EVALUATING A SIMPLE HYBRID METHOD FOR ESTIMATING SUB-NATIONAL TRADE FLOWS

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Abstract

Given the non-uniform distribution of industrial activity within a country, it is well-established that the effects from changes in trade policy have considerable sub-national heterogeneity. (Andriamananjara, Balistreri and Ross (2006), Balistreri, Bohringer and Rutherford (2018), and Caceres, Cerdeiro and Mano (2019)) For industry specific, partial equilibrium analysis, a gravity model based approach, as in Riker (2019), is potentially the most tractable method for time-sensitive analysis because it relies on readily available national accounts and import data to estimate sub-national flows. In this paper, we utilize Japanese inter-prefectural trade flow data from the Japanese inter-regional input-output table from 2005, the most recent year available, to evaluate the estimation method proposed in Riker (2019). In the first round results, we find that the gravity model based method approximates the observed inter-prefectural flow pattern reported in the 2005 Japan inter-regional input-output table, but only after tuning of the trade cost parameters. The main challenge is the lack of trade publicly available Japanese import trade margin data.

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1 Introduction

Given the non-uniform distribution of industrial activity within a country, it is well-established that the effects from changes in trade policy have considerable sub-national heterogeneity. (Andriamananjara et al. (2006), Balistreri et al. (2018), and Caceres et al. (2019)) In light of the highly dynamic trade policy environment of the current U.S. administration, developing tools to accurately assess trade impacts at the within country, regional level has become a pressing issue. However, in the absence of timely, accurate inter-state, or inter-regional, sub-national trade data, economists can only approximate sub-national effects by allocating national-level, industrial sector estimates according to regional shares of sectoral output or sectoral employment. (Miller and Blair (2009)) Ideally, economists would have access to directly collected sub-national trade and economic activity data via an economic census. Unfortunately, few countries conduct such a census, and those that do (e.g. Japan) publish results with a multi-year lag.

To overcome this problem, a number of methods have been used to estimate sub-national trade flows from existing national accounts data, for example by splitting national input-output tables via RAS methods or by directly estimating sub-national trade via a gravity model augmented with region specific supply and demand constraints. (Richardson (1985) and Boero, Edwards and Rivera (2018)) For industry specific, partial equilibrium analysis, a gravity model based approach, as in Riker (2019), is potentially the most tractable method for time-sensitive analysis because it relies on readily available national accounts and import data to estimate sub-national flows.

We contribute to the literature by evaluating the accuracy of the Riker (2019) methodology using observed sub-national trade flows from an economic survey. In this paper, we utilize Japanese inter-prefectural trade flow data from Japan's 2005 Inter-Regional Input-Output Table (IRIOT), the most recent year available, to evaluate the estimation method proposed in Riker (2019). The inter-prefectural trade data are derived from quantity flow data from Japan's 2005 National Commodity Flow Survey and estimated per-unit price data. (Ministry of Land, Infrastructure, and Transportation (2005) and Ministry of Economy, Trade, and Industry (2010)) While sub-national trade flows data derived from microdata are considered to be highly accurate, the required microdata is typically only available with a long lag and for a single country. (Boero et al. (2018)) Therefore, an accurate, actionable method for estimating sub-national trade flow data is needed to generate contemporaneous sub-national trade data.

Previous work on this topic indicates that a gravity approach is the most operational, given data constraints, and potentially the most accurate. Polenske (1970) evaluated the performance of three estimation methods against the 1960 Japan IRIOT data.[1] Polenske (1970) use the inter-regional trade flow data from the 1960 table to calibrate, among others, the Leontief-Strout gravity formulation see Leontief and Strout (1963) and Miller and Blair (2009).

Polenske (1970) then used the models to estimate the inter-regional flows for 1963, summed the implied total production for each region, and compared the totals to the reported national accounts figures from the regional IO table for 1963. She found that the gravity model out performed all other estimation methods. However, Polenske (1970) evaluated the sum of sub-national flows against the observed regional production. As a measure of performance this is somewhat lacking. Firstly, what is desired is a model that accurately predicts region-to-region sub-national flows, not merely total regional production. Secondly, given that total regional production can be included as a constraint in a Gravity based estimation approach of sub-national flows, this model evaluation metric can be achieved with certainty without an consideration of the underlying inter-regional flows. (Horridge, Madden

[1] To our knowledge Polenske (1970) is the only paper in the literature to evaluate the accuracy of estimated sub-national flows against known values.

and Wittwer (2005))

Polenske (1970) demonstrates the potential of the gravity approach. However, the Leontief and Strout (1963) model requires at least one period of observed inter-regional trade flows, which are rarely available.[2] The gravity based method in Riker (2019) does not suffer from this limitation

Our paper contributes to the literature in three ways. First, our paper is the first to evaluate the performance of a truly operational method of estimating sub-national trade against benchmark national accounts values. Second, our paper evaluates the accuracy of the method in estimating region-to-region flows, not implied regional and total production. Third, our model evaluates the Riker (2019) method against the most dis-aggregated data available. Polenske (1970) evaluated their estimation methods against highly aggregated Japanese data (10 sectors). We utilize the 2005 Japan inter-regional input-output table, which dis-aggregates the economy into 53 sector. This is important because the Riker (2019) method was developed to estimate data for narrowly defined, industry specific partial equilibrium models.

As a first pass through the data, we estimate sub-national flows of household electronics for Japan for 2005 and compares these to the micro-data based estimates. In the first round results, we find that the gravity model based method does not well approximate the inter-prefectural flows reported in the 2005 Japan IRIOT.

The paper proceeds as follows. In section 2, we summarize the linearized gravity model use to estimate sub-national flows. In section 3, we discuss the estimation data, which are drawn from a number of disparate sources and need to be harmonized. Section 4 presents the results, and section 5 concludes with a discussion of next steps.

[2]The Horridge formula requires the same type of data for parameterization. (Horridge et al. (2005))

2 Estimating Sub-National Flows

Riker (2019) proposes estimating sub-national flows using a log-linearization of the basic gravity model. The model assumes the basic Armington (1969) framework: markets are perfectly competitive, products are differentiated by country/region of origin, consumers substitute between product varieties at a constant rate. The starting equation of the model is the gravity basic equation.

$$v_{jec} = Y_c \left(\frac{p_j f_{je} d_{ec}}{I_c} \right)^{(1-\sigma)} \frac{1}{d_{ec}} \tag{1}$$

Here, v_{jec} is the landed-duty paid value of imports from country of origin j, imported into region e, and consumed in region c. Region c and region e may be the same region or different. Y_c is the total expenditure on the products of the industry in region c, I_c is the CES industry price index for the region, p_j is the producer price of industry imports from j, f_{je} is the international trade cost factor, d_{ec} is the domestic transport cost factor, and σ is the Armington elasticity of substitution.

Through a bit of Algebra and some simplifying assumptions, Riker (2019) linearizes the model into a form that is operational, given the available data. The estimation process involves two steps. First, we use import and private consumption expenditure data and equation (2) to estimate the Armington elasticity of substitution (σ), the cost factor for shipping products between adjacent regions (α), and the cost factor for shipping products between non-adjacent regions (β).

$$\ln v_{jet} = h_{jt} + (1-\sigma) \ln f_{jet} - \sigma \sum_c \theta_{ct} (\alpha adj_{ec} + \beta nonadj_{ec}) + \epsilon_{jet} \tag{2}$$

In this equation, f_{jet} is the ratio of the landed duty-paid value of imports, from country j arriving in region e in period t, to their customs value. θ_{ct} is the share of expenditures on the product of interest in region c.

Once we have estimated these parameter values, we use equation (3) to predict the trade between Japanese regions.[3]

$$\ln v_{jec} = \ln \theta_c + \sum_{j'} \sum_{e'} (\sigma - 1)(vSHR_{j'e'}) \ln(d_{j'e'c}) - \sigma \ln d_{jec} \tag{3}$$

As in equation (2), θ_c is region c's expenditure share. $vSHR_{jec}$ is the share region c's supply of a product from country j and importing region e. This includes imports of the product and domestic production in region e. $vSHR_{jec}$ is calculated as:

$$vSHR_{je} = \frac{v_{je}}{\sum_{j'} \sum_{e'} v_{j'e'}} \tag{4}$$

In the model, the domestic transportation cost factor is approximated by:

$$d_{jec} = e^{\left(\alpha * adj_{ec} * v_{je} + \beta * nonadj_{ec} * v_{je}\right)} \tag{5}$$

As before, v_{je} is the landed duty-paid value of imports from country j into region e. The term adj_{ec} is a dummy variable that takes a value of one if region c is adjacent to region e. $nonadj_{ec}$ is a region non-adjacency indicator dummy variable. Both dummy variables are equal to zero, if region e and c are the same.

The main estimation equation of interest in Riker (2019) relates to the import penetration rate for industry imports from country j that enter region e and are consumed in region c.

$$\lambda_{jec} = \frac{v_{je} \omega_{jec} d_{jec}}{\sum_{j'} \sum_{e'} v_{j'e'c} \omega_{j'e'c} d_{j'e'c}} \tag{6}$$

[3] The following equations is reported in Riker (2019) as the main estimation equation for v_{jec}.

$$\ln v_{jec} = \ln Y_c + (\sigma - 1) \sum_{j'} \sum_{e'} \phi_{j'e'} \ln(p_{j'} f_{j'e'} d_{e'c}) + (1 - \sigma) \ln(p_j f_{je}) - \sigma \ln d_{ec}$$

However, after speaking with the author, we determined that the implemented equation is equation (3).

ω_{jec} is the share of j'e' supply that is shipped to region c.

$$\omega_{jec} = \frac{v_{jec}}{\sum_{c'} v_{jec'}} \tag{7}$$

The main estimation equation of interest for us, as in Riker (2019), is equation (6). As in Riker (2019), we do not have benchmark data on flows of imports from region of entry to region of consumption. Therefore, rather than comparing our estimates of v_{jec} to entries in the 2005 IRIOT, we will compare estimated import penetration to that reported in the IRIOT.

3 Data and Descriptive Statistics

To evaluate the performance of the Riker (2019) sub-national trade model, we attempt to replicate the Japanese inter-prefectural commodity flows for 2005, as published in Japan's 2005 Inter-Regional Input-Output Table (IRIOT).(Ministry of Economy, Trade, and Industry (2011)) The most detailed version of this table is broken down into 53 industrial sectors. The table contains information on inter-regional and inter-industry transactions of intermediate inputs. Additionally, the table presents final demand flows by origin industry, origin region, and region of consumption.

For our purposes, one weakness of the IRIOT is that it treats imports as fully consumed as part of final demand in the region of entry. The table only captures the flow of domestic production in each industry and region to its consumption region, industry, and sector (i.e. intermediate input or final demand). The table lists imports in the final demand use portion of the table.(Ministry of Economy, Trade, and Industry (2010)) Therefore, we cannot use the entries in the table as direct benchmark values for evaluating the accuracy of the Riker (2019) method.

Japan's IRIOT organizes Japan's 47 prefectures into 9 regions: Hokkaido, Tohoku, Kanto, Chubu, Kinki, Chugoku, Shikoku, Kyushu, and Okinawa. (see table 2) Table 3 summarizes the adjacency relationships between regions. The 9 regions cover Japan's four main islands: Kyushu, Shikoku, Honshu, and Hokkaido. Two regions were denoted as contiguous if (1) they share a land border or (2) they are on separate islands but are connected by a road/rail bridge or underwater rail tunnel.

The 53 sectors from the 2005 IRIOT include 34 sectors related to trade-in-goods, 17 related-to-trade in services, and 2 energy sectors. Because the Riker (2019) model is designed to estimate trade-in-goods, we limit our analysis to the 34 product sectors. (See table 1) Therefore, given the number of regions, our maximum sample of estimable industry-region-region flows is 2754.

To implement the Riker (2019) method we need to gather information on regional imports for each of the 53 sectors by trading partner. Additional, we need information on the ratio of the landed duty-paid and customs values of imports by sector by trading partner. However, Japan only publishes its import data valued at CIF. Additionally, Japan does not publish data on tariffs collected or import margins data by product by trading partner.

Therefore, to estimate the necessary CES and transportation costs parameters, we estimate equation (2) using import and personal consumption expenditure data for the US for the period 2001 - 2005. We then apply these parameters and data from Japan for 2005 to equation (3) to estimate the sub-national flows. While this is not ideal, if we can assume that, on-average, the cost of transporting a product between regions in the US is the same as the cost of transporting the same product between regions in Japan, and Japanese and US consumers are similarly sensitive to changes in relative prices across regional varieties, then estimating the parameters using US data should give us estimates that are similar to what we would have found if Japanese data were available.[4]

[4]The assumption about a common Armington elasticity across countries for a given product is not without precedent in the literature. Until the most recent version of the GTAP database, it was assumed that for each industry, the Armington elasticities were identical across countries. Hertel and van der Mensbrugghe

One potential problem with using the US data to overcome the limitations of the Japanese import data is if there is a difference in the average distance between regions in Japan and regions in the US. In terms of overall size, the US is considerably larger than Japan. For example, the distance between Sapporo, Hokkaido's largest city, and Nagasaki, Japan's most southerly major city on the main island chain, is nearly the same as the distance between San Diego, California and Seattle, Washington or the distance between San Diego, California and Houston, Texas. To check this, we calculated the bilateral distance between each region in the two countries.

To investigate the difference in average region-region bilateral distances, we calculated the shortest driving distance, using Google Maps, between the largest city by population in 2005 in each region.[5] Next, we bifurcated the bilateral distance data by adjacency category and then calculated the mean and standard deviation of the bilateral distances for each group and each region. Table 4 summarizes the results with units in miles. On average, the US adjacent regions are five times farther away from each other than Japanese regions. Non-adjacent US regions are, on-average, about three times farther away than non-adjacent Japanese regions.

Because the region-region distances are on average farther for the US, we would expect that the cost parameters would be larger in the US than in Japan. However, the ratio of the average adjacent and non-adjacent regions is about 3 in the US, whereas it is 4 for Japan. Therefore, it might be the case that estimates of cost parameters using US data are more similar to each other than cost parameters estimated using Japanese data. Therefore, when we interpret our results we need to check if the results consistently under-predict inter-region flows in general and, in-particular, under-predict inter-regional flows between adjacent

(2016) and Hertel and van der Mensbrugghe (2019)

[5] Ideally we would used city-to-city transaction data to calculate a weighted average distance measure between each region. However, the US Commodity Flow Survey does not have the city-city transportation data needed to do this.

regions.

Because our analysis draws on data from Japan and the US, we first had to develop a concordance between novel Japanese industrial classifications for the IRIOT to standard international classifications for trade-in-goods and manufacturing. This was a non-trivial challenge. The Japanese IRIOT is organized according to a unique, Japan specific industrial classification that is different from the standard international classifications used for Japanese import statistics. Moreover, the IRIOT industry classifications are not directly mappable to ISIC or NAICS. For our estimation purposes, we first had to create a concordance between the IRIOT classifications to Japan's national IOT industry categories. We were able to map the national IOT sector classifications ISIC revision 3.1, HS, and year 2002 NAICS. Figure 1 diagrams the specific mappings and data sources. (See figure 1)

Japan collects and publishes its import data at a hybrid HS nine-digit level. The data are internationally comparable at the HS six-digit level. (Ministry of Finance, Customs and Tariff Bureau (2019)) We mapped the 2005 import data to ISIC revision 3.1 using a WITS concordance table. (World Integrated Trade Solution (WITS) (2002)) Japan's Ministry of Internal Affairs and Communication (MIC) publishes a concordance table between the 190 sector version of their 2005 national input table and ISIC revision 3.1 at the four digit level. (Ministry of Internal Affairs and Communications (2009)) Additionally, METI publishes a concordance table between its basic IOT and IRIOT sectors at various aggregations. (Ministry of Economy, Trade, and Industry (2011))

Therefore, we are able to map the 53 IRIOT sectors through this basic sector concordance table to the 190 national IOT sectors. From here, we concord the IRIOT from the national IOT industry classification to ISIC revision 3.1. With the IRIOT data in this format, we are able to marry the import by commodity and trading partner flow and margins data to the regional expenditure data. As a final step, we use a concordance table between ISIC 3.1 and

2002 NAICS (U.S. Census Bureau (2002)) to map IRIOT categories to US data in NAICS[6]

As a first check of the Riker (2019) method, we use the linearized gravity model to estimate the sub-national flows of Household Electronics Equipment (IRIOT Industry 25). We chose this product group because it is the most similar to the category analyzed in Riker (2019).[7] The US import data come from USITC's Dataweb.[8] The data are recorded by import partner and port of entry. The Personal Consumption Expenditure data by state come from the Bureau of Economic Analysis.[9] We aggregate all data to the US region's from Riker (2019). We use these data, and the regional adjacency table from Riker (2019) to estimate equation (2). As in Riker (2019), we use five years of data, 2001 - 2005, to generate more precise estimates of our parameters.

To estimate equation (3), we use Japanese data for 2005 on imports, manufacturing, and private consumption expenditures. The imports data come from the Government of Japan's e-Stat website.[10] The data are by commodity, by trading partner, and by port of entry. We pull the manufacturing data from the 2005 IRIOT. These figures are available from the regional statistical bureaus of the Ministry of Economy, Trade, and Industry, but they are conveniently aggregated in the IRIOT table. The private consumption expenditures data come from the prefectural national accounts tables from the Japanese Cabinet Office.[11] We aggregate these data to the 9 Japanese regions and estimate equation (3) in STATA.

To evaluate the performance of the Riker (2019), we will compare the results of the predicted Japan regional production flows to the benchmark data from the Japan IRIOT. Table 5 summarizes the benchmark values for $\omega_j ec$ calculated from the Japan IRIOT. The

[6]The final concordance table is available in the replication zip file.

[7]Household Electronics Equipment in the 2005 IRIOT corresponds to the following NAICS codes: 339950, 335314, 334511, 334290, 334519, 333618, 332999, 334220, 335991, 335129, 334515, 334210, 333298, 335932, 333319, 336322, 336321, 335999

[8]https://dataweb.usitc.gov/

[9]See table SAEXP1 Total personal consumption expenditures (PCE) by state

[10]https://www.e-stat.go.jp/en

[11]https://www.esri.cao.go.jp/jp/sna/data/data$_list/kenmin/files/contents/main_h21.html$

rows are the supplying regions and the columns list the consuming regions. The values are the percent of domestic regional production in a given region that is consumed in each column region. For this industry, Okinawa has no domestic production of Household Electronic Equipment so all entries are blank. For nearly all regions, a plurality of output is consumed in the two economically largest regions: Kanto, which includes Tokyo, and Kinki, which includes Osaka.

4 Results

We estimate the unrestricted form of the linearized gravity equation from Riker (2019). The results are summarized in table 6. Using the estimated coefficients and standard errors, we draw 1000 values of each from independent, t-distributions. We convert each of the coefficient draws into its corresponding parameter value.

We use these parameter values, the Japanese data described above, and equation (3) to predict inter-regional flows of Household Electronics Equipment. We take these values and use equation (7) to calculate where output from each region A is consumed in Japan by share. We then calculate the mean and standard deviation across all simulations. As a metric of the accuracy of the estimator, we calculate the percent difference between the benchmark value in table 7 and the estimated values.

As the upper panel of table 7 shows, the initial results indicate that almost all domestic regional output is consumed within the region of production. As the lower panel makes clear, the model as parameterized heavily favors the power of gravity in the estimation model and allows for almost no cross-regional flows. The model greatly over-predicts within region consumption, as indicated by positive error values, and vastly under-predicts (negative error values) cross-region consumption.

One concern throughout is that using US data, where adjacent and non-adjacent regions are considerably farther apart than analogous regions in Japan, would cause us to estimate transportation cost parameters that are too large. This would cause the model to over-predict within region consumption and under-predict cross-regional flows.

As a simple check of this hypothesis, we reduced the transportation cost parameter values by a factor equal to the ratio of the average distance between regions in the US and Japan. For each parameter we used the corresponding average distance ratio. Thus, we reduced the adjacent region cost parameter by a fourth and the non-adjacent parameter by a third.

Table 8 presents the results of this, admittedly ad-hoc, sensitivity experiment. These results are much closer to the benchmark values and more closely follow the pattern of within region consumption and cross-region consumption trade. Within region consumption captures a plurality of output for most regions. For all regions, Kanto and Kinki capture a large share of regional output, if not the plurality. In terms of the magnitude of the errors, the lower panel shows that the errors for all entries fall by roughly half or more between the two experiments. This indicates that while using the US data to estimate the trade cost parameter values is a convenient method for overcoming short-comings in the Japanese data, the parameter values may be much larger than the true parameter values for Japan.

5 Conclusions

The main feature of the Riker (2019) method is that it estimates parameter values and simulates sub-national flows within one consistent set of structural equations and data. Mixing Japanese flow data with US import data is a a practical way to deal with the data limitations of Japanese import data. However, it is a deviation from Riker (2019).

In our initial experiment, we find that this hybrid method initially does a poor job of replicating the regional consumption shares of Household Electronics Equipment reported in the 2005 Japan IRIOT. Sensitivity analysis around the trade cost parameter values indicate that those estimated using US data maybe overly large due to differences in the average distance between regions in the US and Japan. However, once the parameters are better tuned, the model generates results that follow the general pattern from the IRIOT.

Therefore, we do not conclude that the Riker (2019) performs poorly in this application; rather, we conclude that our hybrid application needs further refining, specifically around the issue of estimating of trade cost parameters.

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Table 1. Japan IRIOT 2005 Sectors

Sector Code	Japanese Name	Aggregated Sector Name
0010	農林水産業	Agriculture, forestry and fishery
0020	鉱業	Mining
0030	石炭・原油・天然ガス	Coal mining, crude petroleum and natural gas
0040	飲食料品	Beverages and Foods
0050	繊維工業製品	Textile products
0060	衣服・その他の繊維既製品	Wearing apparel and other textile products
0070	製材・木製品・家具	Timber, wooden products and furniture
0080	パルプ・紙・板紙・加工紙	Pulp, paper, paperboard, building paper
0090	印刷・製版・製本	Printing, plate making and book binding
0100	化学基礎製品	Chemical basic product
0110	合成樹脂	Synthetic resins
0120	化学最終製品	Final chemical products
0130	医薬品	Medicaments
0140	石油・石炭製品	Petroleum and coal products
0150	プラスチック製品	Plastic products
0160	窯業・土石製品	Ceramic, stone and clay products
0170	鉄鋼	Iron and steel
0180	非鉄金属	Non-ferrous metals
0190	金属製品	Metal products
0200	一般機械	General machinery
0210	事務用・サービス用機器	Machinery for office and service industry
0220	産業用電気機器	Electrical devices and parts
0230	その他の電気機械	Other electrical machinery
0240	民生用電気機器	Household electric appliances
0250	通信機械・同関連機器	Household electronics equipment
0260	電子計算機・同付属装置	Electronic computing equipment and accessory equipment of electronic computing equipment
0270	電子部品	Electronic components
0280	乗用車	Passenger motor cars
0290	その他の自動車	Other cars
0300	自動車部品・同付属品	Motor vehicle parts and accessories
0310	その他の輸送機械	Other transport equipment
0320	精密機械	Precision instruments
0330	その他の製造工業製品	Miscellaneous manufacturing products
0340	再生資源回収・加工処理	Reused/Recycled products

Table 2. Japanese Regions and Prefectures

Region	Prefecture
Hokkaido	Hokkaido
Tohoku	Aomori, Iwate, Miyagi, Akita, Yamagata, Fukushima
Kanto	Ibaraki, Tochigi, Gunma, Saitama, Chiba, Tokyo, Kanagawa, Niigata, Yamanashi, Nagano, Shizuoka
Chubu	Toyama, Ishikawa, Gifu, Aichi, Mie
Kinki	Kinki, Shiga, Kyoto, Osaka, Hyogo, Nara, Wakayama
Chugoku	Tottori, Shimane, Okayama, Hiroshima, Yamaguchi
Shikoku	Tokushima, Kagawa, Ehime, Kochi
Kyushu	Fukuoka, Saga, Nagasaki, Kumamoto, Oita, Miyazaki, Kagoshima
Okinawa	Okinawa

Table 3. Regional Adjacency Table

	Hokkaido	Tohoku	Kanto	Chubu	Kinki	Chugoku	Shikoku	Kyusyu	Okinawa
Hokkaido	.	1	0	0	0	0	0	0	0
Tohoku	1	.	1	1	0	0	0	0	0
Kanto	0	1	.	1	0	0	0	0	0
Chubu	0	1	1	.	1	0	0	0	0
Kinki	0	0	0	1	.	1	1	0	0
Chugoku	0	0	0	0	1	.	1	1	0
Shikoku	0	0	0	0	1	1	.	1	0
Kyushu	0	0	0	0	0	1	1	.	0
Okinawa	0	0	0	0	0	0	0	0	.

Table 4. Average Distances between Regions

	Japan	USA
Adjacent Regions	228.92	1118.43
	(128.48)	(396.61)
Non-Adjacent Regions	825.77	2276.67
	(462.86)	(480.73)

Table 5. Allocation of Domestic Output by Consuming Region

	Chubu	Chugoku	Hokkaido	Kanto	Kinki	Kyusyu	Okinawa	Shikoku	Tohoku
Chubu	0.12	0.06	0.04	0.43	0.18	0.09	0.01	0.03	0.05
Chugoku	0.10	0.19	0.03	0.29	0.21	0.09	0.02	0.03	0.04
Hokkaido	0.15	0.06	0.20	0.31	0.09	0.07	0.01	0.04	0.07
Kanto	0.12	0.05	0.03	0.50	0.13	0.09	0.01	0.03	0.04
Kinki	0.17	0.08	0.06	0.30	0.21	0.11	0.01	0.03	0.04
Kyushu	0.09	0.04	0.00	0.40	0.21	0.18	0.02	0.02	0.03
Okinawa									
Shikoku	0.04	0.03	0.02	0.27	0.17	0.02	0.01	0.38	0.06
Tohoku	0.07	0.04	0.03	0.51	0.12	0.08	0.00	0.02	0.12

Table 6. Econometric Estimates of the Model Parameters

Dependent Variable: Log of the Value of Imports	Less Restricted Point Estimates (Std. Errors)
Econometric Coefficients	
Log of International Trade Cost Factor	-3.97
	(0.54)
Expenditure Shares in Adjacent Regions	-5.61
	(0.62)
Expenditures Shares in Non-Adjacent Regions	-5.84
	(0.63)
(Country-Year Fixed Effects and Constant Included)	
Implied Values of the Model Parameters	
Elasticity of Substitution (σ)	4.97
Domestic Transport Cost to Adjustment Regions (α)	1.13
Domestic Transport Cost to Non-Adjacent Regions (β)	1.17
R-Squared Statistic	0.90
Number of Observations	3057

Table 7a. Estimated Allocation of Domestic Output by Consuming Region

	Chubu	Chugoku	Hokkaido	Kanto	Kinki	Kyushu	Okinawa	Shikoku	Tohoku
Chubu	0.98	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Chugoku	0.01	0.95	0.00	0.02	0.01	0.01	0.00	0.00	0.00
Hokkaido	0.01	0.00	0.93	0.02	0.01	0.01	0.00	0.00	0.01
Kanto	0.00	0.00	0.00	0.99	0.00	0.00	0.00	0.00	0.00
Kinki	0.00	0.00	0.00	0.01	0.98	0.00	0.00	0.00	0.00
Kyushu	0.01	0.00	0.00	0.01	0.01	0.97	0.00	0.00	0.00
Okinawa	0.05	0.02	0.01	0.10	0.05	0.03	0.70	0.01	0.02
Shikoku	0.02	0.01	0.00	0.03	0.02	0.01	0.00	0.90	0.01
Tohoku	0.01	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.95

Table 7b. Percent Difference in Estimated and Benchmark Omegas

	Chubu	Chugoku	Hokkaido	Kanto	Kinki	Kyushu	Okinawa	Shikoku	Tohoku
Chubu	706%	-98%	-98%	-98%	-98%	-98%	-98%	-97%	-96%
Chugoku	-90%	403%	-92%	-94%	-94%	-93%	-98%	-94%	-89%
Hokkaido	-92%	-93%	370%	-93%	-87%	-90%	-96%	-95%	-91%
Kanto	-98%	-98%	-98%	97%	-98%	-99%	-99%	-99%	-98%
Kinki	-97%	-98%	-98%	-98%	362%	-98%	-98%	-97%	-96%
Kyushu	-93%	-94%	54%	-97%	-97%	423%	-98%	-92%	-93%
Okinawa									
Shikoku	-58%	-74%	-70%	-88%	-88%	-39%	-90%	137%	-88%
Tohoku	-85%	-92%	-90%	-96%	-93%	-94%	-91%	-94%	695%

Table 8a. Estimated Allocation of Domestic Output by Consuming Region

	Chubu	Chugoku	Hokkaido	Kanto	Kinki	Kyushu	Okinawa	Shikoku	Tohoku
Chubu	0.48	0.02	0.02	0.26	0.12	0.04	0.00	0.01	0.05
Chugoku	0.11	0.27	0.03	0.23	0.18	0.10	0.00	0.03	0.04
Hokkaido	0.13	0.05	0.24	0.27	0.13	0.07	0.01	0.02	0.09
Kanto	0.09	0.02	0.01	0.75	0.05	0.03	0.00	0.01	0.04
Kinki	0.13	0.05	0.02	0.17	0.53	0.04	0.00	0.02	0.03
Kyushu	0.10	0.06	0.03	0.22	0.10	0.40	0.00	0.03	0.04
Okinawa	0.16	0.06	0.04	0.35	0.16	0.09	0.05	0.03	0.07
Shikoku	0.12	0.07	0.03	0.26	0.20	0.11	0.00	0.15	0.05
Tohoku	0.16	0.03	0.04	0.34	0.09	0.05	0.00	0.02	0.26

Table 8b. Percent Difference in Estimated and Benchmark Omegas

	Chubu	Chugoku	Hokkaido	Kanto	Kinki	Kyushu	Okinawa	Shikoku	Tohoku
Chubu	292%	-58%	-56%	-40%	-32%	-57%	-54%	-52%	0%
Chugoku	8%	41%	-6%	-22%	-11%	15%	-79%	-4%	24%
Hokkaido	-15%	-28%	22%	-12%	37%	7%	-59%	-50%	34%
Kanto	-30%	-60%	-55%	49%	-60%	-67%	-63%	-70%	-18%
Kinki	-21%	-42%	-63%	-45%	151%	-61%	-59%	-9%	-14%
Kyushu	12%	48%	2429%	-45%	-51%	118%	-73%	88%	23%
Okinawa									
Shikoku	185%	144%	102%	-6%	18%	465%	-32%	-61%	-19%
Tohoku	119%	-17%	53%	-33%	-25%	-37%	-5%	-33%	118%

Figure 1. Concordance between JRIOT to NAICS and HS6