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Abstract

This paper identifies a "border" effect in the absence of a border. The finding that trade between East- and West-Japan is 23.1 to 51.3 percent lower than trade within both country parts, is established despite the absence of an obvious east-west division due to historical borders, cultural differences or past civil wars. Post-war agglomeration processes, reflected by the contemporaneous structure of Japan's business and social networks, rather than cultural differences, induced by long-lasting historical shocks, are identified as an explanation for the east-west bias in intra-Japanese trade.

JEL-Codes: F140, F150, F120.

Keywords: border effects, gravity equation, intra-national Trade, Japan.

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1 Introduction

Beginning with the seminal contribution of McCallum (1995), the literature on international economics (e.g. Anderson and van Wincoop, 2003; Chen, 2004) has repeatedly documented the trade-reducing effect of international borders. Observed border effects between Canada and the US as well as between member states of the European Union not only tend to be puzzlingly large and persistent, but also immune to explanations in terms of political trade barriers (cf. Wei, 1996; Hillberry, 1999; Head and Mayer, 2000; Chen, 2004). After reviewing twenty years of research, Head and Mayer (2013) conclude that in order to explain observed border effects, the genuine effect of political borders has to be carefully disentangled from three usual suspects frequently associated with the so-called border puzzle: imperfect information, localised tastes, and the structure of (distribution) networks. However, if these are the factors responsible for observed border effects, why should they not also matter along other spatial dimensions?

This paper is the first to identify a "border" effect without a border. Focussing on the illustrative example of Japan, it is demonstrated that inter-prefectural trade between East- and West-Japan is 23.1 to 51.3 percent lower than trade within both country parts. Remarkably, this finding is established in the absence of an obvious east-west division due to defunct historical borders, striking cultural differences or past civil wars. A wide range of sensitivity checks (including several millions of placebo regressions) robustly confirm the existence of a single intra-Japanese "border" effect with a clear east-west dimension, and reject possible explanations in terms of statistical artefacts (cf. Hillberry, 2002; Hillberry and Hummels, 2003, 2008).

Having established the existence of an intra-Japanese East-West "border" effect, it is argued that post-war agglomeration processes characterised by a "Tôkyô-Ôsaka bipolar growth pattern" (cf. Fujita and Tabuchi, 1997) led to a persistent and self-reinforcing duality in the structure of Japan's business and social networks, whose trade-enhancing effect today is more pronounced within rather than between the East and the West of Japan. To rule out a legacy of historical isolation or internal conflicts (cf. Head and Mayer, 2013) as the underlying determinant for the agglomeration-based explanation of the (negative) east-west bias in Japan's internal trade, historical dialect data is used to construct a comprehensive index of cultural proximity (cf. Lameli et al., 2015), capturing all long-lasting historical shocks, that left permanent imprints on Japan's culture. It turns out that cultural proximity is characterised by a distinctive core-versus-periphery pattern, which stands in marked contrast to the east-west pattern in the trade data.

The structure of multi-polar business and social networks, as the natural outcomes of endogenous agglomeration processes, is thus most relevant to understand the (negative) east-west bias in Japan's internal trade.

In order to identify an intra-Japanese East-West "border" effect, the analysis imposes a first tentative east-west "border", which not only represents a natural division into two equally-sized prefecture blocks (intuitively labelled as "East" and "West"), but also is in line with the definition of Japan's 9 administrative regions (*Hokkaidô, Tôhoku, Kantô, Chûbu, Kansai, Chûgoku, Shikoku, Kyûshû* and *Okinawa*). Based on the 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 higher within the East and West than between both country parts. Simple gravity regressions, which additionally account for the trade-inhibiting effect of bilateral transportation cost, confirm this pattern. Including an East-West "border" dummy in a gravity equation with exporter- and importer-specific fixed effects, 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 percent in east-west trade. Although this trade reduction may seem moderate compared to a drop in international trade of 80.8 percent, which Anderson and van Wincoop (2003) report for trade between Canadian provinces and U.S. federal states, it is substantial and much larger than the persistent reductions of 20.5 percent or 12.8 percent in contemporaneous intra-national trade across the former border between East- and West-Germany in Nitsch and Wolf (2013) or across the historical border between the Union and the Confederacy in Felbermayr and Gröschl (2014). The intra-Japanese East-West "border" effect represents an *ad valorem* tariff equivalent to about 13.4 to 43.4 percent, 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 percent, 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 that are located in close distance to the intra-Japanese East-West "border" would benefit.[1]

[1] The importance of market access for regional development is highlighted by Redding and Sturm (2008), who exploit the division of Germany after the Second World War and the subsequent reunification of East- and West-Germany in 1990 as natural experiments to show that the loss (restoration) of market access led to a deceleration (acceleration) of city growth in western border regions.

The paper's results are robust against employing alternative methodologies (in particular a Poisson-Pseudo-Maximum-Likelihood model, cf. Santos Silva and Tenreyro, 2006, 2010), measuring trade flows either in quantities or in values (cf. Combes et al., 2005; Nitsch and Wolf, 2013), or drawing on sectoral rather than on aggregate bilateral trade data (cf. Chen, 2004). The intra-Japanese East-West "border" effect can be identified across all waves (2000, 2005, 2010) of the National Commodity Flow Survey, and yearly data from the Japanese Commodity Flow Statistic suggests that there is a moderate increase in the intra-Japanese East-West "border" effect over the decade from 2000 to 2012. In line with the network/agglomeration-based explanation for the intra-Japanese East-West "border" effect, trade reductions tend to be stronger and more robust in secondary sectors (e.g. machinery, chemicals or manufacturing), rather than in primary sectors (e.g. agriculture, forest or minerals), whose homogeneous products can be traded at organised exchanges (cf. Rauch, 1999). Finally, to rule out the internal allocation of international shipments within the East and the West as a possible explanation for the upward bias in intra-block trade several robustness checks (including the subtraction of all international shipments) are performed. Throughout, the outcomes of all these sensitivity checks robustly confirm the presence of a clear east-west bias in Japan's internal trade, which is compatible with a bipolar network structure that fosters trade within rather than between country parts.

A detailed sensitivity analysis, including several millions of randomised placebo regressions (cf. Felbermayr and Gröschl, 2014), not only verifies the existence of a unique intra-Japanese East-West "border" effect, but also points to the importance of purely statistical "border" effects, that may arise due to aggregation bias (cf. Hillberry and Hummels, 2008; Coughlin and Novy, 2016). Although nothing comparable to the intra-Japanese east-west "border" effect has been found in up to 10 million randomised placebo regressions, it is possible to identify statistically significant "border" effects (associated with a small average trade reduction of about 10 percent) in one third of all randomised prefecture allocations. A similar picture arises from a simple heuristic search algorithm, that is introduced as a novel gravity-based approach to identify economics sub-regions, which are disproportionately well integrated through intra-regional trade. Across all runs of the heuristic search algorithm there is a fast and consistent convergence to a clear east-west division, that constitutes a local minimum in terms of the the trade-reducing East-West "border" effect that is associated with the identified prefecture allocation.[2] Although

[2]The identified the east-west division should be understood as a fuzzy (rather than as a sharp) borderline. Indeed it is difficult to associate Japan's fourth largest city *Nagoya*, which is located exactly between the East

there is no evidence for systematic "borders" at a more disaggregated level within the East and the West, it is possible to identify statistically significant but small "border" effects (associated with trade reductions of about 10 percent) in almost one third of all the allocations selected by the algorithm. In both cases the sheer mass of statistically significant but randomly distributed "borders" may be interpreted as suggestive evidence for the importance of purely statistical trade barriers (cf. Hillberry and Hummels, 2008). To rule out aggregation bias as a possible explanation for the much larger intra-Japanese East-West "border" effect the paper's main results are also replicated at different levels of aggregation as recently proposed by Coughlin and Novy (2016).

By relating the intra-Japanese east-west trade pattern to the bi-polar structure of social and business networks inside Japan, this paper not only emphasises the importance of trade-creating network effects (cf. Combes et al., 2005; Garmendia et al., 2012).[3] Complementary to the literature on international trade (Head et al., 2010; Head and Mayer, 2013), which has focused on the legacy of historical isolation and the role of international conflicts as possible long-run determinants of between-country network formation, this paper offers a plausible explanation for spatially heterogeneous network effects, that may result from regional agglomeration processes such as the "Tôkyô-Ôsaka bipolar growth pattern" highlighted by Tabuchi (1988) as well as by Fujita and Tabuchi (1997). In analogy to the international trade literature, which emphasises the importance of endogenous network formation as an underlying determinant of observed (international) border effects (cf. Head and Mayer, 2013), caution is warranted when relating intra-national trade patterns to (seemingly relevant) geographical demarcation lines, such as the 50Hz-versus-60Hz division of Japan's power grid, which appears to be the only institutional difference between the East and the West of Japan.[4] Indeed it is possible to show that the

and the West, with either prefecture block. Reassuringly, the intra-Japanese East-West "border" effect is only marginally affected if the *Aichi* Prefecture (in which *Nagoya* is located) is dropped from the analysis.

[3] The notion of a self-reinforcing social network-structure as a major determinant of the intra-Japanese trade pattern appears to be well in line with the findings of Parsons and Vézina (2014), who use the exodus of the Vietnamese Boat People to the US as a natural experiment to give the trade-enhancing effect of migration networks a causal interpretation. See also Felbermayr et al. (2015) for a recent literature review on the trade-creating effects of migration networks. Genc et al. (2012) provide a meta-analysis.

[4] Japan appears to be the only country in the world whose power grid operates at two different frequencies (50Hz in the East and 60Hz in the West). The division of Japan's power grid recently attracted public attention in the aftermath of 2011's triple disaster (earthquake, tsunami, and meltdown), when bottlenecks between both network parts made it impossible to balance capacities, which lead to electricity shortages in the eastern part of

borderline implied by the east-west division of Japan's power grid actually leads to a sizeable and highly significant reduction in cross-"border" trade. However, so does any of the $2^9 = 512$ implied east-west "borders", that would result from a systematic division of Japan's central *Chûbu* region (literal translation: *Chûbu* (中部) $\rightarrow$ 中 = "middle" + 部 = "part") between the East and the West of Japan. Viewing all these "border" effects as *reductio ad absurdum* of a sharp east-west trade barrier, that can be causally related to an underlying east-west division in Japan's power grid, it is argued that there might be a common cause explaining both patterns: The origin of Japan's divided power grid dates back to a bifurcated technology adoption in 1895 and 1896, when energy providers from *Tôkyô* and *Ôsaka* imported different generators from Germany (50Hz) and the United States (60Hz). While there were more than 70 Japanese electric power providers at the turn of the 20th century, strong increasing returns to scale in combination with steadily improving long-distance transmission technologies lead to a rapid consolidation within the industry (cf. Kikkawa, 2012). For a firm and their standard (e.g. 50Hz or 60Hz) to survive and expand a large and/or fast growing home market was pivotal, which ultimately resulted in a clear east-west division, that was fuelled by the rise of *Tôkyô* in the East and *Ôsaka* in the West. Hence, instead of being suggestive of a direct link between the east-west patterns of trade and energy supply, both phenomena may be seen as the joint outcome of a bi-polar agglomeration process (Fujita and Tabuchi, 1997), which is compatible with the emergence of two trade-creating networks within the East and the West, which partially overlap and therefore are associated with a fuzzy (rather than a sharp) east-west trade barrier.

The identification of systematic discontinuities in (unobservable) trade costs along specific geographic dimensions (e.g. due to heterogeneous network effects), is highly relevant for a fast growing literature, which exploits the properties of the structural gravity equation to quantify the (counter-factual) general equilibrium effects of changes in the underlying trade cost (see Head and Mayer (2015) and Yotov et al. (2016) for detailed reviews). In a recent paper, Allen and Arkolakis (2014) develop a new spatial equilibrium framework, in which the pattern of intra-national trade obeys the law of (structural) gravity, and in which the quantification of the welfare gains from infrastructure investments is based on the correct specification of the structural gravity equation for intra-national trade, taking into account both observable and unobservable trade costs (see also Redding and Rossi-Hansberg (2017) for a literature review).

By introducing a novel gravity-based search algorithm to identify economic sub-regions,

Japan (cf. The New York Times, 2011; The Japan Times, 2011).

which are disproportionately well integrated through trade, this paper also contributes to a literature that is concerned with the identification of economically meaningful regional sub-economies. While regional labour market studies usually draw on the notion of local labour markets (see for example Moretti, 2011), which are identified in terms of "travel-to-work areas" (cf. Ball, 1980) or "commuting zones" (cf. Tolbert and Sizer, 1996; Autor et al., 2013), there also exist cluster detection methods in the spirit of Ellison and Glaeser (1997), which search for unusually high densities of industrial establishments in a spatially coherent subset of regions (cf. Mori and Smith, 2014, 2015). Finally, in Hsu et al. (2014) a partition of the US economy into major economic regions is obtained by associating so-called "central places" (cf. Fujita et al., 1999; Hsu, 2012) with their respective economic hinterlands based on a hierarchical ordering of big cities' import shares in the respective hinterland regions. By linking Japan's post-war agglomeration experience to the structure of bilateral trade barriers, this paper goes beyond a mere association of regions based on aggregate trade volumes, suggesting instead that, once sheer size effects are taken into account, agglomeration forces are still detectable as long-run determinants of bilateral trade costs.

Finally, this paper also adds to a growing literature concerned with the exact measurement of bilateral transportation costs (cf. Anderson and van Wincoop, 2004). Exploiting unique information on Japan's internal trade costs, it turns out that bilateral transportation costs (per ton and kilometre) are rapidly falling over increasing distances. Ignoring the presence of long-haul economies in Japan's transportation technology, therefore would result in biased gravity estimates, which systematically underestimated (overestimated) the trade reducing effect of geography over short (long) distances.

The paper is structured as follows: Data, theory and implementation are discussed in Section 2. Section 3 identifies and explores the intra-Japanese East-West "border" effect. The sensitivity analysis follows in Section 4, before offering a coherent explanation for the intra-Japanese East-West "border" effect in Section 5. Section 6 concludes the paper.

2 Setup

Subsection 2.1 introduces the National Commodity Flow Survey 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 [*Zenkoku Kamotsu Jun Ryûdô Chôsa*] compiled by the Ministry of Land, Infrastructure, Tourism and Transport. The National Commodity Flow Survey reports trade flows (measured in metric tons) between and within all 47 Japanese prefectures on a five-year basis since 1970. Bilateral commodity flows 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.[5] Figure 10 in the Appendix summarizes the structure of the raw data, which is publicly available for 2000, 2005, and 2010. Exploiting this rich data base, three data sets with different levels of aggregation are constructed. The resulting data sets (at the lowest level of aggregation) comprise $46,389$ observations (= 47 exporters $\times$ 47 importers $\times$ 7 sectors $\times$ 3 years), $450,636$ observations (47 exporters $\times$ 47 importers $\times$ 68 sub-sectors $\times$ 3 years), and $185,556$ observations (= 47 exporters $\times$ 47 importers $\times$ 7 sectors $\times$ 4 transport modes $\times$ 3 years), respectively. The National Commodity Flow Survey moreover holds detailed information on prefecture-pair-specific unit transport costs (per metric ton and kilometre). By 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.[6] As a result, exact trade costs account for both distance-related (i.e. gas, tolls, etc.) and time-related (i.e. salaries, insurance, etc.) transport cost.

When necessary, the National Commodity Flow Survey is complemented by data from the Commodity Flow Statistic [*Kamotsu Chiiki Ryûdô Chôsa*], which also is reported by the Ministry of Land, Infrastructure, Tourism and Transport. The Commodity Flow Statistic provides information on the intra-Japanese transport volume at a yearly basis from 2000 to 2012. Commodity flows are disaggregated by industry and transport mode such that two data sets with 689,208 observations (= 47 exporters $\times$ 47 importers $\times$ 8 sectors $\times$ 3 transport modes $\times$ 13 years) and 918,944 observations (= 47 exporters $\times$ 47 importers $\times$ 32 industries $\times$ 13 years) can be

[5] Both 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 percent (31 percent; 38 percent) for 2010 (2005; 2000).

[6] Following 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 4.1 alternative, more flexible distance specifications are considered.

constructed. Figure 11 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 8, which also contains a list of all other data sources used in this study.

2.2 Theory

To account for the rich structure of the National Commodity Flow Survey and the Commodity Flow Statistic, a multi-sector version of an – otherwise standard – Armington model (cf. Arkolakis et al., 2012; Costinot and Rodriguez-Clare, 2015) is adopted. In each prefecture $i, j = 1, \ldots, n$ a representative household aims to maximise aggregate consumption:

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

In this case, total consumption of sector s' varieties in prefecture j takes the form:

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

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:

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

in which

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

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 $P_{ij,s} = \tau_{ij,s} P_{ii,s} = \tau_{ij,s} w_i = \tau_{ij,s} Y_i / L_i$.

Whereby, 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. Following Anderson and van Wincoop (2003), it is possible to combine $P_{ij,s} = \tau_{ij,s}Y_i/L_i$ with Eqs. (3) and (4), such that the sector-level volume $C_{ij,s}$ and value $X_{ij,s}$ of bilateral trade from prefecture i to prefecture j can be expressed as:

$$C_{ij,s} = \frac{E_{j,s}Y_{i,s}}{Y_s}\frac{L_i}{Y_i}\frac{(\psi_{ij}\tau_{ij,s})^{-\sigma_s}}{\Omega_{j,s}^{1-\sigma_s}\Phi_{i,s}^{1-\sigma_s}} \quad \text{and} \quad X_{ij,s} = \frac{E_{j,s}Y_{i,s}}{Y_s}\frac{(\psi_{ij}\tau_{ij,s})^{1-\sigma_s}}{\Omega_{j,s}^{1-\sigma_s}\Phi_{i,s}^{1-\sigma_s}}, \tag{5}$$

respectively. Thereby,

$$\Omega_{j,s}^{1-\sigma_s} = \sum_i \left(\frac{\psi_{ij}\tau_{ij,s}}{\Phi_{i,s}}\right)^{1-\sigma_s}\frac{Y_{i,s}}{Y_s}, \quad \text{and} \quad \Phi_{i,s}^{1-\sigma_s} = \sum_j \left(\frac{\psi_{ij}\tau_{ij,s}}{\Omega_{j,s}}\right)^{1-\sigma_s}\frac{E_{j,s}}{Y_s}. \tag{6}$$

denote the inward and outward multilateral resistance terms, which – as pointed out by Anderson and Yotov (2010) – can be interpreted as buyers' and sellers' overall incidence of trade costs to their trading partners worldwide (i.e. the proportion of the iceberg-type trade cost $\tau_{ij,s}$ that is paid by the buyer and seller, respectively). 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 C_{ij} and X_{ij} (in volumes and values, respectively) can be obtained by dropping the sector index s in Eq. (5).[7] As default the aggregate gravity equations for C_{ij} and X_{ij} are adapted. 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 there are two different approaches to utilise shipment data measured in quantities (rather than in values).[8] Combes et al. (2005) use a monopolistic

[7] As demonstrated by Head and Mayer (2015), structural gravity equations in form of Eq. (5) can be derived from a rich set of models with varying microfoundations, including the Ricardian model by Eaton and Kortum (2002) and the heterogeneous firms model by Chaney (2008).

[8] The 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 tables to derive intra-national trade flows for China. For the case of Japan comparable input-output tables only exist at the aggregated level of the 9 main regions (cf. Okubo, 2004), but not at the more disaggregated level of the 47 Japanese prefectures.

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.[9] In the following, both approaches are used to consistently estimate intra-Japanese trade in quantities and values based on Eq. (5). Thereby, bilateral resistance $\tau_{ij,s} \cdot \psi_{ij}$ is specified as follows:

$$\tau_{ij,s} \cdot \psi_{ij} = \text{Trans}_{ij,s}^{\delta_{1s}} \cdot e^{\delta_2 \text{Bord}_{ij} + \delta_3 \text{Adj}_{ij} + \delta_4 \text{Home}_{ij} + \delta_5 \text{Region}_{ij} + \delta_6 \text{Island}_{ij}}, \tag{7}$$

where 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. The indicator variable Home_{ij} captures the intra-national "home bias" (cf. Wolf, 2000; Hillberry and Hummels, 2003, 2008), i.e. all trade-creating effects that are associated with intra-prefectural trade. To account for possible administrative trade barriers and other trade-creating/reducing effects at the regional level the indicator variable Region_{ij} takes a value of $\text{Region}_{ij} = 1$ if prefecture i and prefecture j are both located in the same of nine administrative regions (*Hokkaidô*, *Tôhoku*, *Kantô*, *Chûbu*, *Kansai*, *Chûgoku*, *Shikoku* and *Kyûshû*) and a value of $\text{Region}_{ij} = 0$ otherwise. Finally, the analogously defined island dummy Island_{ij} takes into account all trade-creating/reducing effects that result from discontinuities in inter-prefectural transportation costs due to Japan's division into four major islands (*Hokkaidô*, *Honshû*, *Shikoku* and *Kyûshû*).

Two major issues concerning the use of shipment data have been identified in the existing literature (cf. Combes et al., 2005; Nitsch and Wolf, 2013): First, a certain fraction of shipments enter or leave Japan via ports (more than 99 percent in 2010) and hubs of air cargo (less than 1 percent in 2010). Since Japan's external trade is channelled through these ports, intra-national

[9] Requena 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.

shipments could be biased towards coastal prefectures. In addition to the standard procedure of including importer- and exporter-specific fixed effects to account for unobservable demand or supply shifters at the prefecture level (cf. Combes et al., 2005, p. 13), the aforementioned indicator variables for intra-prefectural and intra-regional trade are introduced to capture any upward bias in intra-Japanese trade at the level of prefectures or regions, that would result from the local distribution of international shipments (see also Subsection 4.3 for a more detailed discussion). Second, due to the presence of middlemen and intermediaries the same products may enter the shipment data through multiple records.[10] Hillberry and Hummels (2003) show that the underlying hub and spoke distribution patterns then translate into comparatively short distances for shipments that originate from wholesalers rather than from manufacturers. In the empirical analysis, the over-representation of short-distance shipments (e.g. the intra-national home bias), is captured by the aforementioned set of fixed effects, which account for (short-distance) trade within prefectures, regions, and islands.

Following standard practice, Eq. (7) is substituted into the (aggregate) gravity equations from Eq. (5), 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 in the presence of heteroscedasticity and many zero observations (both relevant concerns at higher levels of disaggregation), Eq. (5) is also estimated in its multiplicative form, using the Poisson-Pseudo-Maximum-Likelihood (PPML) estimator proposed by Santos Silva and Tenreyro (2006, 2010).[11]

3 Results

Section 3 is structured as follows: Subsection 3.1 explores the National Commodity Flow Survey, which is then used to identify a unique, spatial barrier to intra-Japanese trade in Subsection 3.2. Subsection 3.3 finally explores how the intra-Japanese East-West "border" effect varies by year, industry and mode of transportation. Finally, in Subsection 3.4, several millions of randomised placebo regressions are performed to verify the unique east-west dimension of the intra-Japanese

[10] Shipments in the National Commodity Flow Survey are aggregated up to the transaction level, where single transactions, due to the unloading and reloading of shipments at warehouses, ports, and railway freight terminals, typically are composed of multiple (inter-modal) shipments.

[11] Fally (2015) demonstrates that under Poisson-Pseudo-Maximum-Likelihood, estimated fixed effects in reduced-form gravity equations are exactly equal to the multilateral resistances terms satisfying Eq. (6).

"border" effect.

3.1 Exploring the National Commodity Flow Survey

To the best of my knowledge, this paper is the first to estimate the extent of intra-Japanese trade based on the National Commodity Flow Survey. To assess the representativeness of the dataset, a standard gravity equation is estimated using varying specifications along the lines of Subsection 2.3. This includes using different trade flow statistics (quantities vs. values), trade cost measures (distance vs. actual transport cost), and estimation techniques (OLS vs. PPML).[12] Table 1 summarises the results for the baseline 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***	−0.7625***	−1.1954***	−0.5614***				
	(.0465)	(.0614)	(.0611)	(.0920)				
ln transport cost$_{ij}$					−0.6761***	−0.6037***	−0.8685***	−0.3843***
					(.0425)	(.0512)	(.0471)	(.0642)
Adjacency$_{ij}$	0.4167***	0.5401***	0.5600**	0.7781***	1.1110***	0.9595***	1.1241***	1.1325***
	(.0893)	(.1042)	(.1126)	(.1578)	(.0874)	(.1235)	(.1044)	(.1703)
Home bias dummy$_{ij}$	1.2813***	1.4772***	2.6314***	2.8812***	3.4264***	2.5204***	4.2655***	3.7588***
	(.3112)	(.1645)	(.3910)	(.2751)	(.2374)	(.1283)	(.3141)	(.1878)
Region dummy$_{ij}$	0.1393	0.3027**	0.0527	0.2924*	0.8263***	0.6788***	0.5700***	0.5559**
	(.0845)	(.1313)	(.1025)	(.1558)	(.0817)	(.1287)	(.0943)	(.1591)
Island dummy$_{ij}$	0.3799***	0.341***	0.5476***	0.5894***	0.6231***	0.3514***	0.6712***	0.6214***
	(.0896)	(.1016)	(.1168)	(.1236)	(.0885)	(.0995)	(.1086)	(.1264)
Fixed effects:								
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: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

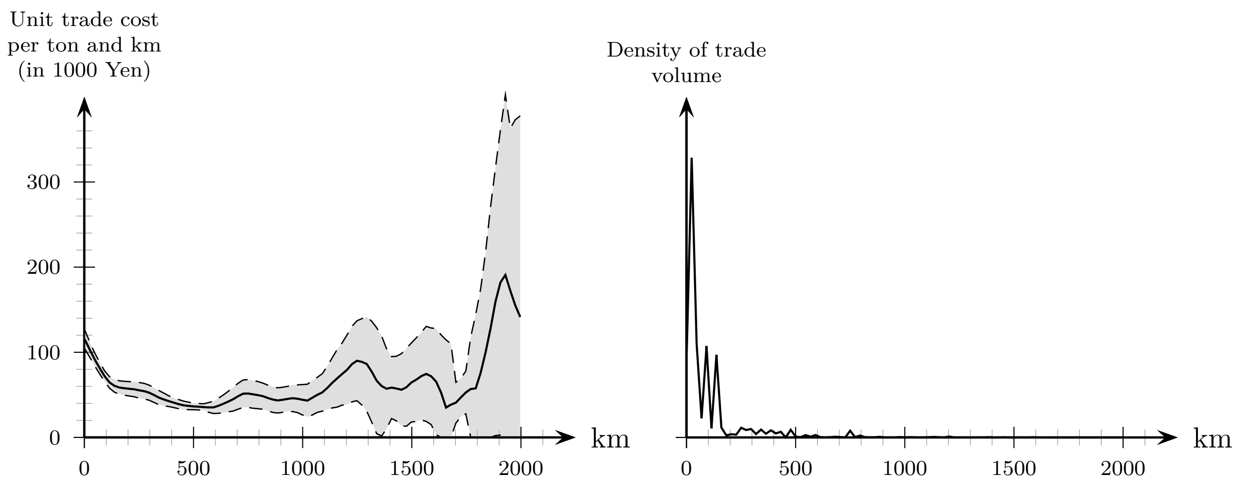
In the Specifications (1) to (4) distance is chosen as a proxy for bilateral trade cost. The coefficients for distance and adjacency take values which are comparable to the mean estimates reported in the meta-analysis by Head and Mayer (2015).[13] As usual, distance estimates un-

[12] To 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.

[13] Head and Mayer (2015) report typical gravity estimates, based on a comparison of 2,508 usable estimates

der OLS 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 U.S. (cf. Wolf, 2000; Millimet and Osang, 2007; Yilmazkuday, 2012). Specifications (5) to (8) repeat the analysis using actual transportation cost instead of the unweighted distance as a proxy for bilateral trade cost.[14] As a striking result, proxies for short-distance trade (e.g. between neighbouring prefectures) deliver estimates of larger (absolute) size. At the same time, the trade reducing effect of actual transport costs seems to be smaller than the effect of unweighted distances. To understand these differences, Figure 1a explores the link between per unit transportation cost and (unweighted) distance.[15]

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



(a) *Unit Trade Cost in 2010* **(b)** *Trade Volume in 2010*

As evident from Figure 1a, unit trade costs fall substantially within the first 500 kilometres, which according to Figure 1b account for more than 95 percent of the intra-Japanese trade volume in 2010.[16] The standard procedure of using unweighted distance as a proxy for bilateral

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).

[14]The trade-reducing effect of changes in bilateral transportation cost is documented in a Technical Supplement, which is available from the author upon request.

[15]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 per unit transpotation 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 percent confidence interval. Figure 1b presents an (Epanechnikov) kernel density (with optimal bandwidth) of the 2010 trade volume (measured in quantities).

[16]Due to the limited number of long-distance transactions (which mainly result from trade with the remote

trade cost ignores the decline of per unit transportation costs over increasing distances due to the presence of long-haul economies in the Japanese transportation sector. As a consequence, the implied reduction in short-distance trade is misattributed to other short-distance-trade proxies, which mitigates the trade-enhancing effect among neighbouring prefectures as well as within single prefectures, regions, and islands.

Taking stock, the main insight from the exploration of the National Commodity Flow Survey may be summarised as follows: Although standard gravity estimates are perfectly in line with the literature, there is evidence for the presence of substantial long-haul economies in the Japanese transportation sector, when going beyond distance as a simple proxy for bilateral transportation cost. Exploiting the National Commodity Flow Survey's unique information on bilateral transportation cost, it is possible to identify a sizeable downward bias in the estimated effects of proxies for short-distance trade (e.g. home bias or adjacency), that results from the inappropriate use of distance as a proxy for bilateral trade cost (see also Section 5.3 for a more detailed discussion).

3.2 Identifying the Intra-Japanese East-West "Border" Effect

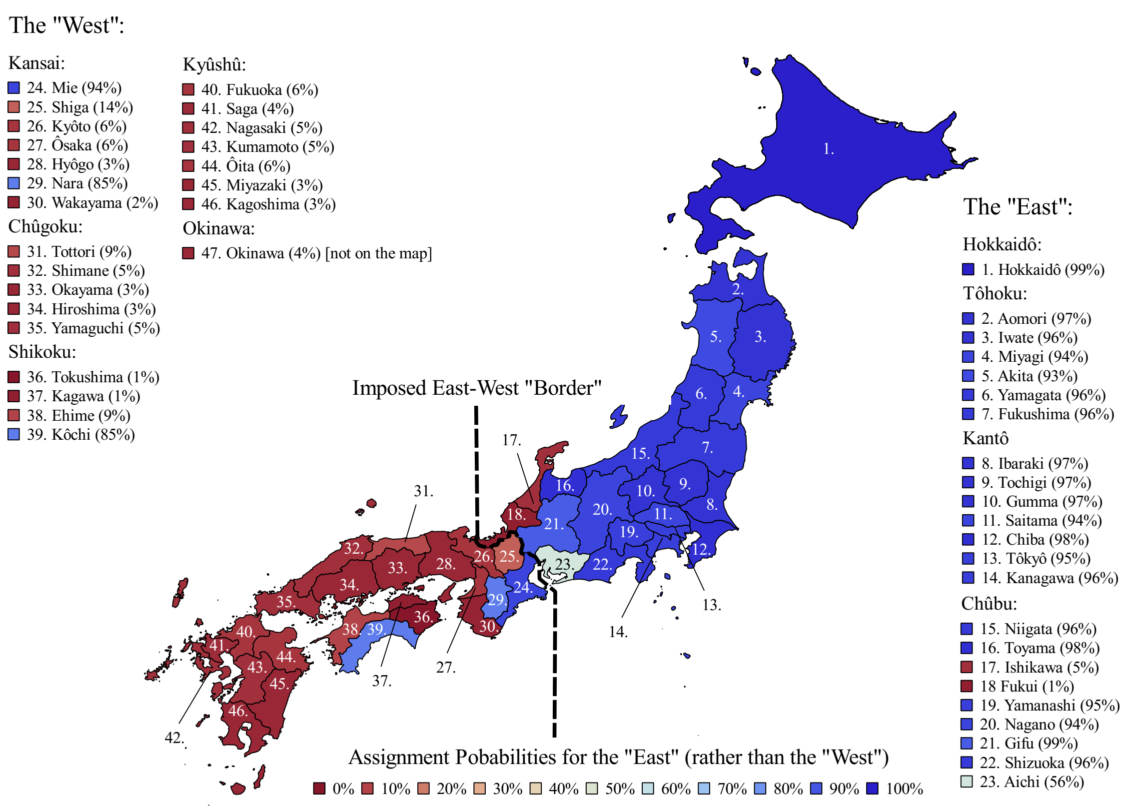
The National Commodity Flow Survey covers 47 Japanese prefectures grouped in 9 administrative regions (*Hokkaidô*, *Tôhoku*, *Kantô*, *Chûbu*, *Kansai*, *Chûgoku*, *Shikoku*, *Kyûshû* and *Okinawa*), which (except for the Region/Prefecture *Okinawa*) are all depicted in Figure 2.[17] Figure 2 also highlights an imposed East-West "border", which not only represents a natural division into two equally-sized prefecture blocks (intuitively labeled as "East" and "West"), but also is in line with the given definition of Japan's 9 administrative regions from above. Rather than to pinpoint an exact borderline the assumed East-West "border" is meant to be a first,

island of *Okinawa*) the measurement of transportation cost over longer distances suffers from aggregation bias. A detailed decomposition based on transportation mode is delegated to a Technical Supplement, which can be obtained from the author upon request. Further evidence in favour of long-haul economies in the Japanese transportation sector comes from Yoko et al. (2012), who use the 2005 wave of the National Commodity Flow Survey to structurally estimate a cost function for (on-the-road) transportation services.

[17] The 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.

unqualified guess capturing a broad east-west trade pattern.[18] An unqualified guess, which actually turns out to be pretty close to an east-west division, that would result from a much more sophisticated heuristic search algorithm, which aims to maximise the trade-reducing "border" effect, that would emerge from a division of Japan into two equally-sized prefecture blocks (see Section 3.4 for a more detailed discussion). According to Figure 2, which illustrates a prefecture's probability of being (systematically) assigned to the "East" through the colouring of the respective prefecture in shades of red and blue, there is an almost perfect overlap. Mismatches relative to the *ad hoc* baseline specification mainly concern neighbouring prefectures along the imposed east-west "border", and only the *Aichi* Prefecture (location of Japan's fourth largest city *Nagoya*) can not be clearly assigned to the "East" or the "West".

Figure 2: *Regions and Prefectures of 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. Trade integration is

[18] Except for an east-west division in Japan's power grid, which can be traced back to a bifurcated technology adoption from Germany (50Hz) and the U.S. (60Hz) at the end of the 19th century, there are no institutional differences between the eastern and western part of Japan (see also Section 3.4 below).

measured by the Head-Ries Index (cf. Head and Ries, 2001):

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

which exploits the Independence of Irrelevant Alternatives property (cf. Anderson et al., 1992) of gravity equation (5) 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 ($\tau_{ii} = \tau_{jj} = 1$).[19] Note that by construction the bilateral-trade-

Table 2: *Bilateral Trade Integration Between Japanese Prefecture*

	1. Hokkaidô	2. Aomori	3. Iwate	4. Miyagi	5. Akita	6. Yamagata	7. Fukushima	8. Ibaraki	9. Tochigi	10. Gunma	11. Saitama	12. Chiba	13. Tôkyô	14. Kanagawa	15. Niigata	16. Toyama	17. Ishikawa	18. Fukui	19. Yamanashi	20. Nagano	21. Gifu	22. Shizuoka	23. Aichi
1. Hokkaidô	1	.03	0	.02	.01	0	0	.01	0	.01	.01	.05	.02	.03	.01	.01	0	0	0	0	0	.01	.01
2. Aomori	.03	1	.03	.03	.02	.01	.01	.02	.01	0	.01	.01	.02	.01	0	0	0	0	0	0	0	0	0
3. Iwate	0	.03	1	.07	.02	.01	.01	.01	.01	0	.01	.01	.05	.01	0	0	0	0	0	0	0	0	0
4. Miyagi	.02	.03	.07	1	.02	.07	.07	.02	.01	.01	.02	.02	.03	.02	.01	.01	0	0	0	0	0	.01	0
5. Akita	.01	.02	.02	.02	1	.02	.01	.01	0	0	.01	0	.01	.01	.01	0	0	0	0	0	0	0	0
6. Yamagata	0	.01	.01	.07	.02	1	.02	.01	.01	.01	.01	.01	.01	.01	.03	0	0	0	0	0	0	0	0
7. Fukushima	0	.01	.01	.07	.01	.02	1	.04	.04	.02	.04	.02	.03	.03	.01	0	0	0	.01	.01	.01	.01	0
8. Ibaraki	.01	.02	.01	.02	.01	.01	.04	1	.09	.05	.07	.10	.09	.04	.01	0	0	0	0	.01	.01	.02	.02
9. Tochigi	0	.01	.01	.01	0	.01	.04	.09	1	.13	.09	.08	.09	.05	.01	0	0	0	0	.01	0	.01	.01
10. Gunma	.01	0	0	.01	0	.01	.02	.05	.13	1	.14	.05	.06	.04	.02	.01	0	0	.01	.02	.01	.02	.02
11. Saitama	.01	.01	.01	.02	.01	.01	.04	.07	.09	.14	1	.08	.27	.07	.03	.01	0	0	.01	.02	.01	.03	.02
12. Chiba	.05	.01	.01	.02	0	.01	.02	.10	.08	.05	.08	1	.15	.10	.02	.01	0	0	.01	.01	.01	.02	.05
13. Tôkyô	.02	.02	.05	.03	.01	.01	.03	.09	.09	.06	.27	.15	1	.20	.03	.01	.01	0	.02	.03	.01	.04	.02
14. Kanagawa	.03	.01	.01	.02	.01	.01	.03	.04	.05	.04	.07	.10	.20	1	.02	.01	0	0	.02	.01	.01	.06	.02
15. Niigata	.01	0	0	.01	.01	.03	.01	.01	.01	.02	.03	.02	.03	.02	1	.02	.01	.02	0	.01	0	.01	.01
16. Toyama	.01	0	0	.01	0	0	0	0	0	.01	.01	.01	.01	.01	.02	1	.09	.03	0	.01	.01	.01	.02
17. Ishikawa	0	0	0	0	0	0	0	0	0	0	0	0	.01	0	.01	.09	1	.05	0	0	.01	0	.01
18. Fukui	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.02	.03	.05	1	0	0	.01	.01	.01
19. Yamanashi	0	0	0	0	0	0	.01	0	0	.01	.01	.01	.02	.02	0	0	0	0	1	.04	0	.04	0
20. Nagano	0	0	0	0	0	0	.01	.01	.01	.02	.02	.01	.03	.01	.01	.01	0	0	.04	1	.01	.01	.01
21. Gifu	0	0	0	0	0	0	.01	.01	0	.01	.01	.01	.01	.01	0	.01	.01	.01	0	.01	1	.01	.21
22. Shizuoka	.01	0	0	.01	0	0	.01	.02	.01	.02	.03	.02	.04	.06	.01	.01	0	.01	.04	.01	.01	1	.09
23. Aichi	.01	0	0	0	0	0	0	.02	.01	.02	.02	.05	.02	.02	.01	.02	.01	.01	0	.01	.21	.09	1
24. Mie	0	0	0	0	0	0	0	.01	.01	.01	.01	.02	.01	.02	0	.01	0	.01	0	.01	.05	.03	.22
25. Shiga	0	0	0	0	0	0	0	.01	0	.01	.01	.01	.01	.01	0	.01	.01	.02	0	.01	.03	.01	.04
26. Kyôto	0	0	0	0	0	0	0	0	0	0	.01	0	.01	.01	0	0	0	.01	0	0	.01	.01	.01
27. Ôsaka	.01	.01	0	.01	0	.01	.01	.01	.01	.01	.02	.02	.03	.02	.02	.02	.01	.02	0	.01	.02	.02	.04
28. Hyôgo	0	0	0	0	0	0	0	.01	.01	.01	.01	.02	.02	.01	.01	.01	.01	.02	0	0	.01	.01	.04
29. Nara	0	0	0	0	0	0	0	0	0	0	0	0	.01	0	0	0	0	.01	0	0	0	.01	.01
30. Wakayama	0	0	0	0	0	0	0	.01	0	0	0	0	0	.01	0	0	0	0	0	0	.01	0	.01
31. Tottori	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32. Shimane	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33. Okayama	0	0	0	0	0	0	0	.01	0	0	.01	.01	.01	.01	0	.01	0	0	0	0	.01	.01	.02
34. Hiroshima	0	0	0	0	0	0	0	.01	0	0	.01	.01	.01	.01	0	0	0	0	0	0	.01	.01	.01
35. Yamaguchi	0	0	0	0	0	0	0	.01	0	0	0	.01	0	0	.01	0	0	.01	0	0	0	0	.01
36. Tokushima	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.01
37. Kagawa	0	0	0	0	0	0	0	0	0	0	0	.01	0	0	0	0	0	0	0	0	0	0	0
38. Ehime	0	0	0	0	0	0	0	.01	0	0	.01	.01	.01	.01	0	0	0	0	0	0	0	0	.01
39. Kôchi	0	0	0	0	0	0	0	0	0	0	0	.01	.01	0	0	0	0	0	0	0	0	0	0
40. Fukuoka	0	0	0	.01	0	0	0	.01	.01	0	.01	.01	.01	.01	.01	0	0	.01	0	0	.01	.01	.03
41. Saga	0	0	0	0	0	0	0	0	0	0	0	0	.01	0	0	0	0	0	0	0	0	0	0
42. Nagasaki	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43. Kumamoto	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44. Ôita	0	0	0	0	0	0	0	0	0	0	0	.01	0	0	0	0	0	0	0	0	0	0	.02
45. Miyazaki	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
46. Kagoshima	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
47. Okinawa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	24. Mie	25. Shiga	26. Kyôto	27. Ôsaka	28. Hyôgo	29. Nara	30. Wakayama	31. Tottori	32. Shimane	33. Okayama	34. Hiroshima	35. Yamaguchi	36. Tokushima	37. Kagawa	38. Ehime	39. Kôchi	40. Fukuoka	41. Saga	42. Nagasaki	43. Kumamoto	44. Ôita	45. Miyazaki	46. Kagoshima	47. Okinawa
1. Hokkaidô	0	0	0	.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2. Aomori	0	0	0	.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3. Iwate	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4. Miyagi	0	0	0	.01	0	0	0	0	0	0	0	0	0	0	0	0	.01	0	0	0	0	0	0	0
5. Akita	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6. Yamagata	0	0	0	.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7. Fukushima	0	0	0	.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8. Ibaraki	.01	.01	0	.01	.01	0	.01	0	0	.01	.01	.01	0	0	.01	0	.01	0	0	0	0	0	0	0
9. Tochigi	.01	0	0	.01	.01	0	0	0	0	0	0	0	0	0	0	0	.01	0	0	0	0	0	0	0
10. Gunma	.01	.01	0	.01	.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11. Saitama	.01	.01	.01	.02	.01	0	0	0	0	.01	.01	0	0	0	.01	0	.01	0	0	0	0	0	0	0
12. Chiba	.02	.01	0	.02	.02	0	0	0	0	.01	.01	.01	0	.01	.01	.01	.01	0	0	0	.01	0	0	0
13. Tôkyô	.01	.01	.01	.03	.02	.01	0	0	0	.01	.01	0	0	0	.01	.01	.01	.01	0	0	0	0	0	0
14. Kanagawa	.02	.01	.01	.02	.01	0	.01	0	0	.01	.01	0	0	0	.01	0	.01	0	0	0	0	0	0	0
15. Niigata	0	0	0	.02	.01	0	0	0	0	0	0	.01	0	0	0	0	.01	0	0	0	0	0	0	0
16. Toyama	.01	.01	0	.02	.01	0	0	0	0	.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17. Ishikawa	0	.01	0	.01	.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18. Fukui	.01	.02	.01	.02	.02	.01	0	0	0	0	0	.01	0	0	0	0	.01	0	0	0	0	0	0	0
19. Yamanashi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20. Nagano	.01	.01	0	.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21. Gifu	.05	.03	.01	.02	.01	0	.01	0	0	.01	.01	0	0	0	0	0	.01	0	0	0	0	0	0	0
22. Shizuoka	.03	.01	.01	.02	.01	.01	0	0	0	.01	.01	0	0	0	0	0	.01	0	0	0	0	0	0	0
23. Aichi	.22	.04	.01	.04	.04	.01	.01	0	0	.02	.01	.01	.01	0	.01	0	.03	0	0	0	.02	0	0	0
24. Mie	1	.04	.01	.05	.03	.01	.01	0	0	.02	.01	.01	0	.01	.01	0	0	0	0	0	0	0	0	0
25. Shiga	.04	1	.06	.07	.04	.01	.02	0	0	.01	.01	0	.01	0	.01	0	.01	.01	0	0	0	0	0	0
26. Kyôto	.01	.06	1	.10	.05	.03	.01	0	0	.01	.01	0	.01	0	.01	0	.01	.01	0	0	0	0	0	0
27. Ôsaka	.05	.07	.10	1	.23	.10	.11	.02	.01	.05	.06	.02	.02	.04	.03	.02	.04	.01	.01	.01	.01	.01	.01	0
28. Hyôgo	.03	.04	.05	.23	1	.03	.05	.02	.03	.07	.04	.03	.04	.05	.03	.01	.02	.01	0	0	.02	0	.01	0
29. Nara	.01	.01	.03	.10	.03	1	.03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30. Wakayama	.01	.02	.01	.11	.05	.03	1	0	0	.01	.01	0	.01	.02	.01	.02	0	0	0	0	0	.01	0	0
31. Tottori	0	0	0	.02	.02	0	0	1	.05	.03	.01	.01	0	0	0	0	0	0	0	0	0	0	0	0
32. Shimane	0	0	0	.01	.03	0	0	.05	1	.02	.06	.02	0	0	0	0	0	0	0	0	0	0	0	0
33. Okayama	.02	.01	.01	.05	.07	0	.01	.03	.02	1	.14	.02	.01	.03	.02	0	.01	0	0	0	.01	0	0	0
34. Hiroshima	.01	.01	.01	.06	.04	0	.01	.01	.06	.14	1	.12	.02	.06	.06	.01	.03	.01	.01	.01	.02	.01	0	0
35. Yamaguchi	.01	0	0	.02	.03	0	0	.01	.02	.02	.12	1	0	.01	.05	0	.07	.02	.01	.02	.05	.01	.01	0
36. Tokushima	0	.01	.01	.02	.04	0	.01	0	0	.01	.02	0	1	.07	.02	.01	0	0	0	0	.01	0	0	0
37. Kagawa	.01	0	0	.04	.05	0	.02	0	0	.03	.06	.01	.07	1	.05	.02	.02	0	0	0	.01	0	0	0
38. Ehime	.01	.01	.01	.03	.03	0	.01	0	0	.02	.06	.05	.02	.05	1	.02	.02	0	0	0	.02	.01	.01	0
39. Kôchi	0	0	0	.02	.01	0	.02	0	0	0	.01	0	.01	.02	.02	1	.01	0	0	0	0	0	0	0
40. Fukuoka	0	.01	.01	.04	.02	0	0	0	0	.01	.03	.07	0	.02	.02	.01	1	.14	.06	.07	.06	.04	.03	.02
41. Saga	0	.01	.01	.01	.01	0	0	0	0	0	.01	.02	0	0	0	0	.14	1	.14	.02	.03	.02	.01	0
42. Nagasaki	0	0	0	.01	0	0	0	0	0	0	.01	.01	0	0	0	0	.06	.14	1	.01	.02	0	.01	0
43. Kumamoto	0	0	0	.01	0	0	0	0	0	0	.01	.02	0	0	0	0	.07	.02	.01	1	.03	.02	.02	0
44. Ôita	0	0	0	.01	.02	0	0	0	0	.01	.02	.05	.01	.01	.02	0	.06	.03	.02	.03	1	.04	.03	0
45. Miyazaki	0	0	0	.01	0	0	.01	0	0	0	.01	.01	0	0	.01	0	.04	.02	0	.02	.04	1	.09	0
46. Kagoshima	0	0	0	.01	.01	0	0	0	0	0	0	.01	0	0	.01	0	.03	.01	.01	.02	.03	.09	1	.03
47. Okinawa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.02	0	0	0	0	0	.03	1

Scale: 0 .05 .10 .15 .20 .25 .30

integration matrix in Table 2 is symmetric and entries at the main diagonal take on a value of one due to $\hat{\phi}_{ii} = 1$.[20] The ordering of prefectures, starting with 1. *Hokkaidô* in the far north-east (upper-left corner) and ending with 47. *Okinawa* in the extreme southwest (lower-right

[19] See Head and Mayer (2015) for a more detailed discussion and further applications.

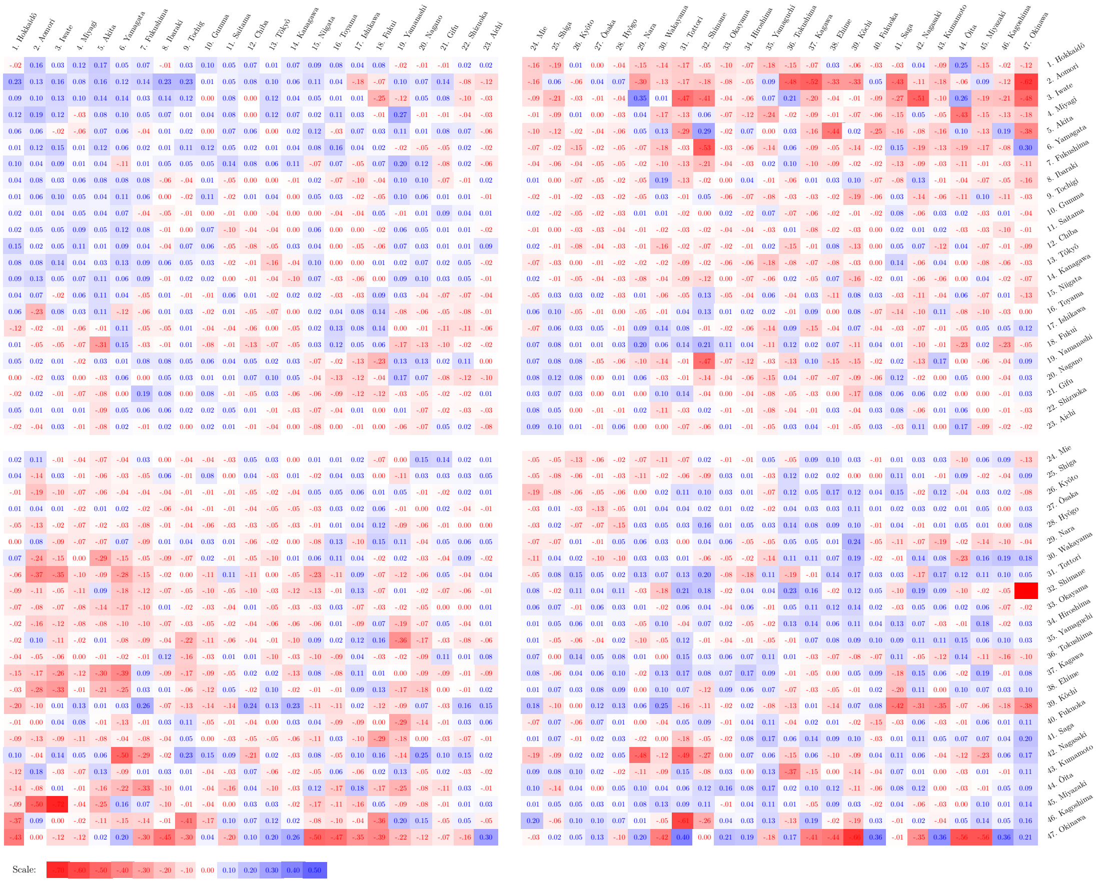
[20] Note, that in Table 2 zeros are (vastly) overreported due to the rounding of index numbers with a value below 0.5 percent. Indeed, the one-year survey for 2010 features only 2 zero-trade-flows out of an overall number of $47 \times 47 = 2,209$ trade flows.

corner), is the same as in Figure 2. Geography hence 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. 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 West. When comparing trade integration across the quadrants in Table 2, a surprisingly stark east-west pattern in Japan's intra-national trade is revealed: prefecture pairs within the East and West are on average five to six times as well integrated as prefecture 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 West are on average separated by larger distances than prefectures which both originate from the same country part. East-west trade should therefore be costlier and less intense. The relevant question, then, is not whether there is (comparatively) less east-west trade, but rather to what extent this pattern persists, once bilateral trade cost are explicitly taken into account. If the lack of east-west trade in Table 2 can be fully explained through (relatively) higher bilateral east-west transportation cost, no systematic geographic variation should be left in the residuals from Table 1. However, as evident from Table 3, there is a pervasive east-west pattern in the residuals from the preferred Specification (5) of Table 1. Table 3 illustrates the residuals from the above gravity estimation (normalised by the actual trade volume in logs). Whenever the actual trade volume is underestimated (overestimated) the residual is positive (negative) and therefore depicted in shades of blue (red), with darker shades referring to larger (absolute) values in the difference between the predicted and observed trade volume. Clearly, trade within the East and West is underestimated, while at the same time the trade volumes between the East and the West are systematically overestimated. The same picture arises from Table 4, which offers a simple sign test, reporting the share of east-east, west-west, east-west and west-east prefecture pairs, for which the actual trade flow is underestimated. According to Table 4, a gravity model, that 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 the presence of long-haul economies in the Japanese transportation sector (cf. Section 3.1).

To assess the average impact of the division into East- and West-Japan on trade between rather

Table 3: *Residual Trade Between Japanese Prefectures*



than within both blocks on a more throughout basis, Eq. (5) is re-estimated at the aggregate and sectoral level, taking into account the East-West "border" dummy introduced in Subsection 2.3. Table 5 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 percent ($e^{-0.719} - 1$) smaller than trade within both blocks. This reduction may seem small compared to a drop of 80.8 percent that Anderson and van Wincoop (2003) report for trade between Canadaian provinces and U.S. federal

Table 4: *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.

states.[21] However, the drop in intra-Japanese East-West trade is substantial and much larger than the persistent reductions of 20.5 or 12.8 percent in contemporaneous intra-national trade across the former border between the German Democratic Republic (East-Germany) and the Federal Republic of Germany (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).[22]

Table 5: *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^{***}	-0.3956^{***}	-0.5395^{***}	-0.3601^{***}	-0.5661^{***}	-0.2631^{*}	-0.3255^{***}
	(.0487)	(.1130)	(.0542)	(.1173)	(.0619)	(.1392)	(.0498)
ln transport cost$_{ij}$	-0.5238^{***}	-0.5494^{***}	-0.9521^{***}	-0.5607^{***}	-0.7487^{***}	-0.3476^{***}	-0.6162^{***}
	(.0426)	(.0599)	(.0451)	(.0671)	(.0495)	(.0760)	(.0652)
Adjacency$_{ij}$	1.0743^{***}	0.9449^{***}	0.9790^{***}	1.0404^{***}	1.0952^{***}	1.1127^{***}	1.0236^{***}
	(.0895)	(.1302)	(.0938)	(.1484)	(.1059)	(.1670)	(.1483)
Home bias dummy$_{ij}$	3.6356^{***}	2.5786^{***}	3.0865^{***}	2.6566^{***}	4.4296^{***}	3.7919^{***}	2.6565^{***}
	(.2396)	(.1248)	(.2664)	(.1617)	(.3154)	(.1879)	(.4265)
Region dummy$_{ij}$	0.5619^{***}	0.5330^{***}	0.4389^{***}	0.3574^{**}	0.3615^{***}	0.4687^{***}	0.4978^{***}
	(.0846)	(.1244)	(.0862)	(.1393)	(.0981)	(.1582)	(.0618)
Island dummy$_{ij}$	0.5937^{***}	0.3590^{***}	0.4950^{***}	0.4128^{***}	0.6490^{***}	0.6127^{***}	0.5512^{***}
	(.0856)	(.0972)	(.0715)	(.0732)	(.1079)	(.1265)	(.1083)
Fixed effects:							
Exporter (i)	✓	✓	✓	✓	✓	✓	✗
Importer (j)	✓	✓	✓	✓	✓	✓	✗
Exporter × Sector ($i \times s$)	✗	✗	✗	✗	✗	✗	✓
Importer × 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: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

In Columns (3) to (7) of Table 5 disaggregated industry-level trade flows from the three-day survey (3DS) are analysed. 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) and (5)-(6) are aggregated up in terms of quantities (cf. Combes et al., 2005) or values (cf. Nitsch and Wolf, 2013) does not make a big difference in terms of estimation results. Finally, to ensure that the results do not depend on sectoral aggregation,

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

[22] See 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: $e^{-0.137} - 1$.

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). This practice has the advantage that all price terms in the sector-level gravity equations from Eq. (5) can be fully absorbed through exporter×sector- and importer×sector-specific fixed effects, which in addition control for varying transport cost across different industries (cf. Chen and Novy, 2011).[23] 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 Poission Pseudo-Maximum-Likelihood estimates for aggregate trade flows in the Columns (4) and (6) and implies a reduction in East-West trade of 27.8 percent ($e^{-0.326} - 1$).

Computing the tariff equivalent of the intra-Japanese East-West "border" effect, requires knowledge of the trade cost elasticity $\sigma - 1$, which can be estimated directly from gravity equation (5), given that the National Commodity Flow Survey provides detailed information on bilateral trade cost per ton and kilometre (cf. Hertel et al., 2007).[24] Following the approach of Hertel et al. (2007), Eq. (7) is re-specified as follows: to approximate for $\tau_{ij,s}$ one plus the *ad valorum* freight rate $\tau_{ij,s} = 1 + \text{Freight}_{ij,s}$ is used, while ψ_{ij} is assumed to have the following function form:

$$\psi_{ij} = \text{Dist}_{ij}^{\mu_1} \, e^{\mu_2 \text{Bord}_{ij} + \mu_3 \text{Adj}_{ij} + \mu_4 \text{Home}_{ij} + \mu_5 \text{Region}_{ij} + \mu_6 \text{Island}_{ij}}, \tag{9}$$

with Dist_{ij} denoting bilateral (greater circle) distance and the remaining variables being defined as in Eq. (7). To obtain an estimate for $\sigma_s - 1$, the terms for $\tau_{ij,s}$ 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×exporter- and sector×importer-specific fixed effects. Table 9 in the Appendix presents the results for 2000, 2005, and 2010. Depending on the sector, σ_s varies

[23] Anderson 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).

[24] Caliendo and Parro's (2015) approach of estimating the trade cost elasticity based on the "tetrads" method (cf. Head and Mayer, 2015) results in estimates (cf. Specifications (6)-(9) in Table 9), that closely resemble the ones obtained from Hertel et al.'s (2007) approach of estimating a log-linearised gravity equation. Eaton and Kortum (2002) offer multiple ways to estimate the trade cost elasticity from a gravity model akin to the aggregate version of Eq. (5) 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.

from 2.03 for "manufacturing" in 2010 to 4.79 for "miscellaneous products" in 2005, which is in line with the findings of Yilmazkuday (2012), who computes elasticities of substitution for trade within the U.S. that range from 1.61 to 5.99 with an average value of 3.01. Pooling over all sectors implies 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.[25] Finally, applying trade cost elasticities of 1.56, 3.19 and 4.51 to the corresponding point estimate for the intra-Japanese East-West "border" effect from Specification (5) in Table 5, implies tariff equivalents of 43.4, 19.0 and 13.4 percent, respectively.

Following Arkolakis et al. (2012), it is moreover possible to quantify how the distribution of prefecture-level real consumption is shaped by the intra-Japanese East-West "border" effect.[26] General equilibrium changes in prefecture-level real consumption $\widehat{C}_j$ in response to a certain (intra-national) trade shock:

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

are proportional to changes in the respective prefecture's domestic expenditure share λ_{jj}.[27]

While Figure 3a shows the prefecture-level gains in per capita consumption from intra-Japanese trade, Figure 3b illustrates how these consumption gains would change in a counterfactual equilibrium without the intra-Japanese East-West "border" effect.[28] Depending on

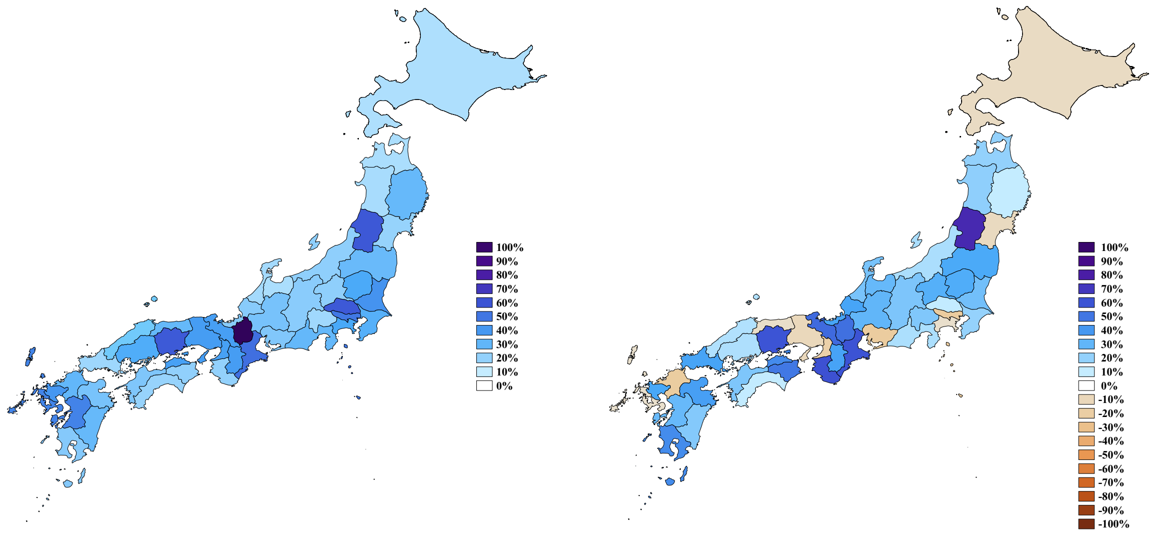
[25] Data on bilateral transport cost in the NCFS are only available at the aggregate level of seven major sectors, which might explain why the estimated elasticity of substitution is comparatively small. Notably, Hummels (1999) shows that estimates for the trade cost elasticity, which are obtained from 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.

[26] Note 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.

[27] As 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.

[28] Both figures assume a trade cost elasticity of 1.56. Outcomes for alternative trade cost elasticities of 3.19 or 4.51 (cf. Head and Mayer, 2015) are reported in the Appendix.

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



(a) *Consumption Gains from Trade* **(b)** *Counterfactual Analysis*

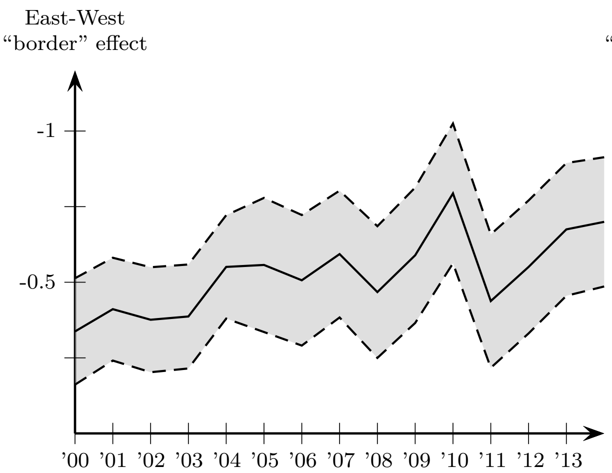
the applied trade cost elasticity (1.56 vs. 3.19 or 4.51), the average consumption gains from inter-prefectural trade in Japan range from 25.1 percent to 7.9 percent. The counterfactual increase in economy-wide real consumption associated with a hypothetical elimination of the intra-Japanese East-West "border" effect would amount to 2.8, 1.7, or 1.2 percent, 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 from a removal of this "border". However, such a removal would at the same time 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 disproportionally well-integrated trading hubs.

In summary, the intra-Japanese East-West "border" effect has a strong and significant impact on the pattern of inter-prefectural trade in Japan. A hypothetical elimination of the intra-Japanese East-West "border" effect is associated with economically meaningful consumption effects, that are unequally distributed between "border" regions, on the one hand, and the (extreme) periphery as well as large trading hubs on the other hand.

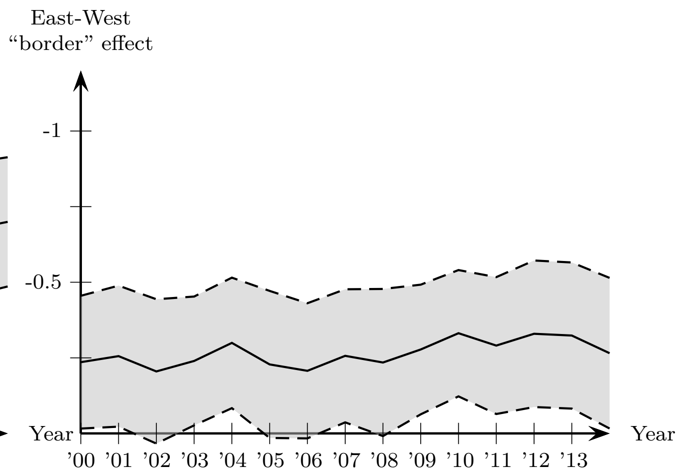
3.3 Exploring the Intra-Japanese East-West "Border" Effect

Table 11 in the Appendix summarises "border" effect estimates obtained from the 2010, 2005, and 2000 wave of the National Commodity Flow Survey (suppressing the other coefficients from Table 5). The Specifications (1) to (7) in Table 11 are the same as in Table 5. The East-West "border" effect is always negative and in all but one specification highly significant. The implied trade reduction ranges from 61.4 to 27.6 percent with the median East-West "border" effect causing a trade reduction of about 42.3 percent. To track the evolution of the intra-Japanese East-West "border" effect more closely year by year over the decade from 2000 to 2014, the Commodity Flow Statistic is used as a complimentary data source. Following Nitsch and Wolf (2013), the baseline specification from Table 5 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 percent confidence interval for the intra-Japanese East-West "border" effect from 2000 to 2014 obtained under pooled OLS and PPML, respectively.[29] The

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



(a) *Pooled OLS*



(b) *PPML*

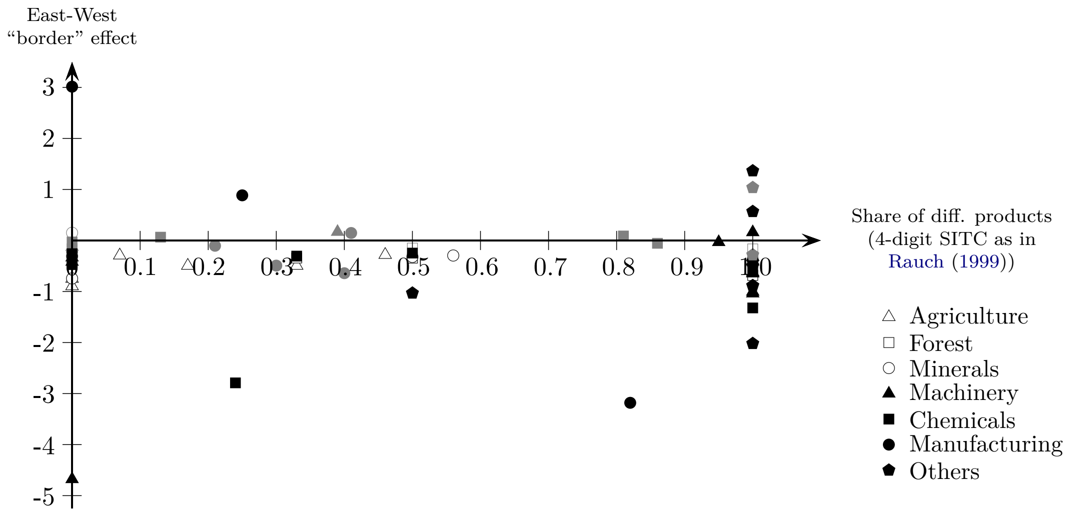
intra-Japanese East-West "border" effect in both figures is significantly below zero over the entire sample period. Moreover, comparing the "border" effects at the beginning and at the end of the sample period reveals an increase in the "border" effect, which is statistically significant at a 1 percent (5 percent) level in Figure 4a (Figure 4b). Together, these findings not only confirm the previous results in Table 11, but also suggest that the intra-Japanese East-West "border"

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

effect has increased slightly over time.

Table 12 in the Appendix uses the 2010, 2005, and 2000 wave of the National Commodity Flow Survey (1YS) to identify the intra-Japanese East-West "border" effect separately for seven major sectors (suppressing again the other coefficients from Table 5). For primary sectors (i.e. agriculture, forest, and minerals) the East-West "border" effect is not always significantly different from zero and sometimes even has the wrong sign, which is compatible with a network-based explanation for the intra-Japanese East-West "border" effect, that should bear little relevance for homogeneous products, which can be traded at organised exchanges. In contrast, there always exists a negative and highly significant East-West "border" effect for secondary sectors, whose differentiated products can not be easily sold at a comparable references price.[30] Figure

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



5, which is based on the more disaggregated three-day survey (3DS), presents estimates for 63 industry-level "border" effects, which are plotted against the share of differentiated products in the respective industry, following the conservative classification in Rauch (1999).[31] To

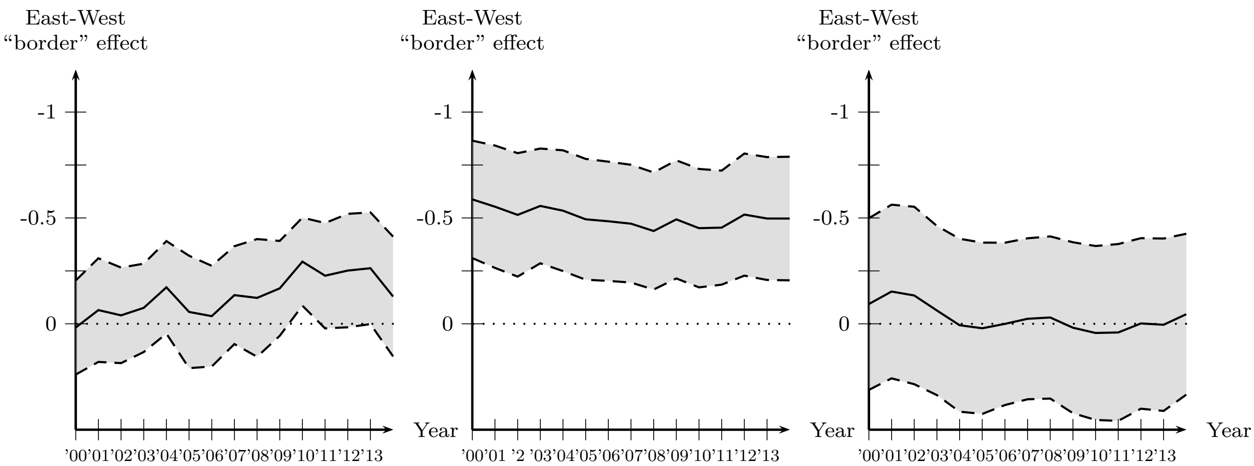
[30]When comparing the East-West "border" effect across sectors s caution is warranted. Estimated "border" effects in Table 12 refer to the product of the trade cost elasticity $\sigma_s - 1$ and the cost-increasing effect of the intra-Japanese East-West "border" δ_{1s}. Table 9 from the Appendix suggest 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) is largely dictated by differences in comparative advantage, that are not included in the simple model from Section 2.

[31]To obtain the share of differentiated products in a given industry, the (updated) Rauch-classification based on the 4-digit Standard International Trade Classification (Rev. 2) is matched to the National Commodity Flow Survey's industry classification. A Technical Supplement, which is available from the author upon request, presents a detailed concordance table and reports the complete set of industry-level estimates for the intra-Japanese East-West "border" effect together with the respective share of differentiated products according to the

maximise the number of available observations, industry-level "border" effects are estimated in a pooled sample, including the 2010, 2005, and 2000 wave of the National Commodity Flow Survey. Taking into account a considerable amount of zero (industry-level) trade flows, Poisson Pseudo-Maximum-Likelihood 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. In line with the previous results, large and statistically significant industry-level "border" effects are more likely to be found for secondary industries, which typically produce differentiated rather than non-differentiated products.[32]

Table 13 in the Appendix reports estimates for the intra-Japanese East-West "border" effect that result from the 2010, 2005, and 2000 waves of the National Commodity Flow Survey (3DS), disaggregated by seven major sectors (cf. Table 12) and four modes of transportation (i.e. by rail, road, sea and air). Exploiting this variation, Specification (1) of Table 13 includes exporter- and importer-specific fixed effects that also vary by sector and by mode of transportation. Throughout all waves of the National Commodity Flow Survey 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 for shipments that are transported either by sea or by road. Figure 6, which uses yearly Commodity Flow Statistic data from 2000 to 2014, confirms

Figure 6: *The East-West "Border" Effect by Transportation Mode from 2000-2014 (PPML)*



(a) *Road* **(b)** *Sea* **(c)** *Rail*

conservative/liberal classification in Rauch (1999).

[32]Figure 5 only includes "border" effects, whose estimation is based at least on 100 observation. Insignificant East-West "border" effects are coloured in grey (rather than in black).

this picture: for shipments that are transported by rail an intra-Japanese East-West "border" effect does not seem to exist.[33] To explain the absence of an intra-Japanese East-West "border" effect for railway-based shipments the historical east-west expansion of Japan's railway network has to be taken into account. The Tôkaidô Main line, which was completed in 1889 as Japan's first long-distance railway line, connecting Tôkyô and Kôbe, is a case in point. By the early 1950's, the Tôkaidô Main line had become Japan's main way of railway-based transportation. Although accounting only for 3 percent of the Japanese National Railways' total railway network, the Tôkaidô Main line carried 24 percent of its passengers and 23 percent of its freight (cf. Smith, 2003). The absence of a (negative) intra-Japanese East-West "border" effect in Specification (2) of Table 13 thus appears to be perfectly in line with a (positive) east-west bias in Japan's railway infrastructure.

To sum up, the intra-Japanese East-West "border" effect can be observed consistently over time and has increased slightly from 2000 to 2014. Moreover, there is no evidence in favour of an explanation of the intra-Japanese East-West "border" effect that is based on the specific pattern of Japan's railway infrastructure.

3.4 Specifying the Intra-Japanese East-West "Border"

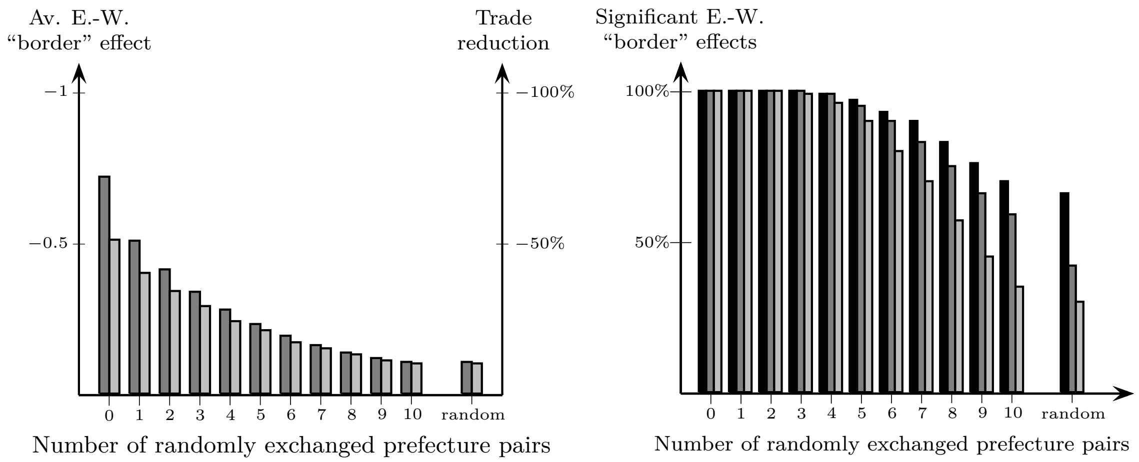
To what extent does trade across the intra-Japanese East-West "border" from Figure 2 differ from trade across any other hypothetical "border" inside Japan? To answer this question the analysis proceeds in three steps: At first, a million placebo regressions based on Specification (1) in Table 5 are performed.[34] Each of these placebo regressions randomly assigns the 47 Japanese prefectures either to a hypothetical "East" or to a hypothetical "West". Surprisingly

[33] Estimates in Figure 6 are obtained from a pooled sample covering the decade from 2000 to 2014. 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 Poisson Pseudo-Maximum-Likelihood 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 percent 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.

[34] After all there exist 2^{47} possible ways of counting Japan's 47 prefectures 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. Results remain unchanged if the number of placebo regression is increased to ten millions instead.

often there is a “border” effect, which at a 1 percent significance level is negative and significant in 33.9 percent of all cases. However, the trade-reducing effect of these hypothetical “borders” on average is rather small (10 percent compared to 51.3 percent in the benchmark case). The largest “border” effect out of a million placebo regressions implies a trade reduction of 36.6 percent, which is still one third smaller than the baseline result of 51.3 percent. 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 percent level of significance. Several authors (cf. Hillberry and Hummels, 2008; Coughlin and Novy, 2016) have argued that aggregation bias may result in purely statistical border effects. The sheer mass of significantly negative “border” effects between prefectures that were randomly assigned into two different prefecture blocks may therefore be regarded as implicit empirical evidence in support of purely statistical “border” effects.

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*

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 size of the East-West “border” effect falls together with the share of placebos, from which a significant “border” effect results as more and more east-west prefecture pairs are “misallocated”.[35] Provided the number of exchanged east-west prefecture pairs is sufficiently

[35]Figure 7a plots the mean estimate (dark gray) together with the implied trade reduction in percent (light

high, the outcome resembles an allocation, in which all prefectures are randomly allocated across the hypothetical "East" and "West".

In a final third step, a simple heuristic is constructed to search for the maximum intra-Japanese "border" effect. 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, which 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, that is comparable to the East-West "border" effect identified in Column (1) of Table 5.[36] Interestingly, the maximum intra-Japanese "border" effect detected in 100 runs is only slightly larger in absolute size and implies a trade reduction of 52.9 percent ($e^{-0.752} - 1$) instead of 51.9 percent, resulting from the baseline regression in Specification (1) of Table 5. The allocations of prefectures preferred by the algorithm are very similar to the *ad hoc* allocation imposed in Figure 2: Across all runs of the algorithm a clear east-west division emerges. 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), with the majority of "missallocated" prefecture pairs (dark-grey bars in Figure 8b) stemming from the *Chûbu* and *Kansai* regions, which are directly adjacent to the East-West "border" in Figure 2. Observing the assignment of prefectures across all allocations that emerge from the search algorithm, it is also possible to compute the prefectural assignment probabilities, which are illustrated in Figure 2 through different shades of red and blue.[37] Except for the *Aichi* Prefecture (hosting Japan's fourth largest city *Nagoya*), there always is an unambiguous assignment of prefectures, which results in the strikingly clear east-west pattern from Figure 2.[38]

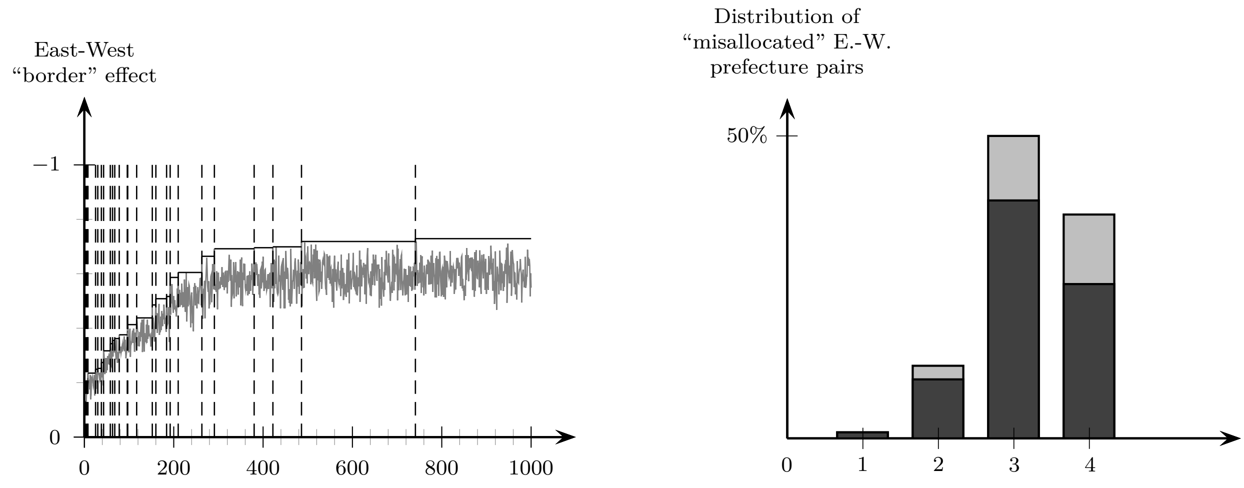
gray). Figure 7b differentiates between the usual 1 percent, (black), 5 percent (dark gray), and 10 percent (light gray) significance levels.

[36] Dashed 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.

[37] To rationalise potential outliers such as *Kôchi* prefecture, which the heuristic search algorithm assigns to the East, it is important to bear in mind that the absolute number of prefectures in each prefecture block is fixed.

[38] Table 14 (from the Appendix) replicates the findings from Table 5 based on the east-west division that emerges

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



(a) *A Simple Heuristic* **(b)** *"Misallocated" East-West Prefecture Pairs*

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 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 are then randomly allocated to both blocks. In 32.3 percent (29.1 percent) of all cases there is a significant intra-East (intra-West) "border" effect, which may be seen as further implicit evidence for the presence of purely statistical borders due to aggregation bias (cf. Hillberry and Hummels, 2008; Coughlin and Novy, 2016). On average these "border" effects (mean point estimate of -0.1106 and -0.1118, respectively) are rather 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. Focussing on the sharp east-west (60Hz-versus-50Hz) division in Japan's power grid (i.e. counting Japan's central *Chûbu* with the exception of *Niigata* Prefecture in Figure 2 to the West), results in a significant trade reduction, which is comparable to the one implied by the imposed east-west "border" effect in Table 5. However, so do most of $2^9 = 512$ possible splits of Japan's central *Chûbu* region (literal translation: *Chûbu* (中部) →

from the heuristic search algorithm (counting *Mie* and *Nara* instead of *Ishikawa* and *Fukui* to the "East").

中 = "middle" + 部 = "part") between the East and the West, which only in 32 percent of all cases deliver an estimate that is statistically different from the baseline estimate in Column (1) of Table 5.[39] Viewing this multiplicity of east-west borders as *reductio ad absurdum* of a sharp east-west trade barrier, that can be causally related to a specific east-west division in Japan's power grid, it is argued that both patterns may bee seen as the common outcome of a bi-polar agglomeration process (Fujita and Tabuchi, 1997): The origin of Japan's divided power grid dates back to a bifurcated technology adoption in 1895 and 1896, when energy provides from *Tôkyô* and *Ôsaka* imported different generators from Germany (50Hz) and the United States (60Hz). While there were more than 70 Japanese electric power providers at the turn of the 20th century, strong increasing returns to scale in combination with steadily improving long-distance transmission technologies lead to a rapid consolidation within the industry (cf. Kikkawa, 2012). For a firm and their standard (e.g. 50Hz or 60Hz) to survive and expand a large and/or fast growing home market was pivotal, which ultimately resulted in a clear east-west division, that was fuelled by the rise of *Tôkyô* in the East and *Ôsaka* in the West. As will be shown below in Section 5.1, the same "Tôkyô-Ôsaka bipolar growth pattern" (cf. Fujita and Tabuchi, 1997) can be related to a dual east-west structure of partially overlapping trade networks, which are associated with a fuzzy (rather than a sharp) east-west trade barrier.

In further robustness checks it also is confirmed that the East-West "border" effect is robust against a complete exclusion of the *Chûbu* region from the sample. Similarly, when dropping potential outliers such as *Okinawa* or *Hokkaidô*, or when focussing only on Japan's main island *Honshû*, the baseline result from Subsection 3.2 is not affected. Finally, there is also no evidence that the East-West "border" effect can be solely linked to the rivalry between *Tôkyô* as the capital in the East and *Ôsaka* or *Kyôto* as natural counterparts in the West. Omitting the respective prefectures from the sample does not change the results from Table 5.

To sum up, several million placebo regressions not only confirm the existence of a fuzzy (rather than a sharp) intra-Japanese "border" effect with a 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 support of alternative and/or additional spatial trade barriers that can be linked to a broad geographic pattern such as the intra-Japanese east-west

[39]In line with the picture of a fuzzy East-West "border" near-by-"border" prefectures in Table 2 and Table 3 appear to be well integrated through inter-prefectural trade.

division.

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: Subsection 4.1 allows for alternative and more flexible specifications of bilateral transportation cost. In Subsections 4.2 and 4.3 the roles of aggregation bias and international shipments are discussed.

4.1 Measurement of Transportation Cost

Table 15 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, 2009; Hillberry and Hummels, 2008). In the benchmark specifications (cf. Columns (1) and (2) of Table 15) 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 percent 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 consistently compute inter- and intra-prefectural distances as population-weighted harmonic means over bilateral distances between a total of 374,674 squared cells of 1km^2 size (cf. Head and Mayer, 2009).[40] Alternatively, bilateral transportation costs in Specification (7) are measured by real travel time (cf. Ozimek and Miles, 2011). Finally, to allow for more flexibility in the measurement of bilateral distances, 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

[40] Following Head and Mayer (2009), bilateral distance between prefecture i and j is computed as population-weighted harmonic mean $\text{dist}_{ij} = (\sum_{\hat{\imath}\in i} \text{pop}_{\hat{\imath}}/\text{pop}_i \sum_{\hat{\jmath}\in j} \text{pop}_{\hat{\jmath}}/\text{pop}_j \text{dist}_{\hat{\imath}\hat{\jmath}}^{\theta})^{1/\theta}$ with $\theta = -1$, in which $\text{pop}_{\hat{\imath}}$ and $\text{pop}_{\hat{\jmath}}$ denote the population at location $\hat{\imath}$ and $\hat{\jmath}$ in 2010. Greater-circle distance between location $\hat{\imath}$ and $\hat{\jmath}$ is denoted by $\text{dist}_{\hat{\imath}\hat{\jmath}}$. Internal distances within 1km×1km cells are set at 250 meters. Providing a geometric analogy between gravity in physics and gravity in trade, Rauch (2016) concludes that distances between regions in empirical gravity estimations should be measured as weighted harmonic means of pairwise distances of local economic activity (see also Head and Mayer (2009) for a detailed review of the literature).

[2000,max], which are implemented in Specification (8) through a set of four dummy variables (using the range [0,250] as reference category).

For all specifications of Table 15 a negative and highly significant intra-Japanese East-West "border" effect exists. However, three 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 costs 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 "border" is underestimated relative to a specification which accounts for the presence of long-haul economies (see also Table 4). Second, in line with the findings of Hillberry and Hummels (2003), the intra-Japanese East-West "border" effect is inflated by the imputation of bilateral (greater-circle) distance. Third, as in Head and Mayer (2009) the intra-Japanese East-West "border" effect is smaller in magnitude (although still highly significant) if distance is measured as a population-weighted harmonic (rather than arithmetic) mean over highly disaggregated geographic units.

Summing up the findings from Table 15 in the Appendix, there is no evidence that the intra-Japanese East-West "border" effect can be explained solely in terms of misspecified bilateral transportation cost. At the same time, the results suggest that the presence of long-haul economies in Japan's transportation sector has to be taken into account to avoid a systematic underestimation of the intra-Japanese East-West "border" effect.

4.2 Aggregation Bias

Motivated by Hillberry and Hummels' (2008) finding that estimates of the intra-national home bias become implausibly large once the analysis is conducted at the level of highly disaggregated spatial units (5-digit ZIP codes), Coughlin and Novy (2016) propose a model, in which the costs of trading within and across borders are asymmetrically affected by spatial aggregation. Due to this asymmetry, there is a spatial attenuation effect, which results in smaller border effect estimates at higher levels of aggregation. To gauge the importance of aggregation bias for the intra-Japanese East-West "border" effect, Table 16 (delegated to the Appendix) presents a hypothetical aggregation exercise along the lines of Coughlin and Novy (2016). Thereby, the 47 prefectures from Figure 2 are merged into 21 hypothetical sub-regions.[41] As predicted by Coughlin and Novy (2016), the intra-Japanese East-West "border" effects for 2010, 2005, and 2000 are smaller when estimated at the level of 21 sub-regions rather than at the level of 47 prefectures.[42] However, given the moderate declines in the estimates from Table 16, it seems rather unlikely that the intra-Japanese East-West "border" effect can be explained away by choice of the underlying aggregation level.

4.3 International Shipments

Due to its island-nation status most of Japan's international trade is channelled through a limited number of ports, which naturally serve as trading hubs for outward bound shipments (cf. Combes et al., 2005).[43] In a scenario where all prefectures within the East or the West would export only via a limited number of specific harbours within their respective prefecture block, the intra-Japanese East-West "border" effect would be upward biased (in absolute terms). Reassuringly, no empirical support for the aforementioned scenario can be found, when consulting the 2013-wave of Japan's International Container Trade Survey [*Zenkoku Yushutsunyû Kontena Kamotsu Ryûdô Chôsa*] on the actual internal distribution of Japan's international container shipments. Table 17 (from the Appendix) maps the distribution of Japan's regional export and import shares to the respective exporting and importing region. An overwhelming share of 80.2 percent of all exports (89.2 percent of all imports) are shipped out (shipped in) through a port that is located within the region of origin (destination).[44] Due to the highly localised internal distribution of Japan's international shipments the resulting upward bias in intra-national trade at the level

[41] Coughlin and Novy (2016) merge 48 U.S. states into 9 aggregate census divisions. Unlike in the U.S., where the number of states per census division is roughly the same, the distribution of Japan's 47 prefectures into the 9 aggregate regions from Figure 2 is highly skewed with the prefectures Hokkaidô and Okinawa each constituting a single region.

[42] In line with Coughlin and Novy (2016), aggregation is associated with a drop in the home bias estimates, captured by the coefficients of the dummy variables for trade within prefectures and sub-regions in Table 16.

[43] The NCFS excludes all imports, which are shipped from the port of entrance to the first domestic destination.

[44] Further evidence comes from the 2014-wave of Japan's Commodity Flow Survey for Bulky Goods [*Buruku Kamotsu Ryûdô Chôsa*]: due to the much higher cost of un- and reloading almost all international trade in bulky goods (i.e. 93.4 percent of the exports and 98.6 percent of the imports) is channelled through a port that is located within the same region as the sending or receiving prefecture.

of prefectures and regions (rather than at the level of prefecture blocks) is fully absorbed by the indicator variables for intra-prefecture and intra-region trade introduced in Subsection 2.3.[45] With the knowledge that any upward bias in intra-prefectural/regional trade is fully captured by a combination of indicator variables for intra-prefectural and intra-regional trade, it is possible to quantify an upper bound for the upward bias in the East-West "border" effect, that would result from *not* taking into account the internal distribution of Japan's international shipments. A comparison of Specifications (1) and (2) in Table 18 (delegated to the Appendix) reveals that the trade-reducing effect of the intra-Japanese East-West "border" would increase from 51.3 percent ($e^{-0.7188} - 1$) to 55.8 percent ($e^{-0.8165} - 1$), which corresponds to a moderate upward bias of 4.5 percentage points or 8.8 percent. To account for the 19.8 percent and 10.8 percent of Japan's international container exports and imports that are inter-regionally traded on their way to or from the respective international harbour, it is worth to note that almost all of these trade flows (96.5 percent of the exports and 96.3 percent of the imports) are channelled through one of seven prefectures (*Tôkyô*, *Kanagawa*, *Aichi*, *Ôsaka*, *Hyôgo*, *Yamaguchi* and *Fukuoka*). Specification (3) of Table 18 therefore introduces a port dummy, which takes a value of one whenever the sending or destination prefecture is one of the aforementioned seven prefectures and a value of zero otherwise. According to the positive and significant coefficient of the port dummy in Specification (3) of Table 18 there is more internal trade with those prefectures which serve as a gate to the word market. However, since the coefficient of the interaction term with the East-West "border" dummy is positive as well, this kind of trade mostly occurs along the east-west dimension, which is the exact opposite of what one would expect if ports were only to serve prefectures that are located in the same prefecture block, i.e. either within the East or within the West.[46] In a final robustness check internal trade flows from the 2013-wave of the CFS in Specification (7) of Table 18 are directly purged from all international shipments.[47] Since all upward biases in intra-prefectural and intra-regional trade are fully captured by the corresponding fixed effects, the coefficients of the intra-Japanese East-West border dummy in

[45] A more detailed discussion based on theoretical minimal working example in the spirit of Head and Mayer (2013) and Novy (2013) is delegated to a Technical Supplement, which is available from the author upon request.

[46] Specifications (4) and (5) of Table 18 invite a similar conclusion. Thereby the port dummy in Specification (4) is only defined for designated exports. Specification (5) drops all seven port prefectures from the sample.

[47] International shipments are based on the prefectural trade shares from the 2013-wave of Japan's International Container Trade Survey [*Zenkoku Yushutsunyû Kontena Kamotsu Ryûdô Chôsa*], which are combined with the total volume of international shipments from the 2013-wave of Japan's Harbour Survey [*Kôwan Chôsa*].

the baseline Specification (6) and the purged Specification (7) of Table 18 are basically the same. In summary, there is no evidence for a systematic bias in the intra-Japanese East-West "border" effect due to the internal distribution of Japan's international shipments, which is little surprise when taking into account that Japan consistently ranks among the least open OECD countries with an export/import to GDP ratio of just 15 percent in 2010.[48]

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 5. Subsection 5.2 then isolates the structure of business and social networks as well as the geography of cultural proximity as those explanatory variables, which display a significant variation along the east-west dimension. To explore the relationship between these variables and the "border" effect, the analysis follows Chen (2004) by introducing the intra-Japanese East-West "border" dummy together with an interaction term between the "border" dummy and the explanatory variable of interest. Finally, Subsection 5.3 concludes by linking Japan's dual east-west network structure to the country's post-war agglomeration experience, characterised by an "Tôkyô-Ôsaka bipolar growth pattern" (cf. Fujita and Tabuchi, 1997).

5.1 In Search for Explanations

This section examines to what extent the intra-Japanese East-West "border" effect is sensitive to the inclusion of observable characteristics at the prefecture-pair level. To this end, a large number of contemporaneous and historical determinants from the empirical trade literature are sequentially introduced into the baseline regression from Subsection 3.2. As a point of reference, Specification (1) in Table 19 (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 et al. (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 prefecture-level exports and imports. In line with the find-

[48] Japan's unusually low export/import to GDP ratio has been extensively debated in the earlier literature (cf. Lawrence, 1987, 1991; Saxonhouse, 1993).

ings of Combes et al. (2005) and Garmendia et al. (2012), the network coefficient in Column (2) is not only positive and significant, but also associated with a reduced (although still significant) intra-Japanese East-West "border" effect.

Social networks: To account for the role of social networks (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 aggregated up over the five-year interval from 2005 to 2009.[49] As suggested by the literature (see Felbermayr et al. (2015) for a recent survey), 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 19 becomes statistically indistinguishable from zero.

Alternatively, Specifications (4) and (5) control for social networks resulting from individual commuting and travel patterns. 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* [*Ryokyaku Chiiki Ryûdô Chôsa*]. Network effects in Specifications (4) and (5) resemble those of internal migration in Specification (3) and have a similar (although less strong) impact on the intra-Japanese East-West "border" effect.[50]

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.[51] The strength of a coethnic network is approximated by the product of the respective minority's prefectural population shares (cf. Rauch and Trindade,

[49] Due to data limitations, the majority of existing studies (see Genc et al., 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.

[50] When accounting for the complete set of controls in Specification (10), 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.

[51] As Japan's two major ethnic minorities, Chinese and Koreans accounted for 27.9 percent and 25.7 percent 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.

2002). Accounting for coethnic networks does not affect the intra-Japanese East-West "border" effect, and unobserved fractionalisation (cf. Felbermayr et al., 2010) may explain the somewhat counterintuitive trade-inhibiting effect of ethnic Korean networks in Specifications (6) and (10) of Table 19.[52]

Trust: To control for the trade-inhibiting effect of limited trust (cf. Guiso et al., 2009), data on individual trust levels from the 2010 wave of the Japanese General Social Survey are used to compute the prefectural population share of people who state that they trust other people.[53] Bilateral trust, approximated by the product of prefectural trust shares, has the expected positive impact on intra-Japanese trade (cf. Guiso et al., 2009). However, in line with the results from Subsection 3.3, the intra-Japanese East-West "border" effect cannot be explained by an east-west heterogeneity in the trade-creating effect of bilateral trust.

History: Recently, several authors (cf. Head et al., 2010; Nitsch and Wolf, 2013; Felbermayr and Gröschl, 2014) have highlighted the long shadow that history casts on contemporary inter- and intra-national trade. Felbermayr and Gröschl (2014) argue that the American Civil War led to a manifestation of long-lasting cultural differences, which continue to shape the pattern of trade between the former Union and Confederacy up to this day. To identify an internal conflict of comparable importance in Japan's history, one has to go back 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, succeeded 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), but also led to a distinction between *fudai* and *tozama* feudal lords (*daimyo*), depending on whether the

[52]The Japanese Population Census does not distinguish between North- and South-Koreans, as most Koreans arrived in Japan prior to the outbreak of the Korean war (1950-1953), that led to the division of Korea into a northern and southern part. Nevertheless, many 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).

[53]Respondents 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 in 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 reported by the 2010 wave of the Japanese General Social Survey.

respective vassal at the battle of Sekigahara was on the winning or losing side. To consolidate their power base the first five Tokugawa rulers (*shoguns*) between 1601 and 1705 confiscated and redistributed 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 was characterised by a clear core-versus-periphery pattern: while most of the loyal *fudai daimyo* were rewarded 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 ultimately also featured prominently in the Tokugawa shogunate's decline, administrative data from the *Summary of han governments* [*Hansei ichiran*] is used. Building upon 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.[54] 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* and *tozama* landholdings. The resulting *fudai*-versus-*tozama* 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 (8) of Table 19 affects neither today's cross-border trade nor does it explain 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 political borders originating from the structure of feudal landholdings in pre-modern Japan, it is of course possible that other (unobserved) historical shocks have the potential to explain the (contemporaneous) 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. In order to meet this challenge, Falck et al. (2012) propose a measure of cultural proximity, which can be constructed from the 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

[54] As in Beasley (1960) the term *fudai* subsumes direct branch houses of the Tokugawa family (*sanke*, *sakyô*, and *kamon*).

Japan [*Nihon Gengo Chizu*]. Based on a survey conducted by the National Language Research Institute between 1957 and 1964, the Linguistic Atlas of Japan covers 285 prototypical language characteristics from 2400 locations all over Japan that were reported by male informants, who were born not later than in 1903.[55] 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.[56] 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 is possible to approximate contemporaneous cultural differences across Japanese prefectures through historical dialect similarity. Importantly, the historical geography of dialect similarity is far from random. For the case of Germany Falck et al. (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 exists for Japan: Using a Geographical Information Systems 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 20 (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 percent). For *Hokkaidô*, which is similarly isolated, the overlap in dialectical imprints with its direct neighbouring prefectures (e.g. *Aomori* with 32 percent overlap and *Iwate* with 39 percent 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 *Honshû* (e.g. *Tôkyô* or *Nagano*, each with an remarkable overlap of 64 percent).

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

[56] Following Falck et al. (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 $c = 1, \ldots, 240$ and zero otherwise.

What is the reason for this striking difference? Unlike *Okinawa*, *Hokkaidô* became the target of systematic colonisation efforts during the second half of the 19th century, which not only resulted in an internal mass migration towards *Hokkaidô* but also in a subsequent acculturation towards central Japan.[57] Both examples highlight how historical interactions between Japanese prefectures are preserved in prefectures' dialects. 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 (9) of Table 19, cultural proximity is not only associated with increased bilateral trade (cf. Felbermayr and Toubal, 2010; Lameli et al., 2015), but also with a mitigated (although still significant) East-West "border" effect.

Summing up the results from Table 19, 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 can (at least partly) be explained by the structure of business and social networks (Combes et al., 2005). On the other hand, it cannot 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 et al., 2015).

5.2 Networks versus History

To sort out whether the intra-Japanese East-West "border" effect can be explained through the geographical structure of business and social networks or through long-lasting historical shocks, Table 6 (suppressing the other controls from Table 5) includes the East-West "border" dummy together with an interaction term between the "border" dummy and the explanatory variable of interest (cf. Chen, 2004). 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 of the respective variable.

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 6 reports results including the busi-

[57] Over 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). A more detailed analysis of *Hokkaidô*'s trade pattern is delegated to a Technical Appendix, which can be obtained from the author upon request.

ness 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. Evaluating the intra-Japanese East-West "border" effect at the 75 percent versus the 25 percent percentile of the headquarter-plant-link distribution implies a reduction of the (absolute) "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 can (at least partly) be explained by the structure of the Japanese business network, which tends to be stronger within rather than between the East and West. Specification (3) of Table 6 suggests that the trade-enhancing effect of social networks is

Table 6: *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^{***}	-0.1034	0.6043^{**}	-1.4651^{***}	-0.2990
	(.0487)	(.1229)	(.2431)	(.1713)	(.4065)
ln number of headquarter-plant links$_{ij}$		0.7780^{***}			0.3837^{***}
		(.0446)			(.0709)
ln number of headquarter-plant links$_{ij}$ × East-West "border" dummy$_{ij}$		-0.0721^{***}			-0.0702
		(.0243)			(.0632)
ln agg. migration flows (2005-2009)$_{ij}$			0.9898^{***}		0.5142^{***}
			(.0429)		(.0802)
ln agg. migration flows (2005-2009)$_{ij}$ × East-West "border" dummy$_{ij}$			-0.0834^{***}		-0.0063
			(.0281)		(.0779)
Cultural proximity$_{ij}$				4.3630^{***}	1.8940^{***}
				(.3409)	(.3881)
Cultural proximity$_{ij}$ × East-West "border" dummy$_{ij}$				2.7277^{***}	1.4569^{***}
				(.4046)	(.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: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

characterised by the same east-west heterogeneity. Even though migration networks generally foster trade, they do less so across the east-west dimension. Again, comparing the 75 percent and 25 percent 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 intuitive explanation for the observed intra-Japanese East-West "border" effect.

Are the network effects along the east-west dimension reinforced or even predetermined by cultural differences between the East and West of Japan? Column (4) of Table 6 answers this question by including an interaction term of the East-West "border" effect with the cultural proximity index from Subsection 5.1. The positive and significant coefficient on the interaction term suggests that the trade-creating effect of cultural proximity is stronger between rather than within both country parts. Table 20 from the Appendix 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 an 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 percent and 75 percent 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. Taking stock, 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 is to some extent concealed by the strong cultural ties between Japan's central prefectures.

Together, the results from Table 6 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, Specification (5) includes all interactions 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 the interaction term with either network variable is restored once the respective other network variable is dropped from the regression.

5.3 Agglomeration and the Intra-Japanese East-West "Border" Effect

Of course, network formation itself is an endogenous process, which ultimately raises the question why Japan's business and social networks are more integrated within rather than between the East and West. 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) such as *Tôkyô* or *Ôsaka* grew at much higher rates than non-MAs, which gave rise to a substantial MA-versus-non-MA income differential, triggering an unprecedented wave of rural-to-urban migration (cf. Tabuchi, 1988).[58] Between 1955 and 1970, the metropolitan areas of *Tôkyô* and *Ôsaka* predominantly drew migrants from the surrounding prefectures, which led to the establishment of an eastern migration network mainly centred around *Tôkyô* and a western migration network disproportionally clustered around *Ôsaka*.[59] Due to their persistent and self-reinforcing nature (cf. Carrington et al., 1996), both migration networks not only outlived the (initialising) *Tôkyô*-*Ôsaka* migration boom (1955-1970), but also became increasingly important for the pattern of intra-Japanese east-west trade. Extending the analysis of Fujita and Tabuchi (1997) and Fujita et al. (2004), Figure 9 depicts the Theil decomposition of inter-prefectural per capita income differentials (cf. Subfigure 9a) together with the (net) migration figures (in thousands) for the MAs of *Tôkyô* and *Ôsaka* (cf. Subfigure 9b).[60] According to Figure 9, Japan's post-war recovery period from 1955 to 1970 was associated with a substantial MA-versus-non-MA (per capita) income differential, which dropped sharply after 1970 and has stayed constant (at a low level) since then. Using Sim's test of causality, Tabuchi (1988) shows that the massive (net) migration to the MAs of *Tôkyô* and *Ôsaka* between 1955 and 1970 occurred in response to the inter-prefectural income differentials presented in Subfigure 9a. Between 1970 and 1975, (net) migration from non-MAs to MAs dropped dramatically, leading to a persistent population drain for the *Ôsaka* MA and moderately fluctuating (net) immigration for the *Tôkyô* MA after 1975. To see how post-war Japan's bipolar agglomeration process has shaped the intra-Japanese migration network consider specification:

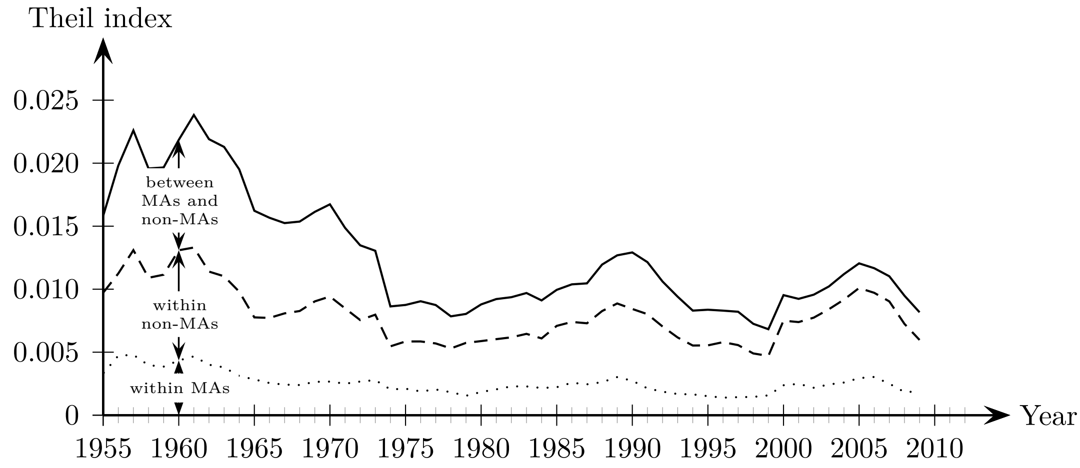
$$\ln(M_{ijt}/L_{it}) = D_{it} + D_{jt} + \alpha_{Dt}\ln(\text{Dist}_{ijt}) + \alpha_{Bt}\ln(\text{Bord}_{ijt}) + \varepsilon_{ijt}, \tag{11}$$

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

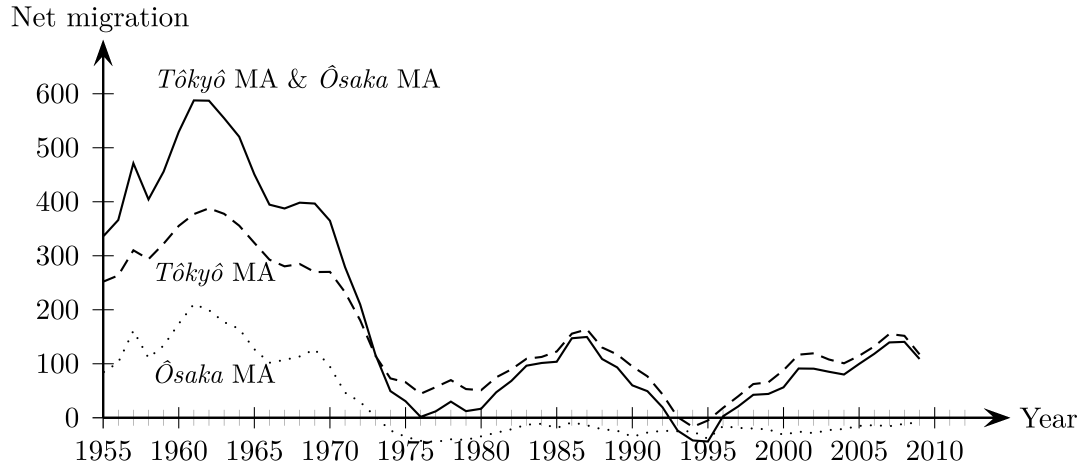
[59]Following Fujita and Tabuchi (1997), the *Tôkyô* MA comprises the prefectures: *Tôkyô*, *Kanagawa*, *Saitama* and *Chiba*. The prefectures of *Ôsaka*, *Hyôgo*, *Kyôto* and *Nara* form the *Ôsaka* MA.

[60]Inter-prefectural inequality in Subfigure 9a is computed based on prefecture-level per capita income data from 1955 to 2010 (evaluated at prices from the base year 2000), which are published by the Economic and Social Research Institute (ESRI); see also Barro and Sala-I-Martin (1992) and Fujita and Tabuchi (1997). Inter- and intra-prefectural migration stocks, underlying the Subfigures 9b and 9c are drawn from the Statistics Bureau of the Ministry of Internal Affairs and Communications. Migration data on *Okinawa* is not available before 1975. Dashed lines in Subfigure 9c indicate the 99 percent confidence interval.

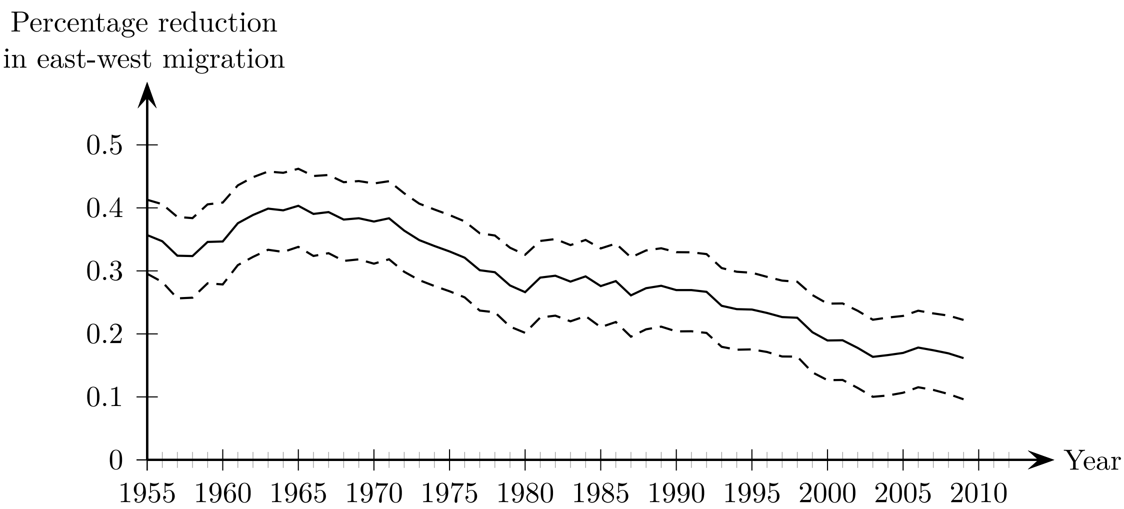
Figure 9: *The pattern of Intra-Japanese Migration from 1955 to 2009*



(a) *Theil Decomposition for the Inter-prefectural per Capita Income Differential*



(b) *Net Migration to Tôkyô and Ôsaka Metropolitan Areas*



(c) *The East-West Bias in the Intra-Japanese Migration Network* which relates the rate of emigration M_{ijt}/L_{it} from prefecture i to prefecture j at time t to a set of monadic source and destination fixed effects, D_{it} and D_{jt}, to bilateral distance Dist_{ijt} as a proxy for migration cost, and to ε_{ijt} as the standard error term.[61] The source- and destination-specific fixed effects capture all prefecture-specific impact variables, such as ongoing wages, prices, and amenities (cf. Roback, 1982; McDuff, 2011). The indicator variable $\text{Bord}_{ijt} \in \{0, 1\}$ takes a value of one if migration occurs along the east-west dimension and zero otherwise. Using the estimate of parameter α_{Bt}, it is possible to quantify the percentage reduction in east-west migration $(1 - e^{\alpha_{Bt}})$ relative to migration within the East and the West. According to Subfigure 9c intra-eastern/western migration peaked in the mid-60s, exceeding east-west migration between comparable prefectures by almost 40 percent. The increasingly dual structure of post-war Japan's internal migration network over the period from 1955 to 1975 can be regarded as an immediate consequence of the "Tôkyô-Ôsaka bipolar growth pattern" (cf. Fujita and Tabuchi, 1997). While the *Tôkyô-Ôsaka* migration boom effectively came to an end in 1975, Japan's internal migration pattern continued to exhibit an astonishingly persistent east-west bias, which may be regarded as implicit evidence for a self-reinforcing duality in Japan's social network structure. To account for the impact of present and past migration networks on the pattern of intra-Japanese trade in 2000, 2005, and 2010, Table 7 regresses the contemporaneous trade volume on lagged bilateral migration stocks (aggregated over varying time windows, reaching up to 55 years back into the past). In addition to the baseline controls from Table 5, an interaction term between the network variable and the East-West "border" dummy is included to control for geographic heterogeneity in the trade-creating effect of migration networks. Several observations can be made: Comparing the trade-creating effects of social networks from 2000 to 2010, suggests that social networks become more important over time. The (size) ranking of effects in 2000, 2005, and 2010 is remarkably stable if networks are defined over longer time spans (e.g. 10, 15, 20... years). An extension of the period over which the network variable is defined lowers the (contemporaneous) trade-creating effect of social networks, which is compatible with the self-reinforcing nature of migration networks and a depreciation of older network links. For the interaction effect, a similar pattern exists: The (negative) east-west bias in the trade-creating effect of social networks in 2010 is stronger than in 2005 and much stronger than in 2000, for which coefficients are statistically indistinguishable from zero (at conventional levels

[61] Following Anderson (2011), gravity equation (11) can be derived from a simple discrete location choice model with random utility (cf. Anderson et al., 1992).

Table 7: *Agglomeration and the Intra-Japanese East-West "Border" Effect*

Dependent variable: Exports in tons from prefecture i to prefecture j									
Survey:	**1YS**								
Unit:	**Quantities**								
Model:	**OLS-FE**								
Specification:	**Transport costs**			**Distance**			**Distance intervals**		
Year:	**2010**	**2005**	**2000**	**2010**	**2005**	**2000**	**2010**	**2005**	**2000**
ln agg. migration stocks$_{ij}$									
from 2005 to 20...	0.9892***			0.9139***			0.9289***		
	(.0428)			(.0524)			(0.0512)		
from 2000 to 20...	1.0079***	0.9398***		0.9436***	0.9343***		0.9554***	0.9477***	
	(.0424)	(.0433)		(.0524)	(.0525)		(.0508)	(.0509)	
from 1995 to 20...	0.9990***	0.9300***	0.8876***	0.9367***	0.9230***	0.7604***	0.9482***	0.9394***	0.7951***
	(.0418)	(.0422)	(.0375)	(.0518)	(.0512)	(.0444)	(.0499)	(.0495)	(.0427)
from 1990 to 20...	0.9732***	0.9021***	0.8483***	0.9058***	0.8858***	0.7169***	0.9205***	0.9074***	0.7543***
	(.0413)	(.0413)	(.0370)	(.0505)	(.0495)	(.0429)	(.0484)	(.0475)	(.0411)
from 1985 to 20...	0.9556***	0.8833***	0.8273***	0.8852***	0.8611***	0.6948***	0.9026***	0.8856***	0.7329***
	(.0408)	(.0408)	(.0367)	(.0495)	(.0483)	(.0420)	(.0474)	(.0463)	(.0404)
from 1980 to 20...	0.9461***	0.8755***	0.8237***	0.8745***	0.8509***	0.6924***	0.8928***	0.8759***	0.7302***
	(.0403)	(.0404)	(.0367)	(.0486)	(.0476)	(.0416)	(.0467)	(.0455)	(.0400)
from 1975 to 20...	0.9336***	0.8643***	0.8105***	0.8594***	0.8358***	0.6792***	0.8795***	0.8622***	0.7172***
	(.0400)	(.0401)	(.0368)	(.0478)	(.0470)	(.0413)	(.0459)	(.0448)	(.0397)
from 1970 to 20...	0.8854***	0.8200***	0.8019***	0.7861***	0.7743***	0.6625***	0.8274***	0.8194***	0.7105***
	(.0377)	(.0380)	(.0343)	(.0434)	(.0435)	(.0385)	(.0419)	(.0418)	(.0369)
from 1965 to 20...	0.8553***	0.7890***	0.7689***	0.7548***	0.7400***	0.6315***	0.7968***	0.7861***	0.6797***
	(.0373)	(.0376)	(.0340)	(.0426)	(.0428)	(.0379)	(.0411)	(.0412)	(.0362)
from 1960 to 20...	0.8345***	0.7686***	0.7497***	0.7337***	0.7175***	0.6139***	0.7757***	0.7637***	0.6617***
	(.0370)	(.0373)	(.0338)	(.0421)	(.0424)	(.0374)	(.0406)	(.0407)	(.0357)
from 1955 to 20...	0.8340***	0.7701***	0.7555***	0.7340***	0.7201***	0.6200***	0.7743***	0.7642***	0.6660***
	(.0368)	(.0370)	(.0337)	(.0420)	(.0423)	(.0375)	(.0405)	(.0405)	(.0356)
East-West "border" dummy$_{ij}$ × ln agg. migration stocks$_{ij}$									
from 2005 to 20...	−0.0837***			−0.0329			−0.0737**		
	(.0281)			(.0298)			(.0286)		
from 2000 to 20...	−0.0821***	−0.0584**		−0.0352	−0.0309		−0.0731**	−0.0682**	
	(.0280)	(.0286)		(.0298)	(.0306)		(.0286)	(.0293)	
from 1995 to 20...	−0.0821***	−0.0598**	−0.0143	−0.0361	−0.0321	0.0268	−0.0736***	−0.0689**	−0.0154
	(.0278)	(.0284)	(.0254)	(.0296)	(.0302)	(.0262)	(.0284)	(.0291)	(.0254)
from 1990 to 20...	−0.0806***	−0.0587**	−0.0112	−0.0330	−0.0286	0.0321	−0.0724**	−0.0679**	−0.0128
	(.0275)	(.0280)	(.0252)	(.0292)	(.0297)	(.0258)	(.0281)	(.0287)	(.0251)
from 1985 to 20...	−0.0773***	−0.0567**	−0.0072	−0.0291	−0.0250	0.0361	−0.0698**	−0.0660**	−0.0100
	(.0273)	(.0278)	(.0250)	(.0289)	(.0294)	(.0255)	(.0279)	(.0284)	(.0250)
from 1980 to 20...	−0.0740***	−0.0534*	−0.0026	−0.0257	−0.0213	0.0397	−0.0672**	−0.0631**	−0.0064
	(.0272)	(.0276)	(.0251)	(.0286)	(.0292)	(.0255)	(.0277)	(.0282)	(.0249)
from 1975 to 20...	−0.0673**	−0.0474*	0.0059	−0.0185	−0.0143	0.0473*	−0.0611**	−0.0570**	0.0007
	(.0270)	(.0275)	(.0251)	(.0283)	(.0289)	(.0254)	(.0275)	(.0280)	(.0249)
from 1970 to 20...	−0.0487*	−0.0376	0.0084	0.0060	0.0020	0.0509**	−0.0451*	−0.0466*	−0.0016
	(.0254)	(.0261)	(.0242)	(.0262)	(.0273)	(.0242)	(.0257)	(.0268)	(.0239)
from 1965 to 20...	−0.0430*	−0.0305	0.0157	0.0122	0.0100	0.0571**	−0.0399	−0.0398	0.0039
	(.0253)	(.0261)	(.0242)	(.0261)	(.0272)	(.0241)	(.0256)	(.0267)	(.0238)
from 1960 to 20...	−0.0377	−0.0247	0.0207	0.0175	0.0160	0.0610**	−0.0349	−0.0341	0.0079
	(.0254)	(.0261)	(.0243)	(.0260)	(.0272)	(.0241)	(.0257)	(.0267)	(.0238)
from 1955 to 20...	−0.0343	−0.0215	0.0229	0.0199	0.0183	0.0622***	−0.0317	−0.0308	0.0103
	(.0254)	(.0262)	(.0244)	(.0261)	(.0272)	(.0241)	(.0257)	(.0267)	(.0239)

Robust standard errors in parenthesis; significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. No migration data available for Okinawa before 1975.

of significance). Again, the ranking is stable if the network variable is defined over longer time spans (e.g. 10, 15, 20... years). However, significance for the years 2010 and 2005 is lost if the respective network variables are extended too far into the past. In summary, the evidence from Table 7 points to a self-reinforcing bi-polar network structure, that can be associated with a increasingly negative east-west bias in intra-Japanese trade.

Finally, to underscore the importance of long-haul economies (cf. Subsection 3.1), Table 7 also replicates the analysis for the case, in which transportation cost are approximated by (un-weighted) distance. The use of (unweighted) greater-circle distance results in a downward bias for the direct effects and in an upward bias for the interaction effects, with the latter ones eventually turning insignificant. Intuitively, this is the case, as the (relative) lack of short-distance trade (due to omitted short-distance trade costs) is misattributed to the regionally concentrated structure of migration networks. Reassuringly, size and significance are restored once the discrete distance intervals introduced in Subsection 4.1 are used to account for the presence of long-haul economies in the Japanese transportation industry (as proposed by Eaton and Kortum, 2002).

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. For the case of Japan, the reduction of 23.1 percent to 51.3 percent in intra-Japanese east-west trade relative to trade within both country parts, can be explained by the dual structure of contemporaneous business and social networks, which disproportionally foster trade within rather than between the East and the West. Thereby, Japan's dual network structure can be interpreted as the natural outcome of post-war agglomeration processes, characterised by a "Tôkyô-Ôsaka bipolar growth pattern" (cf. Fujita and Tabuchi, 1997).

By introducing a new gravity-based search algorithm to identify disproportionately well integrated economic sub-regions such as the East and West of Japan, this paper also points to the presence of a surprisingly large number of randomly distributed and probably purely statistical "border" effects, which most likely arise due to aggregation bias (cf. Hillberry and Hummels, 2008; Coughlin and Novy, 2016). To distinguish network-related and purely statistical trade barriers for more than two equally-sized sub-regions a theory-consistent extension of the gravity-based search algorithm proposed in this paper may be applied to more disaggregated internal trade data.

A Appendix

Figure 10: *The National Commodity Flow Survey (NCFS)*

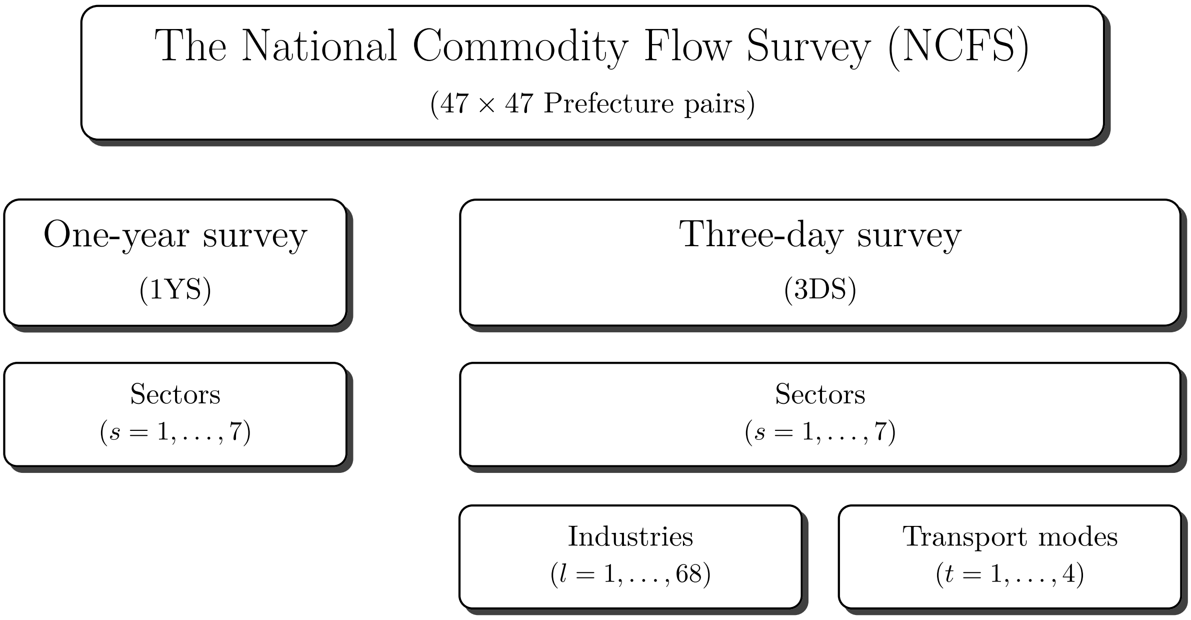


Figure 11: *The Commodity Flow Statistic (CFS)*

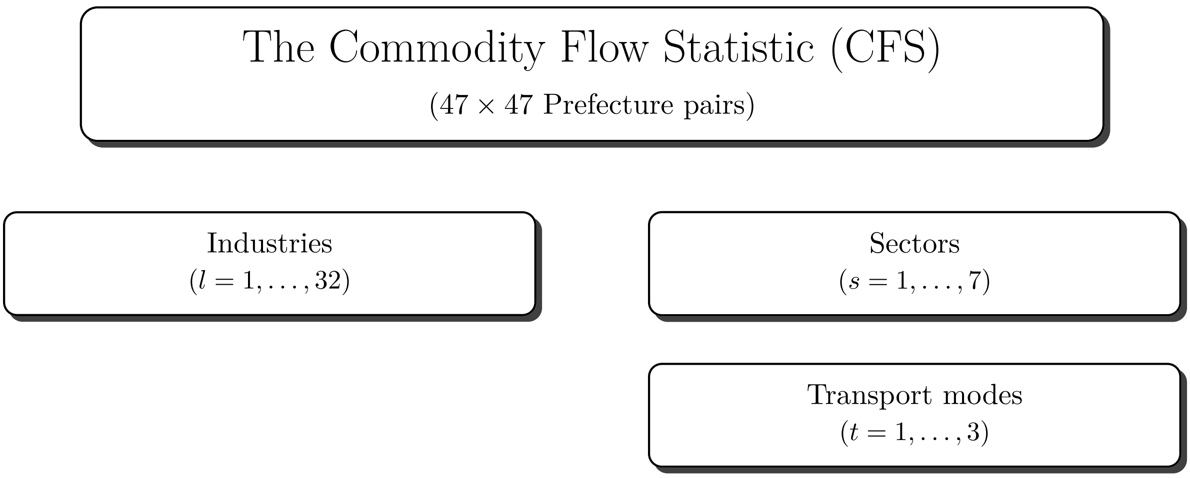


Table 8: *Summary Statistics and Data Sources*

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	
× Korean share_{ij}	2010	0.0472	0.0805	Population Census; Statistics Bureau of the Ministry of Internal Affairs and Communications (MIC)
× Chinese share_{ij}	2010	0.0847	0.0544	
× Philippine share_{ij}	2010	0.0095	0.0100	
× Thai share_{ij}	2010	0.0004	0.0008	
× Indonesian share_{ij}	2010	0.0002	0.0003	
× Vietnamese share_{ij}	2010	0.0003	0.0004	
× UK share_{ij}	2010	0.0000	0.0000	
× US share_{ij}	2010	0.0005	0.0009	
× Brazilian share_{ij}	2010	0.0131	0.0420	
× Peruvian share_{ij}	2010	0.0006	0.0022	
× Trust share_{ij}	2010	0.4510	0.0722	Japanese General Social Surveys (JGSS); JGGS Research Center
Fudai versus tozama dummy_{ij}	1968	0.4581	0.4983	Own Computation based on Beasley (1960)
Cultural proximity_{ij}	1957-1964	0.4110	0.1702	Linguistic Atlas of Japan (LAJ); National Institute for Japanese Language and Linguistics (NINJAL)

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

Table 9: *The Trade Cost Elasticity*

Survey:	**3DS**								
Data:	**Sectoral**								
Unit:	**Values**								
Model:	**OLS-FE** (Hertel et al., 2007)						**OLS** (Caliendo and Parro, 2015)		
Year:	**2010**	**2005**	**2000**	**2010**	**2005**	**2000**	**2010**	**2005**	**2000**
Specification:	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**
$1-\sigma_s$									
Overall	-1.5615^{***}	-1.4899^{***}	-1.5607^{***}				1.4637^{***}	1.4005^{***}	1.3678^{***}
	(.0508)	(.0568)	(.0643)				(.0126)	(0.0136)	(.0126)
Agriculture				-2.1296^{***}	-1.9394^{***}	-1.7002^{***}	2.3280^{***}	1.9772^{***}	1.5078^{***}
				(.0922)	(.1133)	(.1150)	(.0489)	(.0485)	(0.4687)
Forest				-2.8135^{***}	-1.1806^{***}	-1.3821^{***}	4.6386^{***}		
				(.3628)	(.1074)	(.1780)	(.9543)		
Minerals				-1.3001^{***}	-1.1882^{***}	-1.8177^{***}	2.5920^{***}	1.3484^{***}	2.1619^{***}
				(.1500)	(.1286)	(.0870)	(.3244)	(.3022)	(.2065)
Machinery				-1.5805^{***}	-1.8136^{***}	-2.0229^{***}	1.5081^{***}	1.7353^{***}	1.8989^{***}
				(.1081)	(.1607)	(.1592)	(.0222)	(.0316)	(.0362)
Chemicals				-1.9457^{***}	-1.7865^{***}	-1.3756^{***}	1.7073^{***}	1.1940^{***}	1.1882^{***}
				(.1315)	(.2003)	(.1389)	(.0315)	(.0351)	(.0223)
Manufacturing				-1.0342^{***}	-1.1659^{***}	-1.3505^{***}	1.0326^{***}	1.2061^{***}	1.2607^{***}
				(.05699)	(.06139)	(.07943)	(.0169)	(.1516)	(.1669)
Others				-1.9238^{***}	-3.7871^{***}	-2.4876^{***}	2.0910^{***}	3.6906^{***}	1.8069^{***}
				(.2894)	(.3994)	(.4164)	(.0710)	(.1025)	(.0860)
East-West "border" dummy$_{ij}$	-0.1906^{***}	-0.2264^{***}	-0.2409^{***}	-0.1670^{***}	-0.1978^{***}	-0.2459^{***}			
	(0.0488)	(0.0500)	(0.0465)	(0.0487)	(0.0494)	(0.0464)			
ln distance$_{ij}$	-0.8035^{***}	-0.8798^{***}	-0.9033^{***}	-0.8056^{***}	-0.8652^{***}	-0.8840^{***}			
	(0.0543)	(0.0522)	(0.0483)	(0.0534)	(0.0514)	(0.0478)			
Adjacency$_{ij}$	0.7048^{***}	0.6515^{***}	0.6374^{***}	0.6865^{***}	0.6632^{***}	0.6344^{***}			
	(0.0869)	(0.0842)	(0.0806)	(0.0857)	(0.0832)	(0.0800)			
Home bias dummy$_{ij}$	2.6488^{***}	2.6281^{***}	2.4630^{***}	2.6104^{***}	2.6693^{***}	2.4744^{***}			
	(0.2366)	(0.2509)	(0.2186)	(0.2329)	(0.2458)	(0.2189)			
Region dummy$_{ij}$	0.2449^{***}	0.2452^{***}	0.1660^{**}	0.2471^{***}	0.2369^{***}	0.1619^{**}			
	(0.08083	(0.0759)	(0.0740)	(0.0799)	(0.0744)	(0.0733)			
Island dummy$_{ij}$	0.3253^{***}	0.3738^{***}	0.2093^{***}	0.3025^{***}	0.3536^{***}	0.2142^{***}			
	(0.0842)	(0.0815)	(0.0730)	(0.0827)	(0.0804)	(0.0730)			
Fixed effects:									
Exporter × sector ($i \times s$)	✓	-✓	✓	✓	✓	✓	✗	✗	✗
Importer × 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 (in Specifications (1) to (6) clustered at the sector level); significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 10: *Predicted Consumption Gains at the Prefecture Level*

	$\widehat{C}_j^A$			$\widehat{C}_j$		
$1-\sigma$	−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 11: *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^{***}	-0.3956^{***}	-0.5395^{***}	-0.3601^{***}	-0.5661^{***}	-0.2631^{*}	-0.3255^{***}
	(.0487)	(.1130)	(.0542)	(.1173)	(.0619)	(.1392)	(.0498)
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
Year: 2005							
East-West "border" dummy$_{ij}$	-0.6090^{***}	-0.4334^{***}	-0.5503^{***}	-0.4010^{***}	-0.6876^{***}	-0.2484	-0.4495^{***}
	(.0544)	(.0876)	(.0574)	(.1043)	(.0640)	(.1740)	(.1225)
Summary statistics:							
Number of observations	2,207	2,209	2,203	2,209	2,203	2,209	111,281
(Pseudo) R^2	.8206	.9313	.8373	.9382	.8091	.9611	.8815
Year: 2000							
East-West "border" dummy$_{ij}$	-0.8117^{***}	-0.5216^{***}	-0.9525^{***}	-0.5656^{***}	-0.7983^{***}	-0.4704^{***}	-0.5711^{***}
	(.0479)	(.0962)	(.0593)	(.1053)	(.0608)	(.1342)	(.0754)
Summary statistics:							
Number of observations	2,200	2,209	2,191	2,209	2,176	2,209	113,043
(Pseudo) R^2	.8116	.9369	.7807	.9589	.7843	.9599	.9249
Fixed effects:							
Exporter (i)	✓	✓	✓	✓	✓	✓	✗
Importer (j)	✓	✓	✓	✓	✓	✓	✗
Exporter × Sector ($i \times s$)	✗	✗	✗	✗	✗	✗	✓
Importer × 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 12: *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^{***}	-0.6547^{*}	-0.3341	-0.3132^{***}	-0.3825^{**}	-0.4143^{***}	-0.5248^{***}
	(.1528)	(.3819)	(.3815)	(.0954)	(.1796)	(.1021)	(.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^{***}	-1.0140^{***}	-0.5832	-0.3146^{***}	-0.4963^{***}	-0.4860^{***}	-0.4452^{***}
	(.1412)	(.3154)	(.4238)	(.0833)	(.1317)	(.0831)	(.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	0.4489^{*}	-0.9214^{***}	-0.3725^{***}	-0.4079^{***}	-0.3139^{***}	-0.3676^{***}
	(.1808)	(.2670)	(.2903)	(.0852)	(.1226)	(.0921)	(.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)	✓	✓	✓	✓	✓	✓	✓

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

Table 13: *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***	0.5982**	−0.4260***	−0.2946	0.1895
	(.0858)	(.2781)	(.0359)	(.3077)	(.3112)
Summary statistics:					
Number of observations	33,614	7,345	15,416	5,211	5,193
(Pseudo) R^2	.8941	.8046	.9188	.4413	.6045
Year: 2005					
East-West "border" dummy$_{ij}$	−0.5678***	0.3009**	−0.3548***	−0.7837*	−0.1737
	(.1653)	(.1307)	(.0972)	(.4079)	(.2284)
Summary statistics:					
Number of observations	34,241	7,497	15,463	5,456	5,825
(Pseudo) R^2	.9041	.8901	.9339	.4444	.4111
Year: 2000					
East-West "border" dummy$_{ij}$	−0.3169***	−0.3869***	−0.0939	−0.7596***	−0.2338
	(.0457)	(.0357)	(.0907)	(.1960)	(.3395)
Summary statistics:					
Number of observations	36,250	7,775	15,463	6,064	6,948
(Pseudo) R^2	.9405	.6896	.9609	.5706	.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 14: *Alternative Specification of the East-West "Border"*

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$_{ij}$	-0.7448^{***}	-0.6287^{***}	-0.5716^{***}	-0.5762^{***}	-0.6046^{***}	-0.4472^{***}	-0.5514^{***}
	(.0467)	(.0727)	(.0520)	(.0925)	(.0572)	(.1255)	(.0669)
ln transport cost$_{ij}$	-0.5203^{***}	-0.5029^{***}	-0.9473^{***}	-0.5183^{***}	-0.7426^{***}	-0.3159^{***}	-0.5692^{***}
	(.0422)	(.0501)	(.0448)	(.0598)	(.0482)	(.0717)	(.0644)
Adjacency$_{ij}$	0.9856^{***}	0.8646^{***}	0.9102^{***}	$.9586^{***}$	1.0222^{***}	1.0555^{***}	0.9463^{***}
	(.0862)	(.1143)	(.0910)	(.1329)	(.1028)	(.1586)	(.1428)
Home bias dummy$_{ij}$	3.4588^{***}	2.5331^{***}	2.9537^{***}	2.6068^{***}	4.2905^{***}	3.7479^{***}	2.6150^{***}
	(.2394)	(.1202)	(.2664)	(.1533)	(.3148)	(.1782)	(.4232)
Region dummy$_{ij}$	0.7966^{***}	0.6075^{***}	0.6144^{***}	0.4290^{**}	0.5454^{***}	0.5141^{***}	0.5608^{***}
	(.0801)	(.1199)	(.0802)	(.1254)	(.0925)	(.1503)	(.0592)
Island dummy$_{ij}$	0.5003^{***}	0.3252^{***}	0.4219^{***}	0.3849^{***}	0.5716^{***}	0.5881^{***}	0.5218^{***}
	(.0849)	(.0956)	(.0958)	(.1172)	(.1076)	(.1260)	(.0669)
Fixed effects:							
Exporter (i)	✓	✓	✓	✓	✓	✓	✗
Importer (j)	✓	✓	✓	✓	✓	✓	✗
Exporter × Sector ($i \times s$)	✗	✗	✗	✗	✗	✗	✓
Importer × 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	.8316	.9579	.8229	.9509	.7963	.9771	.8845

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

Table 15: *Robustness Checks: Transportation Cost*

Dependent variable: Exports in tons from prefecture i to prefecture j								
Year:	**2010**							
Survey:	**1YS**							
Unit:	**Quantities**							
Model:	**OLS-FE**							
Measurement	**Greater-circle distance**		**Real-road distance**		**Population weighted harmonic mean**		**Travel time**	**Distance intervals**
Specification:	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
East-West "border" dummy$_{ij}$	-0.7188^{***}	-0.3313^{***}	-0.4329^{***}	-0.3178^{***}	-0.3841^{***}	-0.1978^{***}	-0.2942^{***}	-0.2832^{***}
	(.0487)	(.0557)	(.0514)	(.0529)	(.0523)	(.0535)	(.0532)	(.0571)
ln transport cost$_{ij}$	-0.5238^{***}		-0.5167^{***}		-0.5416^{***}			
	(.0426)		(.0294)		(.0294)			
ln distance$_{ij}$		-1.0827^{***}		-1.1818^{***}		-1.2999^{***}		
		(.0579)		(.0580)		(.0525)		
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^{***}	0.5182^{***}	0.7359^{***}	0.4511^{***}	0.6673^{***}	0.2656^{***}	0.4406^{***}	0.9784^{***}
	(.0895)	(.0897)	(.0844)	(.0878)	(.0841)	(.0859)	(.0854)	(.0856)
Home bias dummy$_{ij}$	3.6356^{***}	1.7584^{***}	2.3636^{***}	1.5071^{***}	2.2481^{***}	1.1762^{***}	1.3230^{***}	4.1700^{***}
	(.2396)	(.3148)	(.2661)	(.3081)	(.2399)	(.2403)	(.2919)	(.2222)
Region dummy$_{ij}$	0.5619^{***}	0.1401	0.2952^{***}	0.09520	0.2938^{***}	0.0782	0.04854	0.5019^{***}
	(.0846)	(.0852)	(.0808)	(.0826)	(.0801)	(.0801)	(.0794)	(.0807)
Island dummy$_{ij}$	0.5937^{***}	0.4185^{***}	0.4379^{***}	0.4292^{***}	0.3695^{***}	0.2696^{***}	0.3315^{***}	0.2377^{***}
	(.0856)	(.0893)	(.0834)	(.0878)	(.0802)	(.0787)	(.0858)	(.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	.8458	.8466	.8415	.8386

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

Table 16: *Robustness Checks: Aggregation Bias*

Dependent variable: Exports from prefecture/sub-region i to prefecture/sub-region j						
Survey:	**1YS**					
Unit:	**Quantity**					
Model:	**OLS**					
Year:	**2010**		**2005**		**2000**	
Specification:	(1)	(2)	(3)	(4)	(5)	(6)
Coefficients:						
East-West "border" dummy$_{ij}$	-0.7188^{***}	-0.6444^{***}	-0.6090^{***}	-0.5035^{***}	-0.8117^{***}	-0.6926^{***}
	(.0487)	(.1065)	(.0544)	(.1149)	(.0479)	(.0926)
ln transport cost$_{ij}$	-0.5238^{***}	-0.6623^{***}	-0.6199^{***}	-0.6636^{***}	-0.2926^{***}	-0.4098^{***}
	(.0426)	(.1289)	(.0476)	(.1023)	(.0282)	(.0622)
Adjacency$_{ij}$	1.0743^{***}	0.6898^{***}	1.0118^{***}	0.8006^{***}	1.2065^{***}	0.8536^{***}
	(.0895)	(.1818)	(.0854)	(.1713)	(.0943)	(.1934)
Home bias dummy$_{ij}$	3.6356^{***}		3.6252^{***}		4.1817^{***}	
	(.2396)		(.2553)		(.2464)	
Sub-region dummy$_{ij}$		2.8526^{***}		3.0269^{***}		3.3990^{***}
		(.4307)		(.4191)		(.3879)
Region dummy$_{ij}$	0.5619^{***}	0.1266	0.5864^{***}	0.2298	0.5660^{***}	0.03618
	(.0846)	(.2103)	(.0833)	(.1897)	(.0873)	(.2048)
Island dummy$_{ij}$	0.5937^{***}	0.6212^{***}	0.4271^{***}	0.3556^{*}	0.6049^{***}	0.5819^{***}
	(.0856)	(.1694)	(.0849)	(.1856)	(.0806)	(.1442)
Fixed effects:						
Exporter (i)	✓	✓	✓	✓	✓	✓
Importer (j)	✓	✓	✓	✓	✓	✓
Summary Statistics:						
Number of observations	2,207	441	2,207	441	2,200	441
R^2	.8287	.8786	.8206	.8455	.8116	.8688

Robust standard errors; significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Aggregation: 1. Sub-region: Hokkaidô; 2. Sub-region: Aomori, Iwate, & Akita; 3. Sub-region: Miyagi, Yamagata, & Fukushima; 4. Sub-region: Ibaraki & Tochigi; 5. Sub-region: Gumma & Saitama; 6. Sub-region: Chiba, Tôkyô, & Kanagawa; 7. Sub-region: Niigata & Toyama; 8. Sub-region: Ishikawa & Fukui; 9. Sub-region: Yamanashi, Nagano, & Shizuoka; 10. Sub-region: Gifu & Aichi; 11. Sub-region: Mie & Shiga; 12. Sub-region: Kyôto, Ôsaka, & Hyôgo; 13. Sub-region: Nara & Wakayama; 14. Sub-region: Tottori & Shimane; 15. Sub-region: Okayama, Hiroshima, & Yamaguchi; 16. Sub-region: Tokushima & Kagawa; 17. Sub-region: Ehime & Kôchi; 18. Sub-region: Fukuoka & Ôita; 19. Sub-region: Saga & Nagasaki; 20. Sub-region: Kumamoto, Miyazaki, & Kagoshima; 21. Sub-region: Okinawa.

Table 17: *Internal Distribution of Japanese Container Exports and Imports in 2013*

Data:	**2013 wave of Japan's International Container Trade Survey**									
	Location of the exporting harbour:									
Exporting region:	Hokkaidô	Tôhoku	Kantô	Chûbu	Kansai	Chûgoku	Shikoku	Kyûshû	Okinawa	**Total:**
Hokkaidô	.63343	.00049	.13657	.00257	.01371	.00124	.00116	.00887	–	0.79804
Tôhoku	.00036	1.40841	2.68727	.10236	.08380	.00336	–	.00181	–	4.28737
Kantô	.03836	.00442	27.54502	.47725	.96638	.03202	.00360	.07186	–	29.13891
Chûbu	.00443	.00156	3.42514	24.58061	1.18375	.02579	.00038	.04897	–	29.27063
Kansai	.00142	.00025	.38216	3.96058	14.92171	.04939	.00185	.06597	.00055	19.38388
Chûgoku	.00030	–	.06857	.08770	2.59844	2.99638	.00120	1.08556	–	6.83815
Shikoku	.00065	–	.04715	.01330	1.36128	.08005	1.06727	.01044	–	2.58014
Kyûshû	.00001	–	.09209	.02683	.55478	.02081	–	6.83680	–	7.53132
Okinawa	–	–	.00039	.00068	.00201	–	–	.00182	.16666	0.17156
Total:	0.67896	1.41513	34.38436	29.25188	21.68586	3.20904	1.07546	8.13210	0.16721	100.00000

	Location of the importing harbour:									
Importing region:	Hokkaidô	Tôhoku	Kantô	Chûbu	Kansai	Chûgoku	Shikoku	Kyûshû	Okinawa	**Total**:
Hokkaidô	.97575	.00018	.12615	.00074	.00370	.00004	.00340	.00080	–	1.11074
Tôhoku	–	1.46021	1.64278	.12968	.01737	.00546	–	.01012	–	3.26562
Kantô	.00016	.01350	38.11797	.23773	.42982	.08309	.00230	.04312	–	38.92770
Chûbu	.00109	.00228	1.61685	16.95806	.69796	.02812	.00126	.01003	–	19.31565
Kansai	.00087	.00003	.21418	2.40534	21.30355	.05359	.00053	.02143	.00001	23.99952
Chûgoku	–	–	.01038	.00311	1.34822	2.40503	.00159	.57843	–	4.34676
Shikoku	–	–	.00904	.00565	.68360	.04039	1.04332	.01798	–	1.80000
Kyûshû	–	–	.03458	.00406	.24342	.03106	–	6.72972	.00070	7.04353
Okinawa	–	–	.00073	–	.00460	–	–	.00379	.18136	.19047
Total:	.97788	.47620	41.77265	19.74437	24.73224	2.64679	1.05240	7.41541	0.18207	100.00000

Table 18: *Robustness Checks: International Shipments*

Dependent variable:	**Aggregated exports from prefecture i to prefecture j**						
Year:	**2010**					**2013**	
Data/Survey:	**NCFS (1YS)**					**CFS**	
Unit:	**Quantities**					**Quantities**	
Model:	**OLS**					**OLS**	
Specification:	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Coefficients:							
East-West "border" dummy$_{ij}$	-0.7188^{***}	-0.8165^{***}	-0.7708^{***}	-0.7687^{***}	-0.7474^{***}	-0.6566^{***}	-0.6769^{***}
	(.0487)	(.0531)	(.0576)	(.0523)	(.0592)	(.0965)	(.0967)
Major port dummy$_{ij}$			0.5213^{***}	-0.1970			
			(.1537)	(.2228)			
Major port dummy$_{ij}$ × East-West "border" dummy$_{ij}$			0.1876^{**}	0.3313^{***}			
			(.0873)	(.1107)			
ln transport cost$_{ij}$	-0.5238^{***}	-0.9142^{***}	-0.5196^{***}	-0.5226^{***}	-0.4801^{***}		
	(.0426)	(.0614)	(.0426)	(.0426)	(.0488)		
ln distance$_{ij}$						-1.2232^{***}	-1.1790^{***}
						(.0866)	(.0865)
Adjacency$_{ij}$	1.0743^{***}	1.2040^{***}	1.0835^{***}	1.0698^{***}	1.0885^{***}	1.1627^{***}	1.2143^{***}
	(.0895)	(.0958)	(.0892)	(.0891)	(.1211)	(.1358)	(.1381)
Home bias dummy$_{ij}$	-3.6356^{***}		-3.7170^{***}	-3.6336^{***}	-4.0045^{***}	-2.0824^{***}	-2.2556^{***}
	(.2396)		(.2246)	(.2348)	(.2424)	(.4357)	(.4342)
Region dummy$_{ij}$	-0.5619^{***}		-0.5653^{***}	-0.5741^{***}	-0.6523^{***}	-0.2645^{**}	-0.2149
	(.0846)		(.0852)	(.0848)	(.1201)	(.1329)	(.1355)
Island dummy$_{ij}$	-0.5937^{***}		-0.5785^{***}	-0.5788^{***}	-0.6618^{***}	-0.2321^{*}	-0.2448^{**}
	(.0856)		(.0855)	(.0859)	(.1010)	(.1239)	(.1245)
Fixed effects:							
Exporter (i)	✓	✓	✓	✓	✓	✓	✓
Importer (j)	✓	✓	✓	✓	✓	✓	✓
Summary statistics:							
Number of observations	2,207	2,207	2,207	2,207	1,598	2,109	2,101
R^2	.8287	.7624	.8301	.8293	.8064	.7184	.7117

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

Table 19: *In Search for Explanations of 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)**
East-West "border" dummy$_{ij}$	-0.7188^{***}	-0.3892^{***}	-0.0610	-0.3558^{***}	-0.4686^{***}	-0.7082^{***}	-0.7149^{***}	-0.7156^{***}	-0.4626^{***}	-0.0404
	(.0487)	(.0479)	(.0507)	(.0486)	(.0523)	(.0484)	(.0486)	(.0489)	(.0523)	(.0512)
Business networks:										
ln number of headquarter-plant links$_{ij}$		0.7312^{***}								0.2991^{***}
		(.0394)								(.0588)
Social networks:										
ln agg. migration flows (2005-2009)$_{ij}$			0.9323^{***}							0.4222^{***}
			(.0377)							(.0695)
ln commuting flows (2010)$_{ij}$				0.4613^{***}						0.1406^{***}
				(.0240)						(.0333)
ln agg. passenger flows by road (2005-2009)$_{ij}$					0.0254^{***}					-0.0092
					(.0066)					(.0061)
ln agg. passenger flows by rail (2005-2009)$_{ij}$					0.1056^{***}					0.0022
					(.0121)					(.0126)
ln agg. passenger flows by air (2005-2009)$_{ij}$					0.0474^{***}					0.0163^{**}
					(.0082)					(.0065)
Coethnic networks:										
× Korean share$_{ij}$						-2.3841^{***}				-1.4858^{***}
						(.3719)				(.3484)
× Chinese share$_{ij}$						-4.0124^{***}				0.2058
						(1.5153)				(1.3109)
Bilateral trust:										
× Trust share$_{ij}$							6.7061^{*}			3.0174
							(4.0205)			(3.4171)
Historical controls:										
Fudai vs. tozama dummy$_{ij}$								0.0312		0.0129
								(.0439)		(.0410)
Cultural proximity$_{ij}$									4.9766^{***}	2.1111^{***}
									(.3436)	(.4168)
Geographic controls:										
ln transport cost$_{ij}$	-0.5238^{***}	-0.3564^{***}	-0.3086^{***}	-0.3884^{***}	-0.4346^{***}	-0.5229^{***}	-0.5237^{***}	-0.5240^{***}	-0.4337^{***}	-0.2728^{***}
	(.0426)	(.0385)	(.0399)	(.0411)	(.0408)	(.0429)	(.0426)	(.0426)	(.0402)	(.0374)
Adjacency$_{ij}$	1.0743^{***}	0.1264	0.06565	-0.3386^{***}	0.6878^{***}	1.1383^{***}	1.0721^{***}	1.0731^{***}	0.5954^{***}	-0.3265^{***}
	(.0895)	(.0810)	(.0765)	(.1028)	(.0894)	(.0905)	(.0897)	(.0897)	(.0853)	(.0878)
Home bias dummy$_{ij}$	3.6356^{***}	1.0795^{***}	1.2485^{***}	0.7583^{***}	2.2727^{***}	3.7731^{***}	3.5960^{***}	3.6406^{***}	1.3517^{***}	-0.3761^{*}
	(.2396)	(.1985)	(.2385)	(.2514)	(.2290)	(.2400)	(.2408)	(.2399)	(.2695)	(.2240)
Region dummy$_{ij}$	0.5619^{***}	0.0735	0.0199	0.0248	0.4837^{***}	0.6105^{***}	0.5613^{***}	0.5729^{***}	0.1255	-0.1891^{***}
	(.0846)	(.0711)	(.0669)	(.0779)	(.0778)	(.0860)	(.0848)	(.0865)	(.0798)	(.0688)
Island dummy$_{ij}$	0.5937^{***}	0.1460^{**}	0.3273^{***}	0.4372^{***}	0.3576^{***}	0.6161^{***}	0.6001^{***}	0.5950^{***}	0.5090^{***}	0.2274^{***}
	(.0856)	(.0741)	(.0780)	(.0784)	(.0870)	(.0854)	(.0857)	(.0858)	(.0787)	(.0752)
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	2,207	2,207
R^2	.8287	.8634	.8673	.8535	.8411	.8317	.8289	.8287	.8443	.8773

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

Table 20: *Cultural Proximity between Japanese Prefectures*

	1. Hokkaidô	2. Aomori	3. Iwate	4. Miyagi	5. Akita	6. Yamagata	7. Fukushima	8. Ibaraki	9. Tochig	10. Gumma	11. Saitama	12. Chiba	13. Tôkyô	14. Kanagawa	15. Niigata	16. Toyama	17. Ishikawa	18. Fukui	19. Yamanashi	20. Nagano	21. Gifu	22. Shizuoka	23. Aichi
1. Hokkaidô	1.0	.32	.39	.42	.33	.44	.56	.54	.64	.57	.63	.55	.64	.62	.54	.43	.46	.55	.62	.64	.53	.59	.53
2. Aomori	.32	1.0	.44	.37	.57	.39	.31	.30	.27	.22	.23	.23	.23	.23	.24	.23	.23	.20	.24	.25	.19	.21	.21
3. Iwate	.39	.44	1.0	.55	.56	.55	.43	.42	.33	.29	.30	.32	.29	.28	.33	.22	.22	.24	.31	.31	.23	.27	.24
4. Miyagi	.42	.37	.55	1.0	.43	.54	.51	.47	.42	.33	.35	.38	.35	.36	.34	.24	.25	.28	.37	.35	.26	.31	.27
5. Akita	.33	.57	.56	.43	1.0	.50	.34	.33	.28	.25	.26	.30	.24	.25	.26	.19	.19	.20	.27	.28	.20	.22	.21
6. Yamagata	.44	.39	.55	.54	.50	1.0	.49	.43	.39	.33	.37	.35	.35	.33	.36	.26	.27	.30	.35	.38	.28	.33	.28
7. Fukushima	.56	.31	.43	.51	.34	.49	1.0	.68	.69	.57	.62	.55	.60	.60	.52	.36	.39	.44	.55	.58	.44	.53	.45
8. Ibaraki	.54	.30	.42	.47	.33	.43	.68	1.0	.71	.57	.62	.54	.60	.59	.50	.33	.36	.43	.51	.54	.42	.50	.46
9. Tochigi	.64	.27	.33	.42	.28	.39	.69	.71	1.0	.72	.80	.65	.77	.72	.54	.40	.43	.49	.66	.67	.51	.64	.56
10. Gumma	.57	.22	.29	.33	.25	.33	.57	.57	.72	1.0	.77	.62	.70	.67	.57	.40	.42	.48	.65	.68	.54	.62	.57
11. Saitama	.63	.23	.30	.35	.26	.37	.62	.62	.80	.77	1.0	.68	.83	.76	.55	.43	.44	.53	.66	.68	.55	.66	.58
12. Chiba	.55	.23	.32	.38	.30	.35	.55	.54	.65	.62	.68	1.0	.68	.70	.51	.36	.38	.45	.60	.57	.46	.58	.53
13. Tôkyô	.64	.23	.29	.35	.24	.35	.60	.60	.77	.70	.83	.68	1.0	.85	.51	.45	.47	.53	.70	.67	.58	.71	.60
14. Kanagawa	.62	.23	.28	.36	.25	.33	.60	.59	.72	.67	.76	.70	.85	1.0	.50	.44	.45	.53	.70	.68	.56	.72	.59
15. Niigata	.54	.24	.33	.34	.26	.36	.52	.50	.54	.57	.55	.51	.51	.50	1.0	.46	.49	.48	.51	.56	.46	.50	.48
16. Toyama	.43	.23	.22	.24	.19	.26	.36	.33	.40	.40	.43	.36	.45	.44	.46	1.0	.80	.57	.44	.42	.49	.45	.41
17. Ishikawa	.46	.23	.22	.25	.19	.27	.39	.36	.43	.42	.44	.38	.47	.45	.49	.80	1.0	.64	.46	.43	.50	.45	.43
18. Fukui	.55	.20	.24	.28	.20	.30	.44	.43	.49	.48	.53	.45	.53	.53	.48	.57	.64	1.0	.51	.49	.56	.50	.48
19. Yamanashi	.62	.24	.31	.37	.27	.35	.55	.51	.66	.65	.66	.60	.70	.70	.51	.44	.46	.51	1.0	.70	.55	.69	.60
20. Nagano	.64	.25	.31	.35	.28	.38	.58	.54	.67	.68	.68	.57	.67	.68	.56	.42	.43	.49	.70	1.0	.56	.66	.57
21. Gifu	.53	.19	.23	.26	.20	.28	.44	.42	.51	.54	.55	.46	.58	.56	.46	.49	.50	.56	.55	.56	1.0	.60	.62
22. Shizuoka	.59	.21	.27	.31	.22	.33	.53	.50	.64	.62	.66	.58	.71	.72	.50	.45	.45	.50	.69	.66	.60	1.0	.68
23. Aichi	.53	.21	.24	.27	.21	.28	.45	.46	.56	.57	.58	.53	.60	.59	.48	.41	.43	.48	.60	.57	.62	.68	1.0
24. Mie	.55	.20	.25	.28	.21	.30	.43	.42	.50	.51	.51	.47	.52	.50	.49	.46	.53	.59	.52	.49	.58	.55	.57
25. Shiga	.54	.20	.25	.27	.20	.26	.43	.41	.48	.48	.49	.47	.55	.54	.43	.48	.55	.64	.53	.52	.57	.56	.50
26. Kyôto	.55	.21	.26	.29	.22	.27	.41	.39	.48	.47	.49	.45	.50	.50	.43	.43	.48	.61	.49	.48	.53	.53	.48
27. Ôsaka	.53	.19	.25	.25	.21	.27	.38	.36	.43	.44	.47	.41	.47	.45	.43	.45	.52	.60	.48	.46	.49	.48	.46
28. Hyôgo	.54	.20	.25	.29	.22	.28	.40	.38	.46	.44	.49	.43	.49	.47	.40	.43	.49	.60	.48	.46	.54	.48	.46
29. Nara	.46	.18	.21	.24	.19	.23	.35	.31	.40	.38	.40	.38	.43	.42	.38	.45	.53	.54	.40	.38	.47	.45	.44
30. Wakayama	.47	.18	.21	.23	.18	.23	.37	.37	.44	.41	.46	.42	.50	.48	.38	.46	.48	.57	.44	.41	.50	.50	.50
31. Tottori	.48	.20	.25	.27	.23	.28	.39	.35	.43	.45	.45	.40	.47	.45	.43	.38	.43	.47	.46	.46	.46	.46	.48
32. Shimane	.44	.21	.25	.25	.22	.25	.38	.35	.42	.43	.43	.42	.45	.44	.42	.33	.37	.42	.39	.42	.43	.44	.46
33. Okayama	.43	.19	.23	.26	.21	.25	.38	.35	.42	.44	.45	.45	.42	.45	.38	.36	.40	.47	.40	.42	.46	.40	.44
34. Hiroshima	.42	.16	.22	.24	.18	.24	.38	.34	.42	.42	.43	.39	.42	.41	.37	.34	.38	.41	.40	.40	.43	.43	.46
35. Yamaguchi	.39	.17	.21	.24	.19	.23	.36	.33	.39	.41	.42	.40	.40	.39	.39	.34	.39	.43	.38	.38	.41	.42	.43
36. Tokushima	.46	.19	.23	.25	.21	.26	.39	.36	.41	.40	.43	.40	.45	.45	.41	.41	.44	.45	.40	.44	.46	.49	.43
37. Kagawa	.47	.17	.20	.22	.19	.22	.34	.32	.38	.38	.41	.36	.42	.41	.43	.40	.45	.50	.39	.39	.46	.44	.45
38. Ehime	.48	.19	.24	.25	.20	.27	.40	.37	.43	.45	.45	.41	.43	.43	.42	.36	.41	.47	.40	.43	.45	.43	.45
39. Kôchi	.46	.17	.23	.25	.19	.25	.36	.35	.40	.38	.42	.38	.43	.43	.37	.32	.37	.45	.41	.42	.40	.42	.41
40. Fukuoka	.45	.16	.21	.26	.20	.24	.38	.38	.42	.45	.44	.43	.47	.46	.41	.37	.41	.45	.42	.43	.47	.47	.48
41. Saga	.28	.14	.18	.19	.18	.16	.23	.21	.28	.30	.28	.28	.29	.30	.29	.25	.26	.28	.26	.27	.27	.28	.28
42. Nagasaki	.35	.18	.22	.24	.21	.23	.30	.30	.34	.36	.36	.36	.34	.35	.36	.31	.33	.33	.32	.33	.33	.33	.35
43. Kumamoto	.33	.18	.20	.21	.21	.18	.28	.28	.32	.33	.34	.33	.33	.32	.34	.31	.34	.36	.30	.31	.33	.31	.33
44. Ôita	.33	.18	.22	.22	.20	.20	.27	.25	.30	.30	.31	.34	.32	.35	.31	.29	.33	.33	.29	.32	.31	.32	.35
45. Miyazaki	.28	.17	.21	.24	.21	.19	.26	.24	.30	.29	.30	.33	.32	.32	.28	.28	.30	.30	.25	.27	.29	.30	.32
46. Kagoshima	.21	.13	.16	.15	.16	.13	.18	.17	.18	.20	.20	.22	.22	.21	.23	.21	.23	.22	.20	.20	.21	.20	.20
47. Okinawa	.09	.07	.09	.07	.08	.06	.07	.08	.09	.08	.09	.10	.09	.09	.11	.08	.10	.08	.08	.08	.08	.08	.08

	24. Mie	25. Shiga	26. Kyôto	27. Ôsaka	28. Hyôgo	29. Nara	30. Wakayama	31. Tottori	32. Shimane	33. Okayama	34. Hiroshima	35. Yamaguchi	36. Tokushima	37. Kagawa	38. Ehime	39. Kôchi	40. Fukuoka	41. Saga	42. Nagasaki	43. Kumamoto	44. Ôita	45. Miyazaki	46. Kagoshima	47. Okinawa
1. Hokkaidô	.55	.54	.55	.53	.54	.46	.47	.48	.44	.43	.42	.39	.46	.47	.48	.46	.45	.28	.35	.33	.33	.28	.21	.09
2. Aomori	.20	.20	.21	.19	.20	.18	.18	.20	.21	.19	.16	.17	.19	.17	.19	.17	.16	.14	.18	.18	.18	.17	.13	.07
3. Iwate	.25	.25	.26	.25	.25	.21	.21	.25	.25	.23	.22	.21	.23	.20	.24	.23	.21	.18	.22	.20	.22	.21	.16	.09
4. Miyagi	.28	.27	.29	.25	.29	.24	.23	.27	.25	.26	.24	.24	.25	.22	.25	.25	.26	.19	.24	.21	.22	.24	.15	.07
5. Akita	.21	.20	.22	.21	.22	.19	.18	.23	.22	.21	.18	.19	.21	.19	.20	.19	.20	.18	.21	.21	.20	.21	.16	.08
6. Yamagata	.30	.26	.27	.27	.28	.23	.23	.28	.25	.25	.24	.23	.26	.22	.27	.25	.24	.16	.23	.18	.20	.19	.13	.06
7. Fukushima	.43	.43	.41	.38	.40	.35	.37	.39	.38	.38	.38	.36	.39	.34	.40	.36	.38	.23	.30	.28	.27	.26	.18	.07
8. Ibaraki	.42	.41	.39	.36	.38	.31	.37	.35	.35	.35	.34	.33	.36	.32	.37	.35	.38	.21	.30	.28	.25	.24	.17	.08
9. Tochigi	.50	.48	.48	.43	.46	.40	.44	.43	.42	.42	.42	.39	.41	.38	.43	.40	.42	.28	.34	.32	.30	.30	.18	.09
10. Gumma	.51	.48	.47	.44	.44	.38	.41	.45	.43	.44	.42	.41	.40	.38	.45	.38	.45	.30	.36	.33	.30	.29	.20	.08
11. Saitama	.51	.49	.49	.47	.49	.40	.46	.45	.43	.45	.43	.42	.43	.41	.45	.42	.44	.28	.36	.34	.31	.30	.20	.09
12. Chiba	.47	.47	.45	.41	.43	.38	.42	.40	.42	.45	.39	.40	.40	.36	.41	.38	.43	.28	.36	.33	.34	.33	.22	.10
13. Tôkyô	.52	.55	.50	.47	.49	.43	.50	.47	.45	.42	.42	.40	.45	.42	.43	.43	.47	.29	.34	.33	.32	.32	.22	.09
14. Kanagawa	.50	.54	.50	.45	.47	.42	.48	.45	.44	.45	.41	.39	.45	.41	.43	.43	.46	.30	.35	.32	.35	.32	.21	.09
15. Niigata	.49	.43	.43	.43	.40	.38	.38	.43	.42	.38	.37	.39	.41	.43	.42	.37	.41	.29	.36	.34	.31	.28	.23	.11
16. Toyama	.46	.48	.43	.45	.43	.45	.46	.38	.33	.36	.34	.34	.41	.40	.36	.32	.37	.25	.31	.31	.29	.28	.21	.08
17. Ishikawa	.53	.55	.48	.52	.49	.53	.48	.43	.37	.40	.38	.39	.44	.45	.41	.37	.41	.26	.33	.34	.33	.30	.23	.10
18. Fukui	.59	.64	.61	.60	.60	.54	.57	.47	.42	.47	.41	.43	.45	.50	.47	.45	.45	.28	.33	.36	.33	.30	.22	.08
19. Yamanashi	.52	.53	.49	.48	.48	.40	.44	.46	.39	.40	.40	.38	.40	.39	.40	.41	.42	.26	.32	.30	.29	.25	.20	.08
20. Nagano	.49	.52	.48	.46	.46	.38	.41	.46	.42	.42	.40	.38	.44	.39	.43	.42	.43	.27	.33	.31	.32	.27	.20	.08
21. Gifu	.58	.57	.53	.49	.54	.47	.50	.46	.43	.46	.43	.41	.46	.46	.45	.40	.47	.27	.33	.33	.31	.29	.21	.08
22. Shizuoka	.55	.56	.53	.48	.48	.45	.50	.46	.44	.40	.43	.42	.49	.44	.43	.42	.47	.28	.33	.31	.32	.30	.20	.08
23. Aichi	.57	.50	.48	.46	.46	.44	.50	.48	.46	.44	.46	.43	.43	.45	.45	.41	.48	.28	.35	.33	.35	.32	.20	.08
24. Mie	1.0	.67	.66	.67	.64	.68	.65	.50	.48	.52	.50	.48	.54	.55	.57	.50	.55	.32	.39	.39	.36	.33	.20	.10
25. Shiga	.67	1.0	.77	.71	.70	.70	.65	.49	.50	.50	.48	.47	.56	.55	.54	.49	.49	.28	.33	.33	.35	.30	.22	.09
26. Kyôto	.66	.77	1.0	.75	.77	.73	.67	.53	.55	.52	.52	.50	.61	.61	.56	.53	.51	.28	.36	.34	.39	.31	.20	.09
27. Ôsaka	.67	.71	.75	1.0	.77	.75	.65	.53	.49	.50	.52	.49	.57	.60	.56	.53	.49	.32	.37	.34	.37	.30	.22	.10
28. Hyôgo	.64	.70	.77	.77	1.0	.70	.63	.56	.54	.59	.55	.52	.59	.60	.57	.55	.53	.30	.37	.33	.36	.31	.22	.09
29. Nara	.68	.70	.73	.75	.70	1.0	.67	.46	.47	.46	.44	.44	.55	.59	.51	.49	.49	.30	.35	.35	.38	.32	.21	.12
30. Wakayama	.65	.65	.67	.65	.63	.67	1.0	.46	.48	.48	.50	.48	.54	.54	.52	.45	.49	.29	.35	.34	.35	.34	.20	.10
31. Tottori	.50	.49	.53	.53	.56	.46	.46	1.0	.68	.62	.61	.56	.49	.50	.53	.44	.48	.31	.37	.37	.41	.35	.26	.10
32. Shimane	.48	.50	.55	.49	.54	.47	.48	.68	1.0	.58	.66	.63	.52	.53	.57	.48	.53	.31	.39	.38	.44	.39	.25	.11
33. Okayama	.52	.50	.52	.50	.59	.46	.48	.62	.58	1.0	.64	.57	.49	.55	.55	.43	.50	.31	.38	.36	.40	.39	.24	.11
34. Hiroshima	.50	.48	.52	.52	.55	.44	.50	.61	.66	.64	1.0	.65	.50	.55	.60	.48	.53	.30	.38	.33	.40	.38	.23	.09
35. Yamaguchi	.48	.47	.50	.49	.52	.44	.48	.56	.63	.57	.65	1.0	.48	.50	.60	.49	.56	.31	.40	.40	.45	.43	.24	.10
36. Tokushima	.54	.56	.61	.57	.59	.55	.54	.49	.52	.49	.50	.48	1.0	.64	.62	.56	.48	.27	.39	.36	.43	.38	.24	.12
37. Kagawa	.55	.55	.61	.60	.60	.59	.54	.50	.53	.55	.55	.50	.64	1.0	.60	.50	.51	.30	.38	.38	.42	.38	.26	.13
38. Ehime	.57	.54	.56	.56	.57	.51	.52	.53	.57	.55	.60	.60	.62	.60	1.0	.66	.58	.35	.44	.42	.47	.43	.26	.13
39. Kôchi	.50	.49	.53	.53	.55	.49	.45	.44	.48	.43	.48	.49	.56	.50	.66	1.0	.48	.33	.38	.37	.40	.34	.24	.10
40. Fukuoka	.55	.49	.51	.49	.53	.49	.49	.48	.53	.50	.53	.56	.48	.51	.58	.48	1.0	.46	.55	.55	.53	.48	.31	.11
41. Saga	.32	.28	.28	.32	.30	.30	.29	.31	.31	.31	.30	.31	.27	.30	.35	.33	.46	1.0	.66	.58	.36	.38	.38	.13
42. Nagasaki	.39	.33	.36	.37	.37	.35	.35	.37	.39	.38	.38	.40	.39	.38	.44	.38	.55	.66	1.0	.67	.48	.50	.34	.13
43. Kumamoto	.39	.33	.34	.34	.33	.35	.34	.37	.38	.36	.33	.40	.36	.38	.42	.37	.55	.58	.67	1.0	.51	.57	.39	.15
44. Ôita	.36	.35	.39	.37	.36	.38	.35	.41	.44	.40	.40	.45	.43	.42	.47	.40	.53	.36	.48	.51	1.0	.60	.32	.15
45. Miyazaki	.33	.30	.31	.30	.31	.32	.34	.35	.39	.39	.38	.43	.38	.38	.43	.34	.48	.38	.50	.57	.60	1.0	.38	.13
46. Kagoshima	.20	.22	.20	.22	.22	.21	.20	.26	.25	.24	.23	.24	.24	.26	.26	.24	.31	.38	.34	.39	.32	.38	1.0	.13
47. Okinawa	.10	.09	.09	.10	.09	.12	.10	.10	.11	.11	.09	.10	.12	.13	.13	.10	.11	.13	.13	.15	.15	.13	.13	1.0

Scale: 0.0 .10 .20 .30 .40 .50 .60 .70 .80 .90 1.0

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