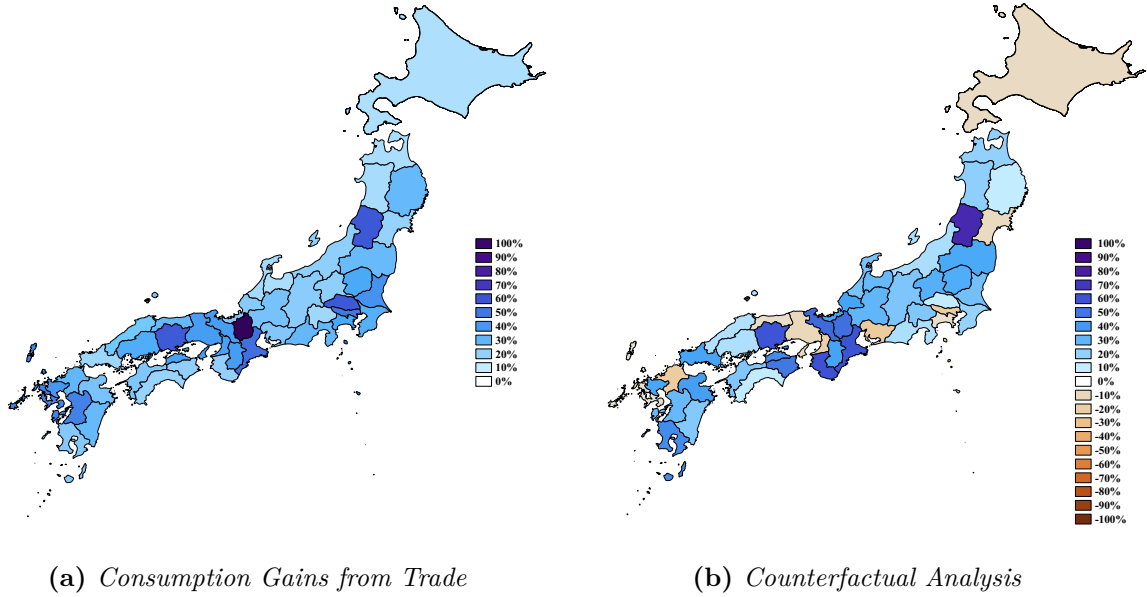
¹⁹Data on bilateral transport cost in the NCFs are only available at the aggregate level of seven major sectors, which might explain why the estimated elasticity of substitution is comparatively small. Notably, [Hummels \(1999\)](#) shows that estimates for the trade cost elasticity, which are obtained from data on international freight rates, tend to be larger if the analysis is conducted at a lower level of disaggregation. The trade cost elasticities for manufacturing products (SITC categories 5-9) equal 5.79, 6.26, 7.04, and 8.26 if estimated at the one-, two-, three-, and four-digit level, respectively.

²⁰Note that it is always possible to quantify the *counterfactual* consumption change associated with a *hypothetical* elimination of the intra-Japanese East-West border effect. However, it is less clear to what extent a change in prefecture-level consumption directly translates into a welfare change. If the intra-Japanese East-West border effect results from *real* trade barriers, which for example have been shaped by some historic event (cf. [Nitsch and Wolf, 2013](#); [Felbermayr and Gröschl, 2014](#)), consumption losses from trade frictions are tantamount to welfare losses. On the contrary, when the intra-Japanese East-West border effect reflects the geography of local preferences, consumption and welfare effects *may* fall apart, which renders (quantitative) welfare prediction problematic.

²¹As common in the literature (cf. [Costinot and Rodriguez-Clare, 2015](#)), the exact hat notation $\hat{v} \equiv v'/v$ is used to denote percentage changes.

²²Both figures assume a trade cost elasticity of 1.56. Outcomes for alternative trade cost elasticity of 3.19 or 4.51 are reported in the appendix.

Figure 3: *Per Capita Consumption and the Intra-Japanese East-West Border Effect*



from a removal of this “border”. However such a removal, at the same time, would divert inter-prefectural trade away from the periphery (i.e. Hokkaidô or Okinawa) and from large cities (e.g. Tôkyô, Yokohama, Ôsaka, Kobe, Fukuoka, and Nagasaki), which according to Figure 2 stand out as disproportionately well-integrated trading hubs.

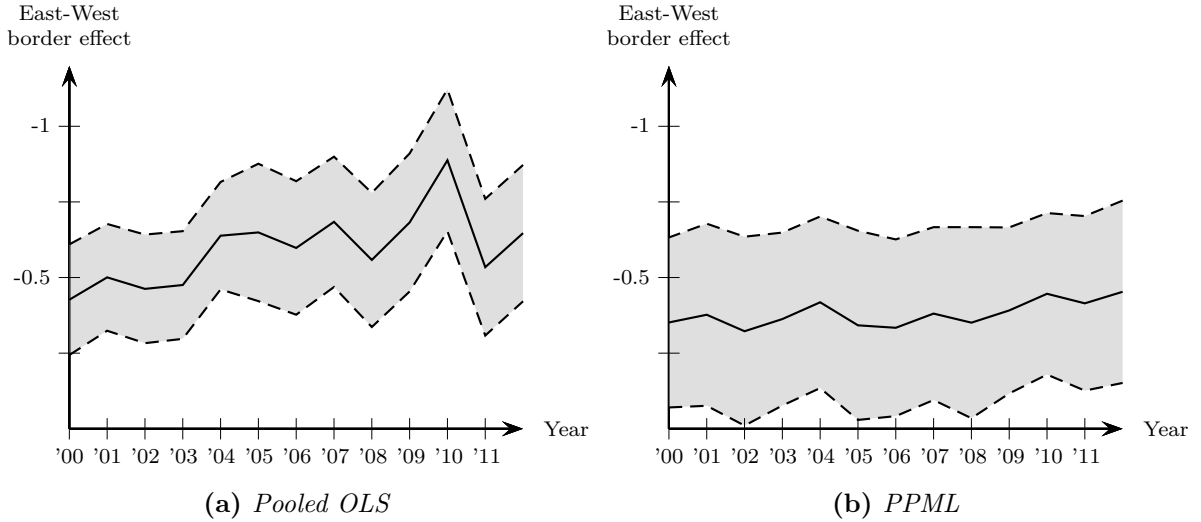
Summing up, the intra-Japanese East-West border effect has a strong and significant impact on the pattern of inter-prefectural trade in Japan, which is associated with economically meaningful consumption losses that are unequally distributed between the (extreme) periphery and large cities on the one hand and Japan’s countryside on the other hand.

3.3 Exploring the Intra-Japanese East-West Border Effect

Table 9 in the Appendix summarises border effect estimates obtained from the 2010, 2005, and 2000 wave of the NCFS (suppressing the other coefficients from Table 4). Thereby, the Specifications (1) to (7) in Table 9 are the same as in Table 4. The East-West border effect always is negative and in all but one specification highly significant. The implied trade reduction ranges from 61.4% to 27.6% with the median East-West border effect causing a trade reduction of about 42.3%. To track the evolution of the intra-Japanese East-West border effect more closely year by year over the decade from 2000 to 2012, the Commodity Flow Statistic (CFS) is used as an alternative data source. Following Nitsch and Wolf (2013), the baseline specification from Table 4 is re-estimated in a pooled sample, allowing the error terms to be correlated within prefecture pairs and controlling for the complete set of time-varying importer- and exporter-

specific fixed effects. Figures 4a and 4b plot the parameter estimates together with the 99%-confidence interval for the intra-Japanese East-West border effect from 2000 to 2012 obtained under pooled OLS and PPML, respectively.²³ Over the entire sample period the intra-Japanese

Figure 4: *The East-West Border Effect from 2000-2012*



East-West border effect in both figures is significantly below zero. Comparing the border effects at the beginning and end of the sample period, moreover reveals an increase in the border effect, which is statistically significant at a 1% (5%) level in Figure 4a (Figure 4b). Together, these findings not only confirm the previous result from Table 9, but also suggest that the intra-Japanese East-West border effect has increased slightly over time.

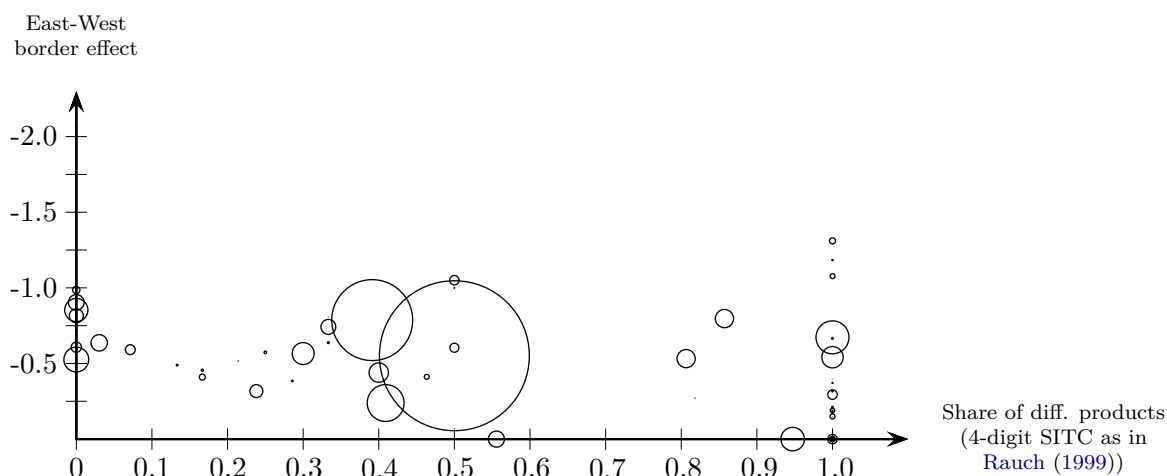
Table 10 in the Appendix uses the 2010, 2005, and 2000 wave of the NCF5 (1YS) to identify the intra-Japanese East-west border effect separately for seven major sectors (suppressing again the other coefficients from Table 4). The East-West border effect in all but one specification has the expected negative sign and is highly significant across all industries belonging to the economy's secondary sector.²⁴ Based on the more disaggregated three-day survey (3DS), Figure 5 presents estimates for 64 industry-level border effects, which are plotted against the share of differentiated products in the respective industry following the conservative classification in Rauch (1999).²⁵ To maximise the number of available observations, industry-level border effects

²³The complete set of estimates from both regressions is reported in a Technical Supplement, which is available from the author upon request.

²⁴When comparing the East-West border effect across sectors s , caution is warranted. Estimated border effects in Table 10 refer to the product of the trade cost elasticity $\sigma_s - 1$ and the cost-increasing effect of the intra-Japanese East-West border δ_{1s} . Table 7 from the Appendix suggest that sectoral trade cost elasticities in 2010 vary from -1.03 for manufacturing to 2.81 for forest. Moreover, it seems likely that the East-West trade pattern for industries belonging to the economy's primary sector (i.e. agriculture, forest, & mining) to a large extent is dictated by differences in comparative advantage, that are not included in the simple model from Section 2.

²⁵To obtain the share of differentiated products in a given industry, the (updated) Rauch-classification based on 4-digit SITC (Rev. 2) codes is matched to the NCF5 industry classification. A Technical Supplement, which is available from the author upon request, presents a detailed concordance table and reports the complete set

Figure 5: *The East-West Border Effect for Differentiated versus Non-differentiated goods*



are estimated in a pooled sample, including the 2010, 2005, and 2000 wave of the NCFCS. Taking into account a considerable amount of zero (industry-level) trade flows, PPML is used as preferred estimation technique. The complete set of time-varying importer- and exporter-specific fixed effects is taken into account and error terms are allowed to be correlated within prefecture pairs. If the intra-Japanese East-West trade pattern would be shaped through the limited trust of market participants or alternatively through strong preferences for local goods, one would not expect to find a significant border effect for standardized (homogenous) products, whose quality is easy to verify and for which idiosyncratic demand shocks have little bearing. Figure 5 rejects these explanations: the obtained border effects in most industries are (significantly) negative and seem not to be (negatively) correlated with the share of differentiated products.²⁶

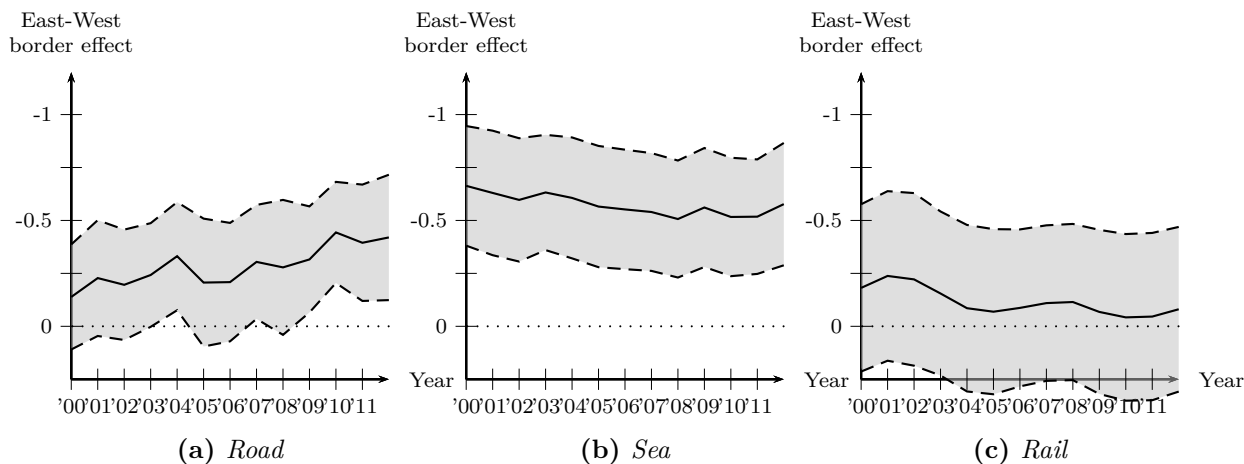
Table 11 in the Appendix reports estimates for the intra-Japanese East-West border effect that result from the 2010, 2005, and 2000 wave of the NCFCS (3DS), disaggregated by seven major sectors (cf. Table 10) and four modes of transportation (i.e. by rail, road, sea and air). Exploiting this variation, Specification (1) of Table 11 includes exporter- and importer-specific fixed effects that also vary by sector and by mode of transportation. Throughout all waves of the NCFCS the estimated intra-Japanese East-West border effect has the expected negative sign and is highly significant, which rules out explanations based on a combination of sector-level comparative advantage and prefecture-specific infrastructure. When estimated separately by mode of transportation, negative and significant border effects can be identified

of industry-level estimates for the intra-Japanese East-West border effect together with the respective share of differentiated products according to the conservative/liberal classification in Rauch (1999).

²⁶Observations in Figure 5 are weighted by the industry-level trade volume. Insignificant East-West border effects are treated as zeros.

for shipments that are transported either by sea or by road. Figure 6, which uses yearly CFS

Figure 6: *The East-West Border Effect by Transportation Mode from 2000-2012 (PPML)*



data from 2000 to 2012, confirms this picture: For shipments that are transported by rail no intra-Japanese East-West border effect seem to exist.²⁷ One explanation for the absence of an intra-Japanese East-West border effect for railway-based shipments may result from the fact that Japan’s railway network historically expanded along an east-west dimension, that still matters today.²⁸ Hence, it is possible that the intra-Japanese East-West border effect is offset or even overcompensated (cf. Specification (2) of Table 11) by a (positive) east-west bias resulting from Japan’s railway infrastructure, that among other things endured the privatisation of formerly state-owned Japanese National Railways (JNR), which in 1987 was split up into seven separate companies (including Japan Railways (JR) East and West).

Summing up, the intra-Japanese East-West border effect can be observed consistently over time and has increased slightly over the decade from 2000 to 2012. Moreover, there is no evidence in favour of explanations for the intra-Japanese East-West border effect that are based on local preferences, limited trust or Japan’s railway infrastructure.

²⁷Estimates in Figure 6 are obtained from a pooled sample covering the decade from 2000 to 2012. Following Nitsch and Wolf (2013), all regressions include the complete set of time-varying importer- and exporter-specific fixed effects and allow error terms to be correlated within prefecture pairs. Disaggregating bilateral trade flows by mode of transportation results in a considerable number of zero trade flows, such that PPML is used as preferred estimation technique. Figures 6a, 6b, and 6c plot the obtained parameter estimates for the intra-Japanese East-West border effect together with the corresponding 99%-confidence intervals. The complete set of estimates from all three regressions is reported in a Technical Supplement, which is available from the author upon request.

²⁸The Tōkaidō Main line, which in 1889 was completed as Japan’s first long-distance railway line, connecting Tōkyō and Kōbe, by the early 1950’s had become Japan’s main artery for railway-based transportation: Although accounting only for 3 percent of Japanese National Railways’ (JNR’s) total railway network, the Tōkaidō Main line carried 24 percent of its passengers and 23 percent of its freight (cf. Smith, 2003).

4 Sensitivity Analysis

To ensure that the intra-Japanese East-West border effect does not result from statistical artefacts, Section 4 offers a wide range of sensitivity checks: In Subsection 4.1 several millions of placebo regressions are performed to verify the unique east-west dimension of the intra-Japanese border effect. Subsection 4.2 allows for alternative and more flexible specifications of bilateral transportation cost.

4.1 Placebo Regressions

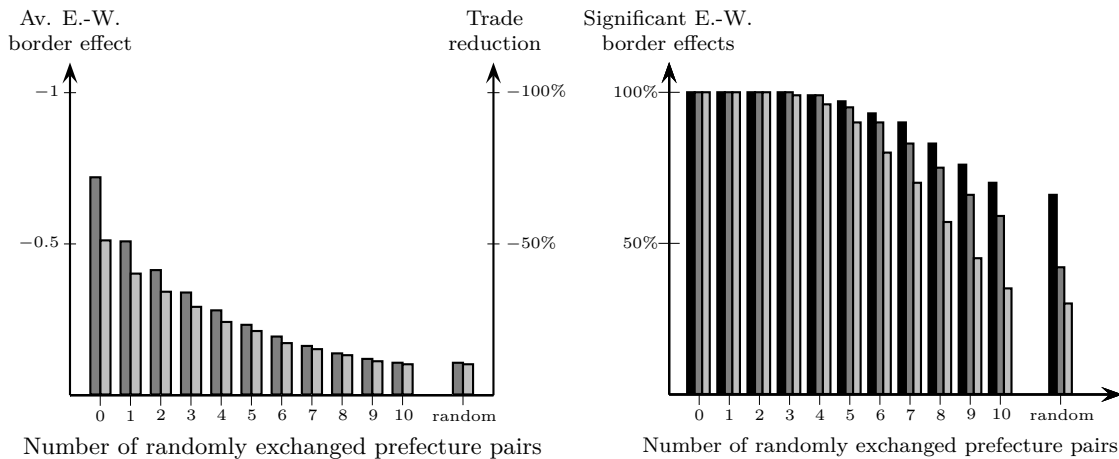
To what extent does trade across the intra-Japanese East-West border from Figure 2, differ from trade across any other *hypothetical* borders inside Japan? To answer this question, in a first step a million placebo regressions based on Specification (1) in Table 4 are performed.²⁹ Thereby each of these placebo regressions randomly assign the 47 Japanese Prefectures either to a hypothetical “East” or to a hypothetical “West”. Surprisingly often there is a border effect, which at a 1% significance level is negative and significant in 33.9% of all cases. However, the trade-reducing effect of these hypothetical borders on average is rather small (10% compared to 51.3% in the benchmark case). The largest border effect out of a million placebo regressions implies a trade reduction of 36.6%, which is still one third smaller than the baseline result of 51.3%. Reassuringly, equality between the border effect in the benchmark scenario and the border effects resulting from the placebo regressions *always* can be rejected at a 1% level of significance.

In a second step, both prefecture blocks (i.e. the hypothetical “East” and the hypothetical “West”) are conditioned to be of similar size. Starting out from the allocation in Figure 2, prefectures in up to 10 randomly chosen East-West prefecture pairs are intentionally misallocated between the “East” and the “West”. Thereby, for each specification with 1 to 10 exchanged East-West prefecture pairs again a *million* placebo regressions are performed. As evident from Figure 7, the average East-West border effect falls together with the share of placebos, in which a significant border effects results, as more and more East-West prefecture pairs are “misallocated”.³⁰ Provided the number of exchanged East-West prefecture pairs is sufficiently large, the outcome resembles an allocation, in which all prefectures are randomly allocated across the hypothetical “East” and “West”.

²⁹After all there exist 2^{47} possible ways of counting Japan’s 47 prefecture either to a hypothetical “East” or to a hypothetical “West”. Covering all these possible allocations in single placebo regressions would be computationally infeasible. Hence, following Felbermayr and Gröschl (2014), a million randomly chosen placebo regressions are performed.

³⁰Figure 7a plots the mean estimate (dark gray) together with the implied trade reduction in percent (light gray). Figure 7b differentiates between the usual 1%, (black), 5% (dark gray), and 10% (light gray) significance levels.

Figure 7: *The Average East-West Border Effect in a Million Placebo Regressions*



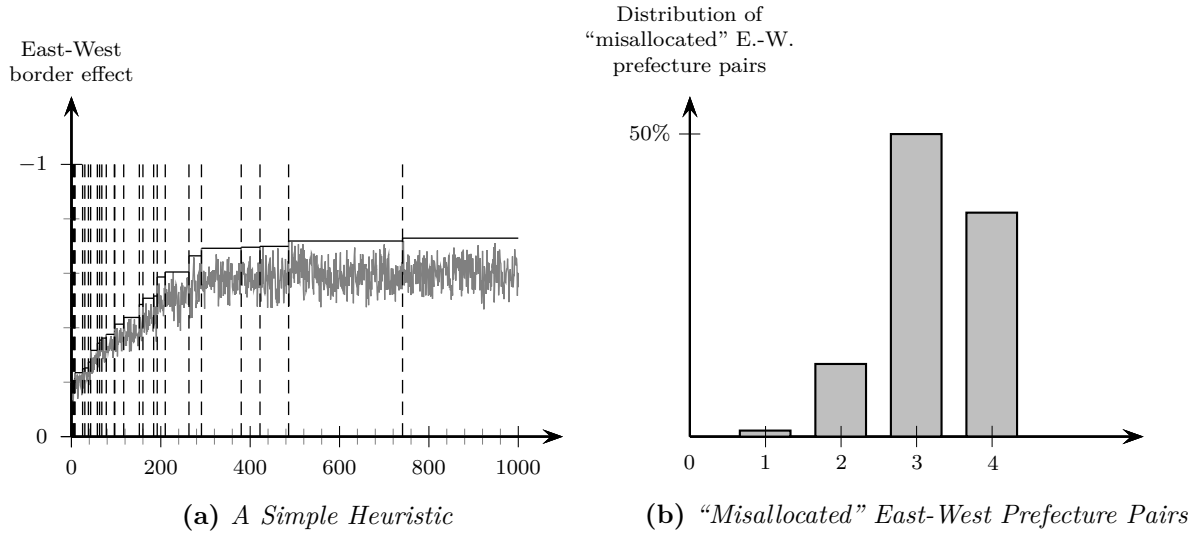
(a) *Average Size of the East-West Border Effect* (b) *Share of Significant East-West Border Effects*

Finally, in a third step, a simple heuristic is constructed to search for the *maximum* intra-Japanese border effect. Thereby the search algorithm starts from a random baseline allocation of prefectures into two similarly sized prefecture blocks. Then in each iteration step one randomly chosen prefecture from each block is experimentally assigned to the respective other block. If one of the newly obtained allocations generates an intra-Japanese border effect, that is larger than the border effect in the baseline allocation, the algorithm stops and adopts this allocation as the new baseline allocation before continuing its search for the *maximum* intra-Japanese border effect. Overall the algorithm is performed 100 times with 10,000 iteration steps in each run. As evident from Figure 8a, which plots the typical first 1,000 iteration steps, the algorithm converges fast to a level, which is comparable to the East-West border effect identified in Column (1) of Table 4.³¹ Interestingly, the maximum intra-Japanese border effect detected in 100 runs thereby is only slightly larger in absolute size and implies a trade reduction of 52.9% ($e^{-0.752} - 1$) instead of 51.9%, resulting from the baseline regression in Specification (1) of Table 4. Interestingly, the allocations of prefectures preferred by the algorithm is very similar to the allocation imposed in Figure 2: The median number of “misallocated” prefecture pairs is three. Overall the number of “misallocated” East-West prefecture pairs does not exceed four (cf. Figure 8b).

To account for the possibility that there might exist further spatial trade barriers above and beyond the intra-Japanese East-West barrier identified in Subsection 3.2, two additional, *hypothetical* “borders” within the East and the West are randomly introduced into another

³¹Dashed lines in Figure 8a indicate the adoption of a *new* baseline allocation of prefectures. The benchmark for the *maximum* border effect at each iteration step thereby is given by the upper envelope over all estimated border effects up to this point.

Figure 8: *In Search for the Maximum Intra-Japanese Border Effect*



million of placebo regressions. For this purpose the East and the West are again subdivided into two blocks of fixed size (12 + 11 eastern and 12 + 12 western prefectures). For each placebo regression prefectures within the East and the West then are randomly allocated to both blocks. In 32.3% (29.1%) of all cases there is a significant intra-East (intra-West) border effect. However, usually these effects (mean point estimate of -0.1106 and -0.1118, respectively) are small compared to the intra-Japanese East-West border effect, which, although slightly reduced in size (with a mean point estimate of -0.5804), is highly significant throughout *all* placebo regressions.

In further robustness checks several plausible prefecture allocations are investigated as alternatives to the allocation in Figure 2. To check the sensitivity of results with respect to the allocation of border prefectures, Japan’s central *Chûbu* region with its 9 prefectures (located in-between the *Kantô* and *Kansai* area) is divided between the East and the West.³² For *all* $2^9 = 512$ possible splits of the *Chûbu* region a negative and highly significant East-West border effect exists, which only in 32% of all cases is statistically different from the baseline estimate in Column (1) of Table 4. Moreover, the East-West border effect is also robust against a complete exclusion of the *Chûbu* region from the sample. Similarly, when dropping potential outliers such as *Okinawa* or *Hokkaidô*, the baseline result from Subsection 3.2 are not affected.

To sum up, several million placebo regressions not only confirm the intra-Japanese border effect’s *unique* east-west dimension, but also show that the intra-Japanese East-West border effect is unchallenged in terms of its economic importance. Along no other spatial dimension trade reductions of comparable magnitude can be identified and there is no evidence in sup-

³²Interestingly the name *Chûbu* (中部) literally translates into “middle” *chû* (中) and “part” *bu* (部).

port of alternative and/or additional spatial trade barriers that can be linked to systematic geographic borderlines.

4.2 Alternative Specification – Bilateral Transportation Cost

Table 12 in the Appendix accounts for the possibility that the intra-Japanese East-West border effect identified in Subsection 3.2 results from the mismeasurement of bilateral transportation cost (cf. Head and Mayer, 2002; Hillberry and Hummels, 2008). In the benchmark specifications (cf. Columns (1) and (2) of Table 12) inter-prefectural distance is measured by the greater-circle distance between prefecture capitals, while intra-prefectural distance is approximated by one fourth of the distance to the closest neighbouring prefecture. Given that 85.0% of all intra-Japanese shipments in 2010 were transported on the road, real-road distance inferred from Google Maps (cf. Ozimek and Miles, 2011) is used in Specifications (3) and (4) as an alternative distance measure. In Specifications (5) and (6) Japan’s unique Grid Square Statistic is employed to compute *consistently* inter- and intra-prefectural distances as population-weighted averages over bilateral distances between 374,674 squared cells of 1km² size (cf. Mayer and Zignago, 2011; Yotov, 2012).³³ Alternatively, bilateral transportation cost in Specification (7) are measured by real travel time (cf. Ozimek and Miles, 2011). Finally, to allow for a more flexibility in the measurement of bilateral distance, Specification (8) introduces distance intervals as in Eaton and Kortum (2002). Following Felbermayr and Gröschl (2014), five distance intervals (in kilometres) are introduced to cover the ranges [0,250), [250,500), [500,1000), [1000,2000), and [2000,max], which are implemented in Specification (8) through a set of four dummy variables (using the range [0,250] as reference category).

Throughout all specifications of Table 12 a negative and highly significant intra-Japanese East-West border effect exists. However, two observations are noteworthy: First, irrespective of how bilateral distances are measured, the intra-Japanese East-West border effect tends to be larger, when unit transport cost (per metric ton and kilometre) are used as distance weights (cf. Specifications (1),(3), and (5) vs. (2), (4), and (6), respectively). As argued in Subsection 3.1, per unit transport cost decline over longer distances (see Figure 1). Thus, if the heterogeneity in unit transport cost is ignored, the impact of distance on bilateral trade is underestimated (overestimated) over short (long) distances, and the implied trade reduction over short distances is misattributed to other proxies for short-distance trade (e.g. proxies for trade within the East or the West). As a consequence, the trade-inhibiting effect of the Intra-Japanese East-West

³³Following Mayer and Zignago (2011) and Yotov (2012) bilateral distance between prefecture i and j is computed as $\text{dist}_{ij} = \sum_{i \in i} \text{pop}_i / \text{pop}_i \sum_{j \in j} \text{pop}_j / \text{pop}_j \text{dist}_{ij}$, where pop_i and pop_j refer to the population at location \hat{i} and \hat{j} in 2010, and dist_{ij} denotes greater-circle distance between location \hat{i} and \hat{j} .

border is underestimated relative to a specification, which accounts for transportation fixed cost (see also Table 3). Second, the intra-Japanese East-West border effect is smaller in magnitude (although still highly significant) if distance is weighted by Japan’s highly disaggregated population distribution (cf. Specification (5) and (6) of Table 12), which is in line with the finding of Hillberry and Hummels (2008) that the home bias in intra-US trade disappears once shipments are tracked at a highly disaggregated ZIP-code level.

Together these findings suggest that there is no evidence supporting an explanation of the intra-Japanese East-West border effect in terms of misspecified bilateral transportation cost.

5 Explaining the Intra-Japanese East-West Border Effect

In order to explain the intra-Japanese East-West border effect Subsection 5.1 gradually introduces a wide range of contemporaneous *and* historical controls into the baseline regression from Table 4. Subsection 5.2 then isolates those explanatory variables, which display a significant variation along the east-west dimension. Following Chen (2004), the relationship between these variables and the border effect is examined by including the intra-Japanese East-West border dummy together with an interaction term between the border dummy and the explanatory variable of interest.

5.1 In Search for Explanations

This section examines whether the intra-Japanese East-West border effect is biased by observable characteristics at the prefecture-pair level. To this end a large number of contemporaneous and historical determinants from the empirical trade literature are introduced one by one into the baseline regression from Subsection 3.2.³⁴ As a point of reference Specification (1) in Table 13 from the Appendix presents the benchmark result including geographic trade costs variables only.

Business networks: Specification (2) in addition controls for the role of business networks. Following Combes, Lafourcade, and Mayer (2005), Japan’s 2009 *Economic Census* [*Keizai Sensasu*] is used to compute the total number of bilateral headquarter-plant links between any two prefectures. By construction the resulting business-network variable is symmetric, suggesting that headquarter-plant links are equally important for exports and imports between any pair of prefectures i and j . In line with the findings of Combes, Lafourcade, and Mayer (2005)

³⁴Following Felbermayr and Gröschl (2014), variables that are not bilateral in nature, are bilateralised by taking the product of the respective variables in prefecture i and prefecture j , which then is denoted by the \times operator. The product of variables thereby in an intuitive manner relates to network effects between prefecture pairs. For a critical discussion on the limits of this approach see Head and Mayer (2015).

and Garmendia, Llano, Minondo, and Requena (2012), the positive and significant network coefficient in Column (2) is associated with a reduced (although still significant) intra-Japanese East-West border effect.

Social networks: To account for the role of social networks resulting from internal migration (cf. Helliwell, 1997; Head and Ries, 1998; Millimet and Osang, 2007) inter- and intra-prefectural migration flows from the 2010 *Report on Internal Migration in Japan* [*Jûmin Kihon Daichô Jinkô Idô Hôkoku*] are aggregate up over the five-year interval from 2005 to 2009.³⁵ As suggested by the literature, migration has a positive and highly significant impact on bilateral trade. Accounting for the social network effect from internal migration moreover mitigates the intra-Japanese East-West border effect, which in Column (3) of Table 13 becomes statistically indistinguishable from zero.

Alternatively, Specifications (4) and (5) control for social networks resulting from individual commuting and travel patterns. Thereby the total number of inter- and intra-prefectural commuters (excluding students) is derived from the 2010 *Population Census* [*Kokusei Chôsa*]. Information on the accumulated flows of road-, rail-, and air-travel passengers over the five-year interval from 2005 to 2009 are obtained from the 2010 *Passenger Flow Survey* [*Ryokuyaku Chiiki Ryûdô Chôsa*]. Network effects in Specifications (4) and (5) resemble those of internal migration in Specification (3) and have a similar (although less intense) impact on the intra-Japanese East-West border effect.³⁶

Coethnic networks: To control for the role of coethnic networks in intra-Japanese trade, the geographic distribution of ethnic Chinese and Koreans from Japan's 2010 *Population Census* [*Kokusei Chôsa*] is taken into account.³⁷ Thereby the strength of a coethnic network is approximated by the product of the respective minority's prefectural population shares (cf. Rauch and Trindade, 2002). Accounting for coethnic networks does not affect the intra-Japanese East-West border effect, and *unobserved* fractionalisation (cf. Felbermayr, Jung, and Toubal, 2010) may explain the somewhat counterintuitive trade-inhibiting effect of ethnic Korean networks in Specifications (6) and (9).³⁸

³⁵Due to data limitations, the majority of existing studies (see Genc, Gheasi, Nijkamp, and Poot, 2012, for a recent meta-analysis) uses migration stocks instead of accumulated migration flows to proxy for migration networks. As a consequence the trade-creating effects of temporary stays due to return or onward migration are ignored.

³⁶When accounting for the complete set of controls in Specification (9), only the trade-enhancing effect of air-travel networks survives, which is in line with the finding of Cristea (2011), who shows that the demand for business-class air travel is directly related to the volume of U.S. state-level exports in differentiated products.

³⁷As Japan's two major ethnic minorities Chinese and Koreans accounted for 27.9% and 25.7% of all non-natives in 2010. While most of today's ethnic Koreans are the descendants of Koreans that stayed in Japan after World War II, Chinese immigration is a more recent phenomenon. Results remain unchanged if coethnic networks among the much smaller groups of immigrants from the Philippines, Thailand, Indonesia, Vietnam, the United Kingdom, the United States, Brazil or Peru are additionally taken into account.

³⁸The Japanese Population Census does not distinguish between North- and South-Koreans, given that most

Religious networks: Data from the 2010 *Religion Yearbook* [*Shûkyô Nenkan*] is used to capture networks originating from Japan’s three major Religions (Shintoism, Buddhism, and Christianity). For each prefecture the share of supporters of a given religion in the respective prefecture’s total number of supporters is computed.³⁹ However, including the product of prefectures’ religion shares as a measure for religious networks in Specification (7) of Table 13 does not impact on the East-West bias in intra-Japanese trade.

Trust: To control for the trade-inhibiting effect of limited trust (cf. Guiso, Sapienza, and Zingales, 2009) data on individual trust levels from the 2010 wave of the Japanese General Social Survey (JGSS) are used to compute the prefectural population share of people which state that they trust other people.⁴⁰ Bilateral trust, approximated by the product of prefectural trust shares, has the expected positive impact on intra-Japanese trade (cf. Guiso, Sapienza, and Zingales, 2009). However, in line with the results from Subsection 3.3, the intra-Japanese East-West border effect can not be explained through an east-west heterogeneity in the trade-creating effect of bilateral trust.

History: Recently, several authors (cf. Head, Mayer, and Ries, 2010; Nitsch and Wolf, 2013; Felbermayr and Gröschl, 2014) have highlighted the long shadow of history for inter- and intra-national trade. Thereby Felbermayr and Gröschl (2014) argue that the American Civil War lead to a manifestation of long-lasting cultural differences, which continue to shape the pattern of trade between the former Union and Confederacy until today. To identify an internal conflict of comparable importance in Japan’s history one has to go back quite far to the end of the *Sengoku* period (15th/16th century), which literally translates into “the period of warring states”. In 1600, Japan’s (re-)unification under Oda Nobunaga, Toyotomi Hideyoshi, and Tokugawa Ieyasu climaxed in the battle of Sekigahara, in which Tokugawa Ieyasu, supported by the majority of eastern feudal lords, succeed over a coalition of mainly western feudal lords. This victory not only formed the basis for the subsequent rule of the Tokugawa dynasty (1603-1868),

Koreans arrived in Japan prior to the outbreak of the Korean war (1950-1953), that lead to the division of Korea. Nevertheless, most Koreans sympathise either with the North or the South and are organised in the General Association of Korean Residents in Japan [*Chongryon*] or in the Korean Residents Union in Japan [*Mindan*], respectively (cf. Ryang and Lie, 2009).

³⁹While in existing studies (cf. Lewer and Van den Berg, 2007a,b) the number of supporters reporting adherence to a certain religion usually is put into relation to the overall population of the respective region or country, this approach would be misleading in the case of Japan, where a substantial part of the population feels attached to more than one religion. According to the *Religion Yearbook*, in 2010 there were 106.5 million people in Japan reporting adherence to Shintoism, 89.7 million people reported adherence to Buddhism, and 2.1 million people declared an affinity to Christianity. Together these numbers exceed Japan’s total population of 127.5 millions in 2010 by 55%.

⁴⁰Respondents were asked: “Generally speaking, would you say that people can be trusted or that you can’t be too careful in dealing with people?” The answers to the trust question then were coded as 1 (almost always trust), 2 (usually trust), 3 (usually can’t be too careful), and 4 (almost always can’t be too careful). At the prefecture-level the share of respondents that have trust towards other people consequently is computed as the number of respondents in categories 1 and 2 relative to the number of respondents in all four categories, taking into account the internal weights of the 2010 wave of the JGSS.

but also lead to a distinction between *fudai* vs. *tozama* feudal lords (*daimyo*), depending on whether the respective vassal at Sekigahara were on the winning or losing side. To consolidate their power base the first five Tokugawa rulers (*shoguns*) between 1601 and 1705 confiscated and redistributed one half of the country’s total taxable land base (cf. Hall, 1991, pp. 150-53). The henceforth stable distribution of land holdings that emerged from this process towards the end of the 17th century then was characterised by a core-versus-periphery pattern: while most of the loyal *fudai daimyo* were rewarded by strategically important domains in central Japan, most of the *tozama daimyo* were pushed to Japan’s north-eastern and south-western periphery. To capture the geographic dimension of this political division, which endured throughout the 18th century and finally also featured prominently in the Tokugawa shogunate’s decline, administrative data from the *Summary of han governments* [*Hansei ichiran*], compiled by the new Meiji government soon after it came to power in 1868, is used. Building up on the work of Beasley (1960), all major feudal domains (*han*) with an annual yield of more than 50,000 *koku* of rice (1 *koku* \approx 5 bushels) are identified as either a *fudai* or *tozama* domain.⁴¹ Using the same concordance list as in Davis and Weinstein (2002) to match Japan’s 68 historical provinces to the present 47 Japanese prefectures, it is possible to reconstruct a historical border between former *fudai* vs. *tozama* landholdings. The resulting border is characterised by a clear core-versus-periphery pattern and differs substantially from the East-West “border” in Figure 2. Reassuringly, the historical *fudai*-versus-*tozama* border in Specification (9) of Table 13 affects neither today’s cross-border trade nor the intra-Japanese East-West border effect.

Thus, while there is little evidence in favour of an explanation for the intra-Japanese East-West border effect in terms of defunct borders originating from the politics of pre-modern Japan, it is of course possible that other (unobserved) historical shocks have the potential to explain the east-west bias in intra-Japanese trade. To account for such explanations a comprehensive measure of *past* economic and political interactions between Japanese prefectures is required. To meet this challenge Falck, Heblich, Lameli, and Südekum (2012) propose a measure of cultural proximity, which can be constructed from geographic variation in historical dialect data. The proposed cultural proximity index thereby builds on the idea that similarities in prefectures’ dialectical imprints are the outcome of an evolutionary process shaped by past interactions between the respective prefectures. For Japan data on the geographic variation of historical dialects exists in form of the Linguistic Atlas of Japan (LAJ) [*Nihon Gengo Chizu*]. Based on a survey conducted by the National Language Research Institute between 1957 and 1964, the LAJ covers 285 prototypical language characteristics from 2400 locations all over Japan, reported

⁴¹As in Beasley (1960) the term *fudai* subsumes direct branch houses of the Tokugawa family (*sanke*, *sakyō*, *kamon*).

by male informants, which are born not later than in 1903.⁴² For each Japanese prefecture a characteristic set of *dominant* realisations for 240 uniquely identifiable language characteristics exists, such that it is possible to compute a simple index of cultural proximity as the percentage overlap in identical realisations at the prefecture-pair level.⁴³ Although, in today’s Japan, which *de jure* and *de facto* is a single-language country, dialects no longer represent an actual hurdle to communication, the modern use of dialects still contributes in an integral way to cultural identities at the sub-national level. By exploiting the strong correlation between modern and historical dialect patterns, it hence is possible to proxy contemporaneous cultural differences across Japanese prefectures through historical dialect similarity. Importantly, the historical geography of dialect similarity thereby is far from random. For the case of Germany Falck, Heblich, Lameli, and Südekum (2012) show that historical dialect patterns can be linked to past geographic, political or religious borders as well as to distinct events of historical mass migrations. Similar anecdotal evidence exist for Japan: Using a Geographical Information Systems (GIS) to match the spatial distribution of negative suffixes to Japan’s surface topography, Onishi (2011) shows that the resulting borderline between the East (using *-nai*) and the West (using *-n* as well as its variants *-sen*, *-hen*, and *-hin*) is exactly predicted by a natural pattern of long valleys and high mountain chains in the Japanese Alps. For another example, consider Table 14 (in the Appendix), which plots Japan’s cultural proximity matrix. Focussing on the prefectures of Hokkaidô and Okinawa it is easily verified that both prefectures are language enclaves located in Japan’s extreme periphery. Due to its isolated location and its unique history Okinawa’s dialect differs substantially from the dialects of mainland Japan (with a maximum overlap of just about 15%). For Hokkaidô, which is similarly isolated, the overlap in dialectical imprints with its direct neighbouring prefectures (e.g. Aomori with 32% overlap and Iwate with 39% overlap) is limited as well. However, Hokkaidô’s dialect at the same time displays a close resemblance to the dialects of more distant prefectures from central Honshu (e.g. Tôkyô or Nagano, each with an remarkable overlap of 64%). What does explain this striking difference? Unlike Okinawa, Hokkaidô during the second half of the 19th century became the target of systematic colonisation efforts, which not only were associated with an internal mass migration towards Hokkaidô but also with a subsequent acculturation towards central Japan.⁴⁴ Both examples highlight how historical interactions between Japanese prefectures are preserved within

⁴²More detailed information on the sampling of locations and informants are reported in Tokugawa and Masanobu (1966).

⁴³Following Falck, Heblich, Lameli, and Südekum (2012) the cultural proximity index for prefecture pair $i \times j$ equals $CP_{ij} \equiv \sum_{c=1}^{240} I_{ijc} / \sum_{c=1}^{240} I_{iic} \in [0, 1]$, in which I_{ijc} is an indicator variable, taking the value one if both prefectures share the same dominant realisation for the language characteristic $c = 1, \dots, 240$ and zero otherwise.

⁴⁴Over the turn of the century the population of Hokkaidô soared. Thereby, the massive increase in population was largely due to immigration, which raised the number of inhabitants from 150,000 in 1870 to almost 2.5 million in 1930 (cf. UNFPA, 1981).

the respective prefectures’ dialectical imprints. Cultural proximity, approximated by historical dialect similarity, therefore represents a comprehensive measure for past interactions at the prefecture-pair level and serves as a natural control for (alternative) history-based explanations of the intra-Japanese East-West border effect. When included into Specification (8) of Table 13, cultural proximity not only is associated with increased bilateral trade (cf. Felbermayr and Toubal, 2010; Lameli, Nitsch, Südekum, and Wolf, 2015), but also with a mitigated (although still significant) East-West border effect.

Summing up the results from Table 13, two potential explanations for the intra-Japanese East-West border effect can be identified: On the one hand, the intra-Japanese East-West border effect (at least partly) can be explained by the structure of business and social networks (Combes, Lafourcade, and Mayer, 2005), which both are a likely outcome of post-war agglomeration trends, associated with a massive concentration of economic activity in Japan’s major metropolitan areas (cf. Fujita and Tabuchi, 1997). On the other hand, it can not be ruled out that unobserved historical shocks gave rise to cultural differences across Japanese prefectures, which still matter today (cf. Felbermayr and Gröschl, 2014; Lameli, Nitsch, Südekum, and Wolf, 2015).

5.2 History versus Agglomeration

To sort out whether the intra-Japanese East-West border effect can be explained through history or agglomeration, Table 5 (suppressing the other controls from Table 4) includes the East-West border dummy together with an interaction term between the border dummy and the explanatory variable of interest (cf. Chen, 2004). Thereby the sign and significance of the coefficient on the interaction term indicates whether the intra-Japanese East-West border is up- or downward biased through the geographic heterogeneity in the effect that business and social networks compared to cultural proximity have on intra-Japanese trade.

Is there any evidence that the East-West border effect can be explained by the structure of intra-Japanese business networks? Column (2) of Table 5 reports the results with the business network variable. The negative and significant coefficient on the interaction term with the East-West border dummy shows that the trade enhancing-effect of business networks is stronger within the East and the West than across the east-west dimension. Comparing the 75% and 25% percentile of the headquarter-plant linkages, implies a reduction in the (absolute) intra-Japanese East-West border effect from $-0.4960 = -0.1034 - (0.0721 \times 5.4424)$ to $-0.2937 = -0.1034 - (0.0721 \times 2.6391)$, which corresponds to an increase in cross-border trade by 13.7 percentage points. The intra-Japanese East-West border effect therefore (at least partly) can

be explained through the structure of Japanese business networks, which are stronger within rather than between the East and the West. Specification (3) of Table 5 reveals that social

Table 5: *Explaining the Intra-Japanese East-West Border Effect*

| Dependent variable: Exports in tons from prefecture i to prefecture j | | | | | |
|---|-----------------------|-----------------------|-----------------------|-----------------------|----------------------|
| Year: | 2010 | | | | |
| Survey: | 1YS | | | | |
| Unit: | Quantities | | | | |
| Model: | OLS-FE | | | | |
| Specification: | (1) | (2) | (3) | (4) | (5) |
| East-West border dummy $_{ij}$ | -0.7188*** (.0487) | -0.1034 (.1229) | 0.6043** (.2431) | -1.4651*** (.1713) | -0.2990 (.4065) |
| \ln number of headquarter-plant links $_{ij}$ | | 0.7780*** (.0446) | | | 0.3837*** (.0709) |
| \ln number of headquarter-plant links $_{ij} \times$ East-West border dummy $_{ij}$ | | -0.0721*** (.0243) | | | -0.0702 (.0632) |
| \ln agg. migration flows (2005-2009) $_{ij}$ | | | 0.9898*** (.0429) | | 0.5142*** (.0802) |
| \ln agg. migration flows (2005-2009) $_{ij} \times$ East-West border dummy $_{ij}$ | | | -0.0834*** (.0281) | | -0.0063 (.0779) |
| Cultural proximity $_{ij}$ | | | | 4.3630*** (.3409) | 1.8940*** (.3881) |
| Cultural proximity $_{ij} \times$ East-West border dummy $_{ij}$ | | | | 2.7277*** (.4046) | 1.4569*** (.4198) |
| Fixed effects: | | | | | |
| Exporter (i) | ✓ | ✓ | ✓ | ✓ | ✓ |
| Importer (j) | ✓ | ✓ | ✓ | ✓ | ✓ |
| Summary statistics: | | | | | |
| Number of observations | 2,207 | 2,207 | 2,207 | 2,207 | 2,207 |
| R^2 | .8287 | .8641 | .8678 | .8486 | .8759 |

Robust standard errors; significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

networks are characterised by the same effect heterogeneity as business networks. Migration networks foster trade, however, they do less so across the east-west dimension. Again comparing the 75% and 25% percentile of aggregated bilateral migration flows, suggests a decline in the magnitude of intra-Japanese East-West border effect from $-0.1666 = 0.6043 - (0.0834 \times 9.2432)$ to $0.0416 = 0.6043 - (0.0834 \times 6.7475)$, which is equivalent to an increase in cross-border trade by 19.6 percentage points. The *dual* structure of Japan's business and social networks thus offers a convincing explanation for the observed intra-Japanese East-West border effect.

Are the network effects along the intra-Japanese east-west dimension reinforced or even predetermined by cultural differences between the East and the West of Japan? To answer this question Column (4) of Table 5 includes an interaction term of the East-West border effect with the cultural proximity index from Subsection 5.1. Interestingly, the positive and significant interaction term suggests that the trade-creating effect of cultural proximity is stronger between rather than within both country parts. Table 14 from Subsection 5.1 confirms this result: instead of the familiar east-west pattern from Table 2 a clear core-versus-periphery pattern can be identified. The index of cultural proximity, which within the core (Prefectures with the numbers 7 to 40) usually ranges between 0.4 and 0.7 drops down to values somewhere around

0.2 or 0.3 once prefecture pairings between the core and the periphery are considered. Finally, comparing the 25% and 75% percentile of the cultural proximity index, implies intra-Japanese East-West border effects of $-0.6582 = -1.4651 + (2.7277 \times 0.2958)$ and $-0.1013 = -1.4651 + (2.7277 \times 0.5000)$, respectively. An equivalent improvement in the cultural ties between Japanese prefecture therefore would be associated with a (relative) increase in East-West trade by 38.6 percentage points. Thus, there is no evidence that the intra-Japanese border effect results from cultural differences between East- and West-Japan. Indeed, the true size of the intra-Japanese border effect to some extent is concealed by the strong cultural ties between Japan’s central prefectures.

Together the results from Table 5 offer clear support for an explanation of the intra-Japanese East-West border effect in terms of business and social networks rather than in terms of cultural differences. As a robustness check, in Column (5) all interaction variables are included jointly in a single regression. While sign and significance for the interaction term with the cultural proximity index are preserved, the interaction terms for the network variables turn insignificant, probably due to a multicollinearity issue. The significance of each interaction term is restored once the respective other network variable is dropped from the regression.

Of course, network formation itself is an endogenous process, which ultimately raises the question why business and social network are stronger *within* rather than *between* the East and the West of Japan. Fujita and Tabuchi (1997) offer a simple answer to this question in terms of what they call the “Tôkyô-Ôsaka bipolar growth pattern”: During Japan’s post-war recovery period large metropolitan areas (MAs) grew at higher rates than the surrounding rural regions, which gave rise to substantial MA-versus-non-MA income differentials, triggering an unprecedented wave of rural-to-urban migration (cf. Tabuchi, 1988). In particular Japan’s three largest MAs: Tôkyô, Ôsaka and Nagoya experienced high rates of net immigration which peaked in 1960 and dropped dramatically after 1970.⁴⁵ Taking into account the self-sustaining and self-reinforcing nature of migration networks (cf. Carrington, Detragiache, and Vishwanath, 1996), it seems not unlikely that today’s dual structure of Japan’s inter-prefectural migration network can be traced back to a bipolarity in post-war agglomeration trends.⁴⁶ Accounting for the impact of past migration networks on Japan’s contemporaneous internal trade, Table 15 from the Appendix supports this view. If the dual structure of Japan’s social networks (gradually) emerged from post-war rural-to-urban migration trends, the capability of past migration net-

⁴⁵According to Fujita and Tabuchi (1997) Japan’s three largest MAs are defined as follows: the Tokyo MA comprises the prefectures Tôkyô, Kanagawa, Saitama and Chiba, the Ôsaka MA includes the prefectures Ôsaka, Hyôgo, Kyôto and Nara, while the Nagoya MA consists of the prefectures Aichi, Gifu, and Mie.

⁴⁶Evidence on how agglomeration affects the location decision of firms and workers is summarised in Head and Mayer (2004).

works to explain the contemporaneous east-west bias in intra-Japanese trade should improve, when moving from the late 1950s until today. Indeed, the trade-creating effect of migration is stronger, when more recent migration networks are taken into account. Even more interestingly, the interaction terms with the East-West border are small and insignificant for networks from the 1950s, 1960s, and 1970s and become *gradually* larger and highly significant if migration networks from the 1980s, 1990s, and 2000s are taken into account.

6 Conclusion

This paper identifies an intra-Japanese East-West border effect in the absence of an intra-Japanese East-West border and argues that discrete barriers to trade may but not necessarily have to coincide in their geography with the shape of present or past political borders. Thereby, the trade reduction of 23.1% to 51.3%, associated with intra-Japanese east-west trade relative to trade within both country parts, can be explained by the structure of contemporaneous business and social networks, which are the likely outcome of post-war agglomeration trends characterised by a “Tôkyô-Ôsaka bipolar growth pattern” (cf. [Fujita and Tabuchi, 1997](#)). To ensure that the intra-Japanese East-West border effect is not an artefact of defunct political borders (cf. [Nitsch and Wolf, 2013](#); [Felbermayr and Gröschl, 2014](#)), the distribution of feudal landholdings in pre-modern Japan as well as the similarity of historical dialects between Japanese prefectures are taken into account. Both measures point to historical differences between Japan’s core and periphery rather than between the East and the West, which (if at all) tend to increase bilateral trade across the east-west dimension.

Several conclusions can be drawn from this result: [The Economist \(2011\)](#) recently warned that the Great East Japan Earthquake around the world triggered concerns with regard to a disruption of global supply chains. According to [Saito \(2012\)](#) the extent to what Japan’s firms actually were affected thereby differed substantially depending on whether they were located in the East or the West of Japan. Accounting only for major supply links and allowing for up to two intermediary firms the fraction of (potentially) affected firms amounts to 54% in Tôhoku and 30% in Hokkaidô, but only to 14% – 17% in the rest of Japan. Thereby, one explanation for the difference in outcomes may lie in the fact that firms in the East and the West not only are separated by larger distances but also in terms of network “membership”, which acts as a natural firewall to prevent negative spillovers.

Taking into account Japan’s relative remoteness, [Eaton and Kortum \(2002\)](#) argue that due to its outstanding competitiveness in 1990 Japan belonged to the most open economies in their sample. However, following the argumentation of [Wolf \(2009\)](#), who uses historical intra-German

trade data from 1885 to 1933 to show that external disintegration led to a deeper internal trade integration, Japan's outstanding openness might alternatively be explained by a lack of internal integration as suggested by the intra-Japanese East-West border effect.

Finally, this paper also challenges (mainly Japanese) views on the *unique* homogeneity of Japan's society, as popularised by post-war theories (*Nihonjinron*) on the "unique qualities of Japanese culture, Japanese society, and the Japanese people" (cf. Befu, 2001). Cultural differences between Japanese prefectures, inferred from historical dialect data, exist – in particular between the core and the periphery of Japan. When accounting for the impact of cultural differences on inter-prefectural trade, a positive and significant effect of cultural proximity on intra-Japanese trade can be identified. Thereby the trade-enhancing effect of cultural similarity is stronger within the core than between the core and the periphery of Japan.

Summing up, this paper offers a simple and intuitive roadmap to identify discontinuous trade barriers in space, which not inevitably have to coincide with the geography of present or past political borders at the sub-national level. Focussing on the illustrative example of post-war agglomeration in Japan, it is argued that differences in regional growth led to a dual structure of business and social networks that favour intra-national trade within rather than between certain country parts. The network channel highlighted in this paper thereby points to the important role of agglomeration forces in shaping the geography of intra-national trade.

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A Appendix

Figure 9: *The National Commodity Flow Survey (NCFS)*

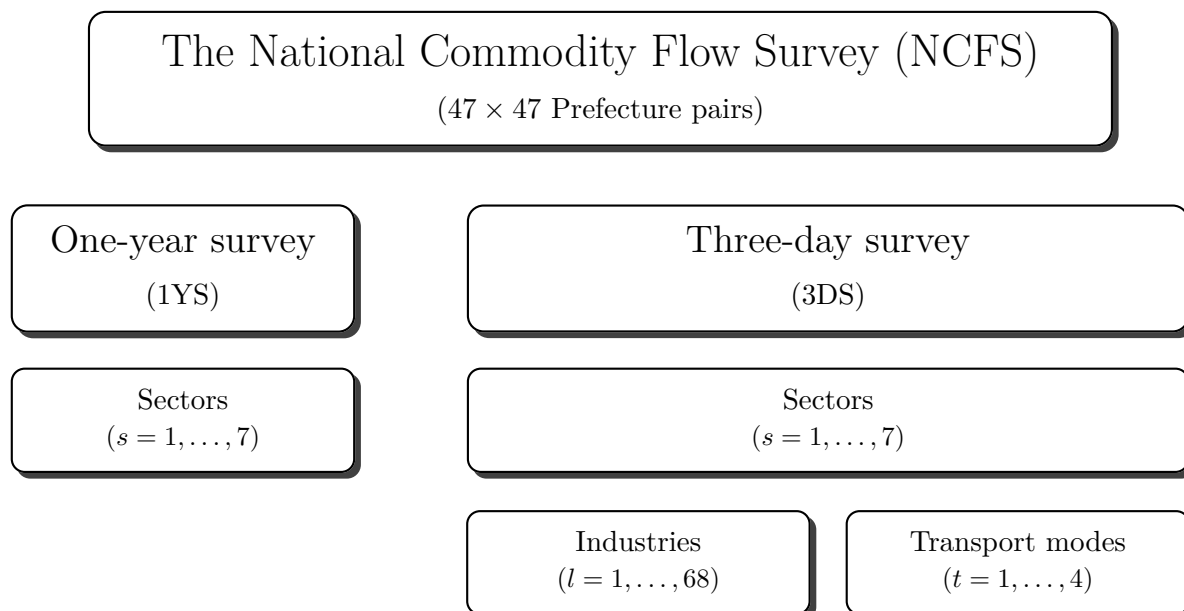


Figure 10: *The Commodity Flow Statistic (CFS)*

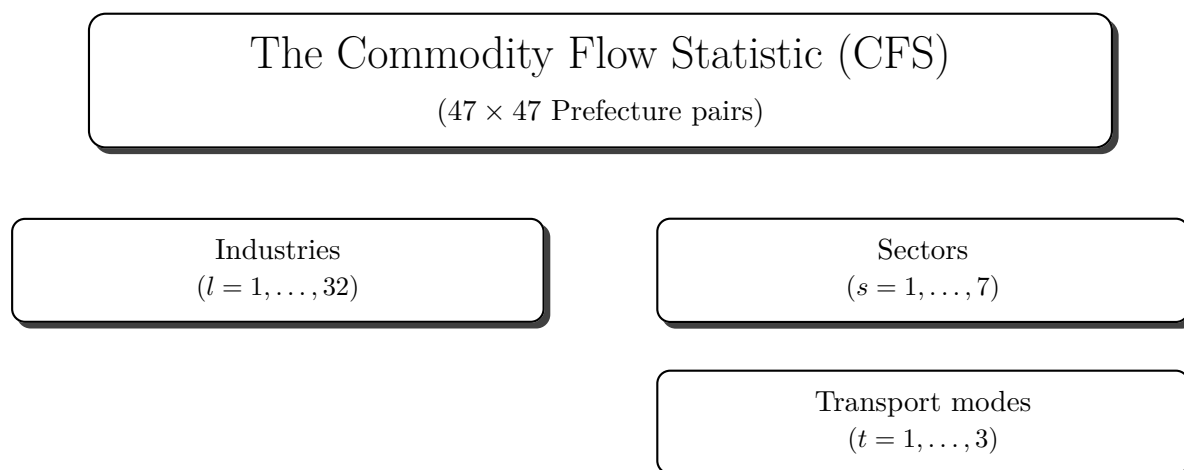


Table 6: Summary Statistics and Data Sources

| Unit of observation: Pairs of prefectures ($i \times j$) | | | | |
|---|------------------|-----------|----------|---|
| Variable | Year | Av. | S.D. | Data Source |
| \ln exports $_{ij}$ (1YS: disagg. by sector) | 2000, 2005, 2010 | 11.4396 | 2.3297 | } National Commodity Flow Survey; Ministry of Land, Infrastructure, Transport and Tourism (MLIT) |
| \ln exports $_{ij}$ (3DS: disagg. by industry & transport mode) | 2000, 2005, 2010 | 3.7796 | 3.1893 | |
| \ln transport cost $_{ij}$ (3DS: disagg. by transport mode) | 2000, 2005, 2010 | 9.0043 | 2.4351 | |
| \ln exports $_{ij}$ (disagg. by industry & transport mode) | 2000-2012 | 10.2585 | 2.7236 | Commodity Flow Statistic; Ministry of Land, Infrastructure, Transport and Tourism (MLIT) |
| \ln distance $_{ij}$ | – | 5.9114 | 0.9381 | } Own computation |
| Adjacency $_{ij}$ | – | 0.0806 | 0.2722 | |
| Prefecture border dummy $_{ij}$ | – | 0.9787 | 0.1443 | |
| Region border dummy $_{ij}$ | – | 0.8610 | 0.3459 | |
| Sea border dummy $_{ij}$ | – | 0.4463 | 0.4972 | |
| \ln number of headquarter-plant links $_{ij}$ | 2009 | 4.1930 | 2.0767 | Economic Census; Statistics Bureau of the Ministry of Internal Affairs and Communications (MIC) |
| \ln agg. migration flows $_{ij}$ | 2005-2009 | 8.0745 | 1.6952 | Report on Internal Migration in Japan; Statistics Bureau of the Ministry of Internal Affairs and Communications (MIC) |
| \ln agg. migration stocks $_{ij}$ | 1955-2010 | 6.5879 | 1.8311 | Historical Statistics of Japan; Statistics Bureau of the Ministry of Internal Affairs and Communications (MIC) |
| \ln commuting flows $_{ij}$ | 2010 | 4.1655 | 2.4721 | Population Census; Statistics Bureau of the Ministry of Internal Affairs and Communications (MIC) |
| \ln agg. passenger flows by road $_{ij}$ | 2005-2009 | 1.7623 | 4.5714 | } Passenger Flow Survey; Ministry of Land, Infrastructure, Transport and Tourism (MLIT) |
| \ln agg. passenger flows by rail $_{ij}$ | 2005-2009 | 10.4412 | 4.5798 | |
| \ln agg. passenger flows by air $_{ij}$ | 2005-2009 | 1.0362 | 3.5157 | |
| \times Shinto share $_{ij}$ | 2010 | 1744.1770 | 840.5430 | } Religion Yearbook; Agency for Cultural Affairs of the Ministry of Education (MEXT) |
| \times Buddhism share $_{ij}$ | 2010 | 1405.1470 | 457.0423 | |
| \times Christian share $_{ij}$ | 2010 | 25.3038 | 84.1938 | |
| \times Korean share $_{ij}$ | 2010 | 0.0472 | 0.0805 | |
| \times Chinese share $_{ij}$ | 2010 | 0.0847 | 0.0544 | |
| \times Philippine share $_{ij}$ | 2010 | 0.0095 | 0.0100 | |
| \times Thai share $_{ij}$ | 2010 | 0.0004 | 0.0008 | |
| \times Indonesian share $_{ij}$ | 2010 | 0.0002 | 0.0003 | |
| \times Vietnamese share $_{ij}$ | 2010 | 0.0003 | 0.0004 | |
| \times UK share $_{ij}$ | 2010 | 0.0000 | 0.0000 | |
| \times US share $_{ij}$ | 2010 | 0.0005 | 0.0009 | } Population Census; Statistics Bureau of the Ministry of Internal Affairs and Communications (MIC) |
| \times Brazilian share $_{ij}$ | 2010 | 0.0131 | 0.0420 | |
| \times Peruvian share $_{ij}$ | 2010 | 0.0006 | 0.0022 | |
| \times Trust share $_{ij}$ | 2010 | 0.4510 | 0.0722 | |
| Fudai versus tozama dummy $_{ij}$ | 1968 | 0.4581 | 0.4983 | Japanese General Social Surveys (JGSS); JGSS Research Center |
| Cultural proximity $_{ij}$ | 1957-1964 | 0.4110 | 0.1702 | Own Computation based on Beasley (1960) |
| | | | | Linguistic Atlas of Japan (LAJ); National Institute for Japanese Language and Linguistics (NINJAL) |

The operator \times denotes the product of variables in prefecture i and prefecture j .

Table 7: The Trade Cost Elasticity

| Dependent variable: Exports from prefecture i to prefecture j | | | | | | |
|---|-------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|
| Survey: | 3DS | | | | | |
| Data: | Sectoral | | | | | |
| Unit: | Values | | | | | |
| Model: | OLS-FE | | | | | |
| Year: | 2010 | 2005 | 2000 | 2010 | 2005 | 2000 |
| Specification: | (1) | (2) | (3) | (4) | (5) | (6) |
| $1 - \sigma_s$ | | | | | | |
| Overall | -1.5615*** (.0508) | -1.4899*** (.0568) | -1.5607*** (.0643) | | | |
| Agriculture | | | | -2.1296*** (.0922) | -1.9394*** (.1133) | -1.7002*** (.1150) |
| Forest | | | | -2.8135*** (.3628) | -1.1806*** (.1074) | -1.3821*** (.1780) |
| Minerals | | | | -1.3001*** (.1500) | -1.1882*** (.1286) | -1.8177*** (.0870) |
| Machinery | | | | -1.5805*** (.1081) | -1.8136*** (.1607) | -2.0229*** (.1592) |
| Chemicals | | | | -1.9457*** (.1315) | -1.7865*** (.2003) | -1.3756*** (.1389) |
| Manufacturing | | | | -1.0342*** (.05699) | -1.1659*** (.06139) | -1.3505*** (.07943) |
| Others | | | | -1.9238*** (.2894) | -3.7871*** (.3994) | -2.4876*** (.4164) |
| East-West border dummy $_{ij}$ | -0.1906*** (0.0488) | -0.2264*** (0.0500) | -0.2409*** (0.0465) | -0.1670*** (0.0487) | -0.1978*** (0.0494) | -0.2459*** (0.0464) |
| ln distance $_{ij}$ | -0.8035*** (0.0543) | -0.8798*** (0.0522) | -0.9033*** (0.0483) | -0.8056*** (0.0534) | -0.8652*** (0.0514) | -0.8840*** (0.0478) |
| Adjacency $_{ij}$ | 0.7048*** (0.0869) | 0.6515*** (0.0842) | 0.6374*** (0.0806) | 0.6865*** (0.0857) | 0.6632*** (0.0832) | 0.6344*** (0.0800) |
| Prefecture border dummy $_{ij}$ | -2.6488*** (0.2366) | -2.6281*** (0.2509) | -2.4630*** (0.2186) | -2.6104*** (0.2329) | -2.6693*** (0.2458) | -2.4744*** (0.2189) |
| Region border dummy $_{ij}$ | -0.2449*** (0.08083) | -0.2452*** (0.0759) | -0.1660** (0.0740) | -0.2471*** (0.0799) | -0.2369*** (0.0744) | -0.1619** (0.0733) |
| Sea border dummy $_{ij}$ | -0.3253*** (0.0842) | -0.3738*** (0.0815) | -0.2093*** (0.0730) | -0.3025*** (0.0827) | -0.3536*** (0.0804) | -0.2142*** (0.0730) |
| Fixed effects: | | | | | | |
| Exporter \times sector ($i \times s$) | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Importer \times sector ($j \times s$) | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Summary statistics: | | | | | | |
| Number of observations | 10, 713 | 10, 343 | 10, 590 | 10, 713 | 10, 343 | 10, 590 |
| R^2 | .7699 | .7753 | .7728 | .7644 | .7802 | .7749 |

Robust standard errors clustered at the sector level; significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 8: *Predicted Consumption Gains at the Prefecture Level*

| ε | \hat{C}_j^A | | | \hat{C}_j | | |
|---------------|---------------|--------|--------|-------------|--------|--------|
| | -1.56 | -3.19 | -4.51 | -1.56 | -3.19 | -4.51 |
| Hokkaidô | 1.0467 | 1.0226 | 1.0159 | 0.9457 | 0.9730 | 0.9808 |
| Aomori | 1.0511 | 1.0247 | 1.0174 | 1.1008 | 1.0544 | 1.0401 |
| Iwate | 1.1901 | 1.0888 | 1.0620 | 1.0008 | 0.9893 | 0.9900 |
| Miyagi | 1.0944 | 1.0451 | 1.0317 | 0.9280 | 0.9635 | 0.9735 |
| Akita | 1.0573 | 1.0276 | 1.0194 | 1.1079 | 1.0533 | 1.0370 |
| Yamagata | 1.4880 | 1.2145 | 1.1474 | 1.6564 | 1.2973 | 1.2064 |
| Fukushima | 1.1845 | 1.0863 | 1.0603 | 1.2446 | 1.1250 | 1.0899 |
| Ibaraki | 1.3138 | 1.1428 | 1.0990 | 1.1657 | 1.0899 | 1.0653 |
| Tochigi | 1.2440 | 1.1127 | 1.0784 | 1.2343 | 1.1211 | 1.0870 |
| Gunma | 1.3130 | 1.1424 | 1.0988 | 1.2249 | 1.1096 | 1.0774 |
| Saitama | 1.4858 | 1.2137 | 1.1468 | 1.0031 | 1.0037 | 1.0030 |
| Chiba | 1.2216 | 1.1028 | 1.0717 | 1.0964 | 1.0814 | 1.0649 |
| Tôkyô | 1.3935 | 1.1762 | 1.1216 | 0.7727 | 0.8774 | 0.9095 |
| Kanagawa | 1.2493 | 1.1150 | 1.0800 | 0.9858 | 1.0102 | 1.0110 |
| Niigata | 1.1080 | 1.0514 | 1.0361 | 1.0513 | 1.0271 | 1.0197 |
| Toyama | 1.0518 | 1.0250 | 1.0176 | 1.1891 | 1.1037 | 1.0763 |
| Ishikawa | 1.0656 | 1.0315 | 1.0222 | 1.1537 | 1.0811 | 1.0594 |
| Fukui | 1.1220 | 1.0579 | 1.0406 | 1.2612 | 1.1300 | 1.0924 |
| Yamanashi | 1.0742 | 1.0356 | 1.0251 | 1.1382 | 1.0715 | 1.0516 |
| Nagano | 1.1185 | 1.0563 | 1.0395 | 1.1440 | 1.0778 | 1.0575 |
| Gifu | 1.1553 | 1.0731 | 1.0512 | 1.2008 | 1.1093 | 1.0810 |
| Shizuoka | 1.1933 | 1.0903 | 1.0630 | 1.0493 | 1.0279 | 1.0207 |
| Aichi | 1.1367 | 1.0647 | 1.0453 | 0.7377 | 0.8777 | 0.9158 |
| Mie | 1.4208 | 1.1874 | 1.1292 | 1.5030 | 1.2504 | 1.1742 |
| Shiga | 1.9575 | 1.3888 | 1.2615 | 1.4172 | 1.1845 | 1.1240 |
| Kyôto | 1.2793 | 1.1280 | 1.0889 | 1.4349 | 1.2235 | 1.1591 |
| Ôsaka | 1.2733 | 1.1254 | 1.0872 | 0.8207 | 0.9158 | 0.9415 |
| Hyôgo | 1.2908 | 1.1329 | 1.0923 | 0.9065 | 0.9600 | 0.9724 |
| Nara | 1.2851 | 1.1305 | 1.0906 | 1.2680 | 1.1306 | 1.0903 |
| Wakayama | 1.0992 | 1.0473 | 1.0333 | 1.5089 | 1.2577 | 1.1822 |
| Tottori | 1.1914 | 1.0894 | 1.0624 | 0.9711 | 0.9672 | 0.9724 |
| Shimane | 1.1255 | 1.0595 | 1.0417 | 1.0402 | 1.0117 | 1.0093 |
| Okayama | 1.4826 | 1.2124 | 1.1459 | 1.4996 | 1.2695 | 1.1944 |
| Hiroshima | 1.2352 | 1.1088 | 1.0758 | 1.0460 | 1.0231 | 1.0163 |
| Yamaguchi | 1.0784 | 1.0376 | 1.0264 | 1.2632 | 1.1594 | 1.1194 |
| Tokushima | 1.1033 | 1.0493 | 1.0346 | 1.3920 | 1.1977 | 1.1388 |
| Kagawa | 1.2731 | 1.1253 | 1.0871 | 1.3384 | 1.1665 | 1.1186 |
| Ehime | 1.1403 | 1.0663 | 1.0464 | 1.1413 | 1.0719 | 1.0517 |
| Kôchi | 1.0929 | 1.0444 | 1.0312 | 1.0043 | 0.9938 | 0.9921 |
| Fukuoka | 1.1973 | 1.0920 | 1.0643 | 0.7798 | 0.8913 | 0.9240 |
| Saga | 1.3014 | 1.1375 | 1.0954 | 1.2518 | 1.1147 | 1.0799 |
| Nagasaki | 1.3564 | 1.1608 | 1.1112 | 0.9940 | 0.9715 | 0.9742 |
| Kumamoto | 1.3625 | 1.1633 | 1.1129 | 1.1883 | 1.0807 | 1.0549 |
| Ôita | 1.1536 | 1.0724 | 1.0507 | 1.2777 | 1.1434 | 1.1033 |
| Miyazaki | 1.1908 | 1.0891 | 1.0623 | 1.1297 | 1.0571 | 1.0384 |
| Kagoshima | 1.1281 | 1.0607 | 1.0426 | 1.3338 | 1.1648 | 1.1124 |
| Okinawa | 1.0480 | 1.0232 | 1.0163 | 0.6583 | 0.7871 | 0.8349 |
| Overall | 1.2508 | 1.1139 | 1.0789 | 1.0279 | 1.0168 | 1.0123 |

Table 9: *The East-West Border Effect in 2000, 2005, and 2010*

| Dependent variable: Exports from prefecture i to prefecture j | | | | | | | |
|---|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| Survey: | 1YS | | | | 3DS | | |
| Data: | Aggregated | | Aggregated | | Sectoral | | |
| Unit: | Quantities | | Quantities | | Values | | Quantities |
| Model: | OLS-FE | PPML-FE | OLS-FE | PPML-FE | OLS-FE | PPML-FE | PPML-FE |
| Specification: | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| Year: 2010 | | | | | | | |
| East-West border dummy $_{ij}$ | -0.7188*** (.0487) | -0.3956*** (.1130) | -0.5395*** (.0542) | -0.3601*** (.1173) | -0.5661*** (.0619) | -0.2631* (.1392) | -0.3255*** (.0498) |
| Summary statistics: | | | | | | | |
| Number of observations (Pseudo) R^2 | 2,207 .8287 | 2,209 .9367 | 2,199 .8914 | 2,209 .9494 | 2,199 .7944 | 2,209 .9766 | 109,104 .8839 |
| Year: 2005 | | | | | | | |
| East-West border dummy $_{ij}$ | -0.6090*** (.0544) | -0.4334*** (.0876) | -0.5503*** (.0574) | -0.4010*** (.1043) | -0.6876*** (.0640) | -0.2484 (.1740) | -0.4495*** (.1225) |
| Summary statistics: | | | | | | | |
| Number of observations (Pseudo) R^2 | 2,207 .8206 | 2,209 .9313 | 2,203 .8373 | 2,209 .9382 | 2,203 .8091 | 2,209 .9611 | 111,281 .8815 |
| Year: 2000 | | | | | | | |
| East-West border dummy $_{ij}$ | -0.8117*** (.0479) | -0.5216*** (.0962) | -0.9525*** (.0593) | -0.5656*** (.1053) | -0.7983*** (.0608) | -0.4704*** (.1342) | -0.5711*** (.0754) |
| Summary statistics: | | | | | | | |
| Number of observations (Pseudo) R^2 | 2,200 .8116 | 2,209 .9369 | 2,191 .7807 | 2,209 .9589 | 2,176 .7843 | 2,209 .9599 | 113,043 .9249 |
| Fixed effects: | | | | | | | |
| Exporter (i) | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ |
| Importer (j) | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✗ |
| Exporter \times Sector ($i \times s$) | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✓ |
| Importer \times Sector ($j \times s$) | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✓ |

Robust standard errors (in Specification (7) clustered at the industry level); significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 10: *The East-West Border Effect Sector by Sector for 2000, 2005, & 2010*

| Dependent variable: Exports in tons from prefecture i to prefecture j | | | | | | | |
|---|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| Survey: | 1YS | | | | | | |
| Unit: | Quantities | | | | | | |
| Model: | PPML-FE | | | | | | |
| Sector: | Agriculture | Forest | Minerals | Machinery | Chemical | Manufact. | Others |
| Specification: | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| Year: 2010 | | | | | | | |
| East-West border dummy $_{ij}$ | -0.7704*** (.1528) | -0.6547* (.3819) | -0.3341 (.3815) | -0.3132*** (.0954) | -0.3825** (.1796) | -0.4143*** (.1021) | -0.5248*** (.1299) |
| Summary statistics: | | | | | | | |
| Number of observations | 2,209 | 2,162 | 2,209 | 2,209 | 2,209 | 2,209 | 2,209 |
| Pseudo R^2 | .9581 | .9732 | .9627 | .9544 | .9587 | .9216 | .7659 |
| Year: 2005 | | | | | | | |
| East-West border dummy $_{ij}$ | -0.9571*** (.1412) | -1.0140*** (.3154) | -0.5832 (.4238) | -0.3146*** (.0833) | -0.4963*** (.1317) | -0.4860*** (.0831) | -0.4452*** (.1003) |
| Summary statistics: | | | | | | | |
| Number of observations | 2,209 | 2,209 | 2,209 | 2,209 | 2,209 | 2,209 | 2,209 |
| Pseudo R^2 | .9654 | .8107 | .9664 | .9228 | .9386 | .8931 | .9102 |
| Year: 2000 | | | | | | | |
| East-West border dummy $_{ij}$ | -0.2811 (.1808) | 0.4489* (.2670) | -0.9214*** (.2903) | -0.3725*** (.0852) | -0.4079*** (.1226) | -0.3139*** (.0921) | -0.3676*** (.0867) |
| Summary statistics: | | | | | | | |
| Number of observations | 2,209 | 2,209 | 2,209 | 2,209 | 2,209 | 2,209 | 2,209 |
| Pseudo R^2 | .9228 | .9357 | .9824 | 0.9438 | 0.9610 | 0.9158 | 0.9003 |
| Fixed effects: | | | | | | | |
| Exporter (i) | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Importer (j) | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

Significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 11: *The East-West Border Effect by Transportation Mode for 2000, 2005, and 2010*

| Dependent variable: Exports from prefecture i to prefecture j | | | | | |
|---|-----------------------|-----------------------|-----------------------|-----------------------|--------------------|
| Survey: | 3DS | | | | |
| Data: | Sectoral | | | | |
| Unit: | Quantities | | | | |
| Model: | PPML-FE | | | | |
| Transportation mode: | all | rail | road | sea | air |
| Specification: | (1) | (2) | (3) | (4) | (5) |
| Year: 2010 | | | | | |
| East-West border dummy $_{ij}$ | -0.4723*** (.0858) | 0.5982** (.2781) | -0.4260*** (.0359) | -0.2946 (.3077) | 0.1895 (.3112) |
| Summary statistics: | | | | | |
| Number of observations (Pseudo) R^2 | 33,614 .8941 | 7,345 .8046 | 15,416 .9188 | 5,211 .4413 | 5,193 .6045 |
| Year: 2005 | | | | | |
| East-West border dummy $_{ij}$ | -0.5678*** (.1653) | 0.3009** (.1307) | -0.3548*** (.0972) | -0.7837* (.4079) | -0.1737 (.2284) |
| Summary statistics: | | | | | |
| Number of observations (Pseudo) R^2 | 34,241 .9041 | 7,497 .8901 | 15,463 .9339 | 5,456 .4444 | 5,825 .4111 |
| Year: 2000 | | | | | |
| East-West border dummy $_{ij}$ | -0.3169*** (.0457) | -0.3869*** (.0357) | -0.0939 (.0907) | -0.7596*** (.1960) | -0.2338 (.3395) |
| Summary statistics: | | | | | |
| Number of observations (Pseudo) R^2 | 36,250 .9405 | 7,775 .6896 | 15,463 .9609 | 6,064 .5706 | 6,948 .6872 |
| Fixed effects: | | | | | |
| Exporter×Sector ($i \times s$) | ✗ | ✓ | ✓ | ✓ | ✓ |
| Importer×Sector ($j \times s$) | ✗ | ✓ | ✓ | ✓ | ✓ |
| Exporter×Sector×Transport mode ($i \times s \times t$) | ✓ | ✗ | ✗ | ✗ | ✗ |
| Importer×Sector×Transport mode ($j \times s \times t$) | ✓ | ✗ | ✗ | ✗ | ✗ |

Robust standard errors clustered at the industry level; significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 12: Robustness Checks: Transportation Cost

| Dependent variable: Exports in tons from prefecture i to prefecture j | | | | | | | | |
|---|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| Year: | 2010 | | | | | | | |
| Survey: | 1YS | | | | | | | |
| Unit: | Quantities | | | | | | | |
| Model: | OLS-FE | | | | | | | |
| Specification: | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| East-West border dummy $_{ij}$ | -0.7188*** (.0487) | -0.3313*** (.0557) | -0.4329*** (.0514) | -0.3178*** (.0529) | -0.3942*** (.0527) | -0.1818*** (.0548) | -0.2942*** (.0532) | -0.2832*** (.0571) |
| ln transport cost $_{ij}$ | -0.5238*** (.0426) | | -0.5167*** (.0294) | | -0.5377*** (.0303) | | | |
| ln distance $_{ij}$ | | -1.0827*** (.0579) | | -1.1818*** (.0580) | | -1.3508*** (.0568) | | |
| ln travel time $_{ij}$ | | | | | | | -1.3796*** (.0592) | |
| Within 250 - 500 km | | | | | | | | -0.7817*** (.0580) |
| Within 500 - 1000 km | | | | | | | | -1.5872*** (.0789) |
| Within 1000 - 2000 km | | | | | | | | -2.6022*** (.1640) |
| More than 2000 km | | | | | | | | -4.5850*** (.5950) |
| Adjacency $_{ij}$ | 1.0743*** (.0895) | 0.5182*** (.0897) | 0.7359*** (.0844) | 0.4511*** (.0878) | 0.7225*** (.0842) | 0.3566*** (.0861) | 0.4406*** (.0854) | 0.9784*** (.0856) |
| Prefecture border dummy $_{ij}$ | -3.6356*** (.2396) | -1.7584*** (.3148) | -2.3636*** (.2661) | -1.5071*** (.3081) | -2.7631*** (.2419) | -2.3030*** (.2455) | -1.3230*** (.2919) | -4.1700*** (.2222) |
| Region border dummy $_{ij}$ | -0.5619*** (.0846) | -0.1401 (.0852) | -0.2952*** (.0808) | -0.09520 (.0826) | -0.3153*** (.0803) | -0.1002 (.0804) | -0.04854 (.0794) | -0.5019*** (.0807) |
| Sea border dummy $_{ij}$ | -0.5937*** (.0856) | -0.4185*** (.0893) | -0.4379*** (.0834) | -0.4292*** (.0878) | -0.3851*** (.0819) | -0.2807*** (.0812) | -0.3315*** (.0858) | -0.2377*** (.0822) |
| Fixed effects: | | | | | | | | |
| Exporter (i) | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Importer (j) | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Summary statistics: | | | | | | | | |
| Number of observations | 2,207 | 2,207 | 2,207 | 2,207 | 2,207 | 2,207 | 2,207 | 2,207 |
| R^2 | .8287 | .8357 | .8425 | .8396 | .8438 | .8438 | .8415 | .8386 |

Robust standard errors; significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 13: *In Search for Explanations of the Intra-Japanese East-West Border Effect*

| Dependent variable: Exports in tons from prefecture <i>i</i> to prefecture <i>j</i> | | | | | | | | | | | |
|---|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|------------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| Year: | 2010 | | | | | | | | | | |
| Survey: | 1YS | | | | | | | | | | |
| Unit: | Quantities | | | | | | | | | | |
| Model: | OLS-FE | | | | | | | | | | |
| Specification: | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) |
| East-West border dummy _{ij} | -0.7188*** (.0487) | -0.3892*** (.0479) | -0.0610 (.0507) | -0.3558*** (.0486) | -0.4686*** (.0523) | -0.7082*** (.0484) | -0.7181*** (.0486) | -0.7149*** (.0490) | -0.7156*** (.0489) | -0.4626*** (.0523) | -0.0385 (.0511) |
| Business networks: | | | | | | | | | | | |
| <i>ln</i> number of headquarter-plant links _{ij} | | 0.7312*** (.0394) | | | | | | | | | 0.2998*** (.0594) |
| Social networks: | | | | | | | | | | | |
| <i>ln</i> agg. migration flows (2005-2009) _{ij} | | | 0.9323*** (.0377) | | | | | | | | 0.4234*** (.0702) |
| <i>ln</i> commuting flows (2010) _{ij} | | | | 0.4613*** (.0240) | | | | | | | 0.1380*** (.0332) |
| <i>ln</i> agg. passenger flows by road (2005-2009) _{ij} | | | | | 0.0254*** (.0066) | | | | | | -0.0106* (.0061) |
| <i>ln</i> agg. passenger flows by rail (2005-2009) _{ij} | | | | | 0.1056*** (.0121) | | | | | | 0.0029 (.0126) |
| <i>ln</i> agg. passenger flows by air (2005-2009) _{ij} | | | | | 0.0474*** (.0082) | | | | | | 0.0166** (.0065) |
| Coethnic networks: | | | | | | | | | | | |
| × Korean share _{ij} | | | | | | -2.3841*** (.3719) | | | | | -1.4639*** (.3454) |
| × Chinese share _{ij} | | | | | | -4.0124*** (1.5153) | | | | | 0.3181 (1.3561) |
| Religious networks: | | | | | | | | | | | |
| × Shintoism share _{ij} | | | | | | | 0.0001 (.0002) | | | | -0.0001 (.0001) |
| × Buddhism share _{ij} | | | | | | | -0.0004* (.0002) | | | | -0.0001 (.0002) |
| × Christian share _{ij} | | | | | | | 0.0041 (.0049) | | | | -0.0014 (.0037) |
| Bilateral trust: | | | | | | | | | | | |
| × Trust share _{ij} | | | | | | | | 6.7061* (4.0205) | | | -2.9383 (3.4190) |
| Historical controls: | | | | | | | | | | | |
| Fudai vs. tozama dummy _{ij} | | | | | | | | | 0.0312 (.0439) | | 0.0135*** (.0412) |
| Cultural proximity _{ij} | | | | | | | | | | 4.9766*** (.3436) | 2.1379*** (.4234) |
| Geographic controls: | | | | | | | | | | | |
| <i>ln</i> transport cost _{ij} | -0.5238*** (.0426) | -0.3564*** (.0385) | -0.3086*** (.0399) | -0.3884*** (.0411) | -0.4346*** (.0408) | -0.5229*** (.0429) | -0.5240*** (.0428) | -0.5237*** (.0426) | -0.5240*** (.0426) | -0.4337*** (.0402) | -0.2724*** (.0375) |
| Adjacency _{ij} | 1.0743*** (.0895) | 0.1264 (.0810) | 0.06565 (.0765) | -0.3386*** (.1028) | 0.6878*** (.0894) | 1.1383*** (.0905) | 1.0662*** (.0900) | 1.0721*** (.0897) | 1.0731*** (.0897) | 0.5954*** (.0853) | -0.3130*** (.0881) |
| Prefecture border dummy _{ij} | -3.6356*** (.2396) | -1.0795*** (.1985) | -1.2485*** (.2004) | -0.7583*** (.2385) | -2.2727*** (.2514) | -3.7731*** (.2290) | -3.6689*** (.2400) | -3.5960*** (.2408) | -3.6406*** (.2399) | -1.3517*** (.2695) | 0.3108 (.2334) |
| Region border dummy _{ij} | -0.5619*** (.0846) | -0.0735 (.0711) | -0.0199 (.0669) | -0.0248 (.0779) | -0.4837*** (.0778) | -0.6105*** (.0860) | -0.5632*** (.0846) | -0.5613*** (.0848) | -0.5729*** (.0865) | -0.1255 (.0798) | 0.1903*** (.0690) |
| Sea border dummy _{ij} | -0.5937*** (.0856) | -0.1460** (.0741) | -0.3273*** (.0780) | -0.4372*** (.0784) | -0.3576*** (.0870) | -0.6161*** (.0854) | -0.5949*** (.0858) | -0.6001*** (.0857) | -0.5950*** (.0858) | -0.5090*** (.0787) | -0.2252*** (.0754) |
| Fixed effects: | | | | | | | | | | | |
| Exporter (<i>i</i>) | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Importer (<i>j</i>) | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Summary statistics: | | | | | | | | | | | |
| Number of observations | 2,207 | 2,207 | 2,207 | 2,207 | 2,207 | 2,207 | 2,207 | 2,207 | 2,207 | 2,207 | 2,207 |
| R ² | .8287 | .8634 | .8673 | .8535 | .8411 | .8317 | .8292 | .8289 | .8287 | .8443 | .8773 |

Robust standard errors; significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 15: Agglomeration and the Intra-Japanese East-West Border Effect

| Dependent variable: Exports in tons from prefecture i to prefecture j | | | | | | | | | | | |
|---|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| Year: | 2010 | | | | | | | | | | |
| Survey: | 1YS | | | | | | | | | | |
| Unit: | Quantities | | | | | | | | | | |
| Model: | OLS-FE | | | | | | | | | | |
| Specification: | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) |
| East-West border dummy $_{ij}$ | -0.1074 (.2152) | -0.0988 (.2212) | 0.0069 (.2208) | 0.0236 (.2237) | 0.2428 (.2355) | 0.4488* (.2362) | 0.4973** (.2306) | 0.5693** (.2390) | 0.6682*** (.2437) | 0.6283** (.2448) | 0.6068** (.2431) |
| ln agg. migration stocks (1955-1959) $_{ij}$ | 0.6364*** (.0316) | | | | | | | | | | |
| ln agg. migration stocks (1955-1959) $_{ij}$ × East-West border dummy $_{ij}$ | 0.0035 (.0262) | | | | | | | | | | |
| ln agg. migration stocks (1960-1964) $_{ij}$ | | 0.5869*** (.0321) | | | | | | | | | |
| ln agg. migration stocks (1960-1964) $_{ij}$ × East-West border dummy $_{ij}$ | | -0.0016 (.0253) | | | | | | | | | |
| ln agg. migration stocks (1965-1969) $_{ij}$ | | | 0.6257*** (.0328) | | | | | | | | |
| ln agg. migration stocks (1965-1969) $_{ij}$ × East-West border dummy $_{ij}$ | | | -0.0122 (.0246) | | | | | | | | |
| ln agg. migration stocks (1970-1974) $_{ij}$ | | | | 0.6816*** (.0343) | | | | | | | |
| ln agg. migration stocks (1970-1974) $_{ij}$ × East-West border dummy $_{ij}$ | | | | -0.0117 (.0245) | | | | | | | |
| ln agg. migration stocks (1975-1979) $_{ij}$ | | | | | 0.8125*** (.0378) | | | | | | |
| ln agg. migration stocks (1975-1979) $_{ij}$ × East-West border dummy $_{ij}$ | | | | | -0.0343 (.0262) | | | | | | |
| ln agg. migration stocks (1980-1984) $_{ij}$ | | | | | | 0.8577*** (.0382) | | | | | |
| ln agg. migration stocks (1980-1984) $_{ij}$ × East-West border dummy $_{ij}$ | | | | | | -0.0590** (.0266) | | | | | |
| ln agg. migration stocks (1985-1989) $_{ij}$ | | | | | | | 0.8585*** (.0390) | | | | |
| ln agg. migration stocks (1985-1989) $_{ij}$ × East-West border dummy $_{ij}$ | | | | | | | -0.0678** (.0266) | | | | |
| ln agg. migration stocks (1990-1994) $_{ij}$ | | | | | | | | 0.8789*** (.0394) | | | |
| ln agg. migration stocks (1990-1994) $_{ij}$ × East-West border dummy $_{ij}$ | | | | | | | | -0.0767*** (.0268) | | | |
| ln agg. migration stocks (1995-1999) $_{ij}$ | | | | | | | | | 0.9639*** (.0409) | | |
| ln agg. migration stocks (1995-1999) $_{ij}$ × East-West border dummy $_{ij}$ | | | | | | | | | -0.0843*** (.0275) | | |
| ln agg. migration stocks (2000-2004) $_{ij}$ | | | | | | | | | | 1.0078*** (.0420) | |
| ln agg. migration stocks (2000-2004) $_{ij}$ × East-West border dummy $_{ij}$ | | | | | | | | | | -0.0822*** (.0279) | |
| ln agg. migration stocks (2005-2009) $_{ij}$ | | | | | | | | | | | 0.9892*** (.0428) |
| ln agg. migration stocks (2005-2009) $_{ij}$ × East-West border dummy $_{ij}$ | | | | | | | | | | | -0.0837*** (.0281) |
| ln transportation cost $_{ij}$ | -0.3587*** (.0367) | -0.3780*** (.0365) | -0.3711*** (.0361) | -0.3550*** (.0359) | -0.3312*** (.0388) | -0.3164*** (.0388) | -0.3128*** (.0384) | -0.3081*** (.0386) | -0.2936*** (.0386) | -0.2920*** (.0388) | -0.3088*** (.0397) |
| Adjacency $_{ij}$ | 0.2881*** (.0772) | 0.3235*** (.0791) | 0.2992*** (.0774) | 0.2680*** (.0768) | 0.1339* (.0771) | 0.0913 (.0773) | 0.1051 (.0783) | 0.1090 (.0783) | 0.0362 (.0773) | 0.0009 (.0775) | 0.01483 (.0782) |
| Prefecture border dummy $_{ij}$ | -1.2806*** (.2028) | -1.4822*** (.2016) | -1.3679*** (.1974) | -1.1881*** (.1958) | -0.8007*** (.2116) | -0.6923*** (.2129) | -0.7109*** (.2127) | -0.6355*** (.2137) | -0.3323 (.2161) | -0.1768 (.2215) | -0.2852 (.2282) |
| Region border dummy $_{ij}$ | -0.2727*** (.0689) | -0.3538*** (.0689) | -0.3296*** (.0670) | -0.3069*** (.0666) | -0.1610** (.0691) | -0.1013 (.0693) | -0.0969 (.0698) | -0.0540 (.0702) | 0.0247 (.0694) | 0.0750 (.0694) | 0.0420 (.0694) |
| Sea border dummy $_{ij}$ | -0.3217*** (.0745) | -0.4871*** (.0744) | -0.5031*** (.0736) | -0.4979*** (.0739) | -0.4748*** (.0779) | -0.4052*** (.0777) | -0.3819*** (.0774) | -0.3988*** (.0774) | -0.3549*** (.0769) | -0.3443*** (.0772) | -0.3375*** (.0783) |
| Fixed effects: | | | | | | | | | | | |
| Exporter (i) | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Importer (j) | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Summary statistics: | | | | | | | | | | | |
| Number of observations | 2,116 | 2,116 | 2,116 | 2,116 | 2,207 | 2,207 | 2,207 | 2,207 | 2,207 | 2,207 | 2,207 |
| R^2 | .8606 | .8593 | .8617 | .8638 | .8657 | .8669 | .8672 | .8677 | .8696 | .8700 | .8678 |

Robust standard errors; significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. For Okinawa no migration data available before 1972.