Chapter 40
The Spatial Dimension of Chinese Trade with Russia: Evidence from Regional Data

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Abstract The present study estimates the magnitude of trade barriers between Chinese regions and their trading partners. The analysis shows that trade barriers between Russia and the Chinese regions are comparable with South American countries and Pakistan, but they are higher vis-à-vis Hong Kong, Taiwan, Kazakhstan and Southeast Asia. A common border with a foreign country leads to a significant increase in trade of Chinese regions. The results explain the unevenly distributed trade between Chinese regions and Russia. Other institutional factors—common language and colonial ties—contribute to an increase in bilateral trade and a reduction of trade barriers. Transport infrastructure, built during Tsarist/Soviet control over some parts of China in the nineteenth and twentieth centuries, contributes to the concentration of Sino-Russian trade interactions in these Chinese regions. The findings also indicate that due to globalization and the growth of the overall economies of scale, trade costs decline with increasing distances between the trading Chinese regions and foreign countries. This, to some extent, explains the obtained values of trade barriers for Russia.

40.1 Introduction

Strong engagement with the global economy is an important source of rapid economic growth for the Chinese economy. China is characterized by a large territory, population and differentiated development of regional economies. At the same time, openness to foreign markets positively influenced the economic growth of all Chinese regions. The complex process of trade and economic integration of the national market also contributes to the economic development of the regions of

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China. However, China's trade in the domestic market and with foreign countries is constrained by the barriers that appear at the regional level.

The total trade turnover between the Chinese regions and Russia by 2019 increased to $109 bn. Over the past two decades, the interest of the Russian and Chinese sides in further developing and deepening strategic partnership with each other, coordinating joint actions in solving various problems has noticeably increased. Against the background of increased competition in the markets of developed countries, Chinese companies see the markets of developing and transit countries, including Russia, as an alternative. Chinese business relies on developing countries, as well as on a number of post-Soviet countries.

Russia and China have a long land border, and some border regions in China are characterized by close trade and economic ties with the Russian market. However, the Chinese economy interacts unevenly with the Russian market. By 2019, almost half of Chinese exports to Russia came from Zhejiang, Guangdong and Jiangsu provinces, and about 70% of imports from Russia to China were provided by Heilongjiang, Beijing and Shandong. The potential for further expansion of Sino-Russian cooperation is determined not only by the level of structural complementarity, by the comparative scale of supply and demand, but also by the comparative potential of expanding bilateral cooperation in each region of China. From this point of view, in order to assess trade barriers that hinder China's interaction with Russia, it is necessary to take into account the spatial structure of the Chinese economy, i.e., feature of interactions at the regional level in China. At the same time, it can be assumed that various barriers at the regional level of China may hamper trade interactions between Russia and China.

40.2 The Relevance of the Research and Literature Review

One of the most common methods for quantifying trade barriers is to build gravity dependencies to determine the "border effect" [1], understood as a set of trade and economic costs arising from the goods crossing any border. Gravity models describe one of the most stable empirical dependencies in economic analysis, having a high explanatory power of the variables that form trade flows [2]. Therefore, on the basis of this approach, there are a large number of studies of the Chinese economy's interaction with various countries of the world, both at the level of the national economy [3, 4] and at the industry level [5]. Also, barriers to trade interactions between Chinese regions among themselves are being actively studied [6, 7].

In recent years, there is a lack of studies on border effects and comparative assessments of trade barriers, as well as studies on the intensity dynamics of trade of China's regions with foreign countries. In addition, an important point is the correctness of the estimate of the gravity dependence, since the experience of a large number of empirical studies allows us to formulate the following recommendations [8]: Whenever available, panel data should be used to obtain structural gravity estimates; panel data with intervals should be used instead of data pooled over consecutive years in order to allow for adjustment in trade flows; gravity estimations should be performed with intranational and international trade flows data; in accordance with gravity theory, directional time-varying (importer and exporter) fixed effects should be included in panel trade data; pair fixed effects should be included in gravity estimation with panel trade data; estimate gravity with the Poisson pseudo maximum likelihood (PPML) estimator, which solves the problem of heteroskedasticity [9]. Also, this method makes it possible to include "zero" trade flows in panel data, since there is no need for logarithms. The application of PPML shows satisfactory results, even if the proportion of "zero" trade flows in the panel data is very large [10].

40.3 The Purpose of the Study and Methodology

The present study extends the existing literature on assessing the border effects of Chinese regions in recent years. We have consistently studied the border effects by comparing intra-regional and external trade and economic interactions of Chinese regions. In this article, we also examine the influence of the distance factor and institutional factors, explaining the trade of Chinese regions with various countries, including Russia.

In this study, we follow the aforementioned recommendations, with the exception of highlighting time intervals in panel data due to the short time series. The dependent variable is bilateral trade adjusted for the size of economies *i* and *j* to solve the endogeneity problem [11] and to guarantee the absence of a significant correlation between errors and regressors [12].

The equation was estimated in a nonlinear form by the PPML method:

$$\frac{x_{ijt}}{y_{it}y_{jt}} = \exp[k + (1-\sigma)\rho \ln d_{ij} + (1-\sigma)\ln b_{ij} \quad - (1-\sigma)\ln P_i - (1-\sigma)\ln P_j] \times \varepsilon_{ijt}, \tag{40.1}$$

where x_{ij}—exports from region/country i to region/country j; y_i—the size of the economy of region/country i; y_j—the size of the economy of region/country j; b—the barriers to trade; d—the physical distance between trading regions/countries; P_i—the average value of trade costs between region/country i and its trading partners; P_j—the average value of trade costs between region/country j and its trading partners; σ—the elasticity of substitution. The ad valorem tariff equivalent of the border effect (b-1) is calculated using an elasticity of substitution in the range between 5 and 10.

Physical distances between the analyzed objects can be represented in various ways [13]. There are databases on distances between countries specifically for the purpose of gravity modeling (e.g., CEPII). However, as analysis has shown, these databases include linear distances between national economies, which in most cases are significantly less than nonlinear (real) distances. For this reason, in this study, distances were calculated independently: for sea and transoceanic transportation and for land transportation in kilometers. It should be noted that for the countries of North and South America, Australia and Oceania, Africa, Western Europe and for most countries of Asia and Central Europe, trade with China is carried out mainly in the framework of sea and transoceanic transportation. Therefore, for the vast majority of China's trading partner countries under consideration, the distance to Chinese territory was initially calculated to the nearest largest port (Shanghai, Guangzhou, Dalian, etc.) and then to the rest of China based on the distances of highways and railways.

The rest of the countries have transit railway and automobile infrastructure with border checkpoints with the internal Chinese regions or have access to it: most countries of the former Soviet Union, some countries of Central Europe, Finland, Mongolia, Pakistan, a number of countries in South and Southeast Asia. For most of these countries, the distance to the border of interior Chinese regions was calculated on the basis of direct roads and railways connecting it with other regions—first by sea and transoceanic transportation, then by land. A special case for determining the distance to Chinese regions is Russia, since this country covers a large territory: Exports from China are mainly oriented toward the western part of Russia; imports are mainly carried out from the Russia's eastern part. Therefore, distance for exports and imports is different. For Chinese exports to Russia, Moscow is selected as the focal point, and for imports from Russia to Irkutsk.

Distance within Chinese regions is defined as the distance between the two largest regional agglomerations (for the cases of Beijing, Tianjin, Chongqing and Shanghai—the distance between the most distant parts of cities) along highways and railways. Distances between Chinese regions are calculated both by road, rail and sea routes.

Bilateral trade of Chinese regions with foreign countries is reported by Chinese customs statistics based on the location of exporters and importers for three years: 2017–2019, covering 217 countries and territories. Accordingly, exports are presented in FOB prices ("on board"), and imports are presented in CIF prices, i.e. including transportation and cargo insurance costs. In some studies, transportation costs are determined by subtracting "mirror" exports (in FOB prices) from imports (in CIF prices) [13]. Thus, transportation costs are already included in the cost of imports in CIF prices, which, along with an assessment of the effect of physical distance on bilateral interactions, leads to a deviation in the gravitational dependence. Therefore, exports and imports should be presented at the same price. For this, the import of Chinese regions based on an indirect estimate [14] of travel time and average transportation costs based on calculated nonlinear distances between regions/countries was reduced to FOB prices. Zero values were also included in the export and import data set.

In line with the aforementioned recommendations for gravity model estimations, it is necessary to include intranational trade in the equation. We distinguish border effects within Chinese regions and between them by including intra- and inter-regional trade. In the existing data set, intra-regional trade in China is measured as wholesale and retail trade turnover excluding exports and imports. Missing data for 2019 are calculated using the moving average method over the 12 previous years. The dynamics of inter-regional trade were calculated employing the proportions from earlier input–output tables [15], and the exports and imports of goods for the corresponding regions for 2017–2019 were used as the basic indicator for the assessment.

The size of the economies of foreign countries (GDP) is measured by the existing and forecast values reported by the IMF. Data on the size of China's regional economies (GRP) were obtained from the China's National Statistical Bureau, forecast estimates from Bloomberg, the Economist Intelligence Unit, HKTDC Research and statistical agencies in several Chinese provinces.

Variables expressing values are denoted in US dollars at current prices, allowing us to avoid errors that often arise in empirical estimates of gravity equations [16, 17].

For our purposes, Eq. (40.1) is presented in the following form:

$$\frac{x_{ijt}}{y_{it}y_{jt}} = \exp[\lambda_i + \lambda_j + \eta_t + \beta_0 + \beta_1 \ln DIST_{ij} + \beta_2 CONT_{ij} + \beta_{3\ldots n}(CN_{1\ldots31} \times N_{1\ldots m})] \times \varepsilon_{ijt}, \tag{40.2}$$

where x_{ij}—exports from region/country i to region/country j; y_i—GRP/GDP of region/country i; y_j—GRP/GDP of region/country j; t—time; $DIST_{ij}$—distance between trading regions/countries i and j in km. The other independent variables are dummies. The dummy variable $CONT_{ij}$ reflects the existence of joint borders between the Chinese region i and its trading partner j. Other dummies characterize the effects of borders on trade by Chinese regions (CN) with their partners (N) consisting of 31 Chinese provinces and 217 countries and territories of the world. Variation across time and cross-sectional factors are controlled via fixed effects for years (η) and exporting and importing regions and countries (λ). The model in Eq. (40.2) was estimated as panel data with fixed effects using PPML. The initial data set describing bilateral trade covers three years (2017–2019) and involves 43,244 observations.

Due to the large number of China's trading partners, only the main ones were singled out, while the rest were either grouped in terms of their membership in economic entities, or assigned to others. As a result, the model in Eq. (40.2) is adjusted as follows:

$$\begin{aligned}\frac{x_{ijt}}{y_{it}y_{jt}} = {} & \exp[\lambda_i + \lambda_j + \eta_t + \beta_0 + \beta_1 \ln DIST_{ij} \\ & + \beta_2 CONT_{ij} + \beta_3(CN) + \beta_4(CN \times CN)] \\ & \times \exp[\beta_5(CN \times RU) + \beta_6(CN \times JP) + \beta_7(CN \times KR) \\ & + \beta_8(CN \times USA) + \beta_9(CN \times HK)] \\ & \times \exp[\beta_{10}(CN \times TW) + \beta_{11}(CN \times EU) \\ & + \beta_{12}(CN \times AUSNZ) + \beta_{13}(CN \times AFRICA)] \\ & \times \exp[\beta_{14}(CN \times SAMERICA) + \beta_{15}(CN \times CAN) \\ & + \beta_{16}(CN \times MEX) + \beta_{17}(CN \times KZ)] \\ & \times \exp[\beta_{18}(CN \times PAK) + \beta_{19}(CN \times IND)\end{aligned}$$

$$+ \beta_{20}(CN \times GULF) + \beta_{21}(CN \times ASEAN)]$$
$$\times \exp[\beta_{22}(CN \times OTHERS)] \times \varepsilon_{ijt}, \quad (40.3)$$

where *CN*—trade within Chinese regions; *CN* × *CN*—between Chinese regions, *CN* × *RU*—with Russia, *CN* × *JP*—with Japan, *CN* × *KR*—with the Republic of Korea, *CN* × *USA*—with the USA, *CN* × *EU*—with the EU-28, *CN* × *HK*—with Hong Kong, *CN* × *TW*—with Taiwan, *CN* × *AUSNZ*—with Australia and New Zealand (Agreement on Close Economic Relations), *CN* × *AFRICA*—with African countries (55 countries of the African Union), *CN* × *SAMERICA*—with South American countries (12 countries that are full and associate members of MERCOSUR), *CN* × *CAN*—with Canada, *CN* × *MEX*—with Mexico, *CN* × *KZ*—with Kazakhstan, *CN* × *PAK*—with Pakistan, *CN* × *IND*—with India, *CN* × *GULF*—with the Gulf countries (6 members of the Council for Cooperation of the Arab States of the Gulf), *CN* × *ASEAN*—with 10 countries of ASEAN, *CN* × *OTHERS*—with other countries.

It should be noted that: Firstly, including intranational trade can significantly weaken the effect of physical distance on the dependent variable, due to the relatively large volumes of trade within and between Chinese regions compared with foreign trade; secondly, the liberalization of foreign economic activity, mass transportation, including container transportation, combined with fragmentation of production of transnational corporations between different countries contributed to the fact that the distances over which goods are transported increased significantly [18]. In other words, due to the economies of scale, the relative costs of transporting goods between geographically remote economies have declined significantly, especially in transoceanic transport [14]. Therefore, even if countries are located at a considerable distance from each other, but their trade is included in transoceanic logistics routes, it can be assumed that the effect of the borders between them may be less than with countries closer by.

Taking this fact into account, Chinese regions and countries were divided into groups in terms of the distance ranges between them [19, 20]: up to 750 km, from 750 to 1500 km, from 1500 to 3000 km, from 3000 to 6000 km, more than 6000 km. Further, these groups were included in the transformed model in Eq. (40.3) as dummy variables, whereby physical distance and contiguity were dropped to avoid multicollinearity.

Accordingly, the impact of different distance ranges on bilateral trade was assessed by transforming Eq. (40.1) as follows:

$$\frac{x_{ijt}}{y_{it}y_{jt}} = \exp[\lambda_i + \lambda_j + \eta_t + \beta_0 + \beta_1 DIST(0-750) + \beta_2 DIST(751-1500)]$$
$$\times \exp[\beta_3 DIST(1501-3000) + \beta_4 DIST(3001-6000) + \beta_5 DIST(>6000)]$$
$$\times \exp\left[\beta_6 LANGUAGE_{ij} + \beta_7 COLONY_{ij}\right] \times \varepsilon_{ijt} \quad (40.4)$$

where *DIST*(0–750)—the distance between objects is up to 750 km, *DIST*(751–1500)—from 750 to 1500 km, *DIST*(1501–3000)—from 1500 to 3000 km, *DIST*(3001–6000)—from 3000 to 6000 km, *DIST*(>6000)—more than 6000 km, *LANGUAGE*—a common language, *COLONY*—the colonial ties of a Chinese region over the period 1840–1945.

Two new variables were included in the model. The first one is a dummy variable, reflecting the common language of Chinese regions with foreign countries. Singapore, Taiwan, Hong Kong and Macau are characterized by a common language with all Chinese regions. As for other countries, the main criterion for assigning values was the common language with the national minorities living in a particular Chinese region, which, in most cases, have territorial autonomy. Thus, it was determined that Mongolia has a common language with Inner Mongolia and Gansu province; North Korea and the Republic of Korea—with the provinces of Jilin and Liaoning; Kazakhstan, Kyrgyzstan, Uzbekistan and Turkmenistan, as well as Turkey—with Xinjiang; Myanmar—with the provinces of Yunnan, Qinghai and Tibet; Bhutan and Nepal—with Tibet.

The second dummy variable reflects the colonial past. In most cases, the long-term ties between the mother country and its dominions resulted in the creation of a joint transport infrastructure, as well as the accumulation of experience in trade and economic interactions, which can positively affect bilateral relations for a long time. In the years 1840–1945, the territory of today's China was unevenly distributed in time and space into spheres of influence between the largest empires in the world [21].

As a result, the dummy variable for colonial ties assumes a value of one for the following country/region pairs: Russia—Inner Mongolia, Xinjiang, Heilongjiang and Jilin; Kazakhstan, Kyrgyzstan, Tajikistan, Uzbekistan and Turkmenistan (as part of the Russian Empire and the USSR)—Xinjiang; Great Britain (including Canada, Australia, New Zealand and Hong Kong)—Shanghai, Jiangsu, Zhejiang, Anhui, Jiangxi, Hunan, Hubei, Chongqing, Sichuan, Guangdong; France (including Vietnam)—Hainan, Guangxi, Yunnan, Guizhou, Guangdong; Germany—Shandong; Japan (including North Korea, Republic of Korea, and Taiwan)—Inner Mongolia, Heilongjiang, Jilin, Liaoning, Beijing, Tianjin, Hebei, Shanxi, Shandong, Jiangsu, Anhui, Hubei, Henan, Zhejiang, Fujian and Guangdong; Portugal (Macau)—Guangdong.

40.4 Results

A benchmark for comparing the border effect should be based on a category excluded from the number of dummy variables in the model. The results show that trade within Chinese regions exhibits the lowest border effects relative to trade between Chinese regions and trade with foreign countries. Border effects between Chinese regions amounted to 67.5% relative to intra-regional barriers. India and other countries record the highest border effects with Chinese regions (491.3 and 500.4% in ad valorem tariff equivalents, respectively). The border effect with Russia was 437.1%, which is lower than for most other trading partners of China and is comparable with South American countries and Pakistan. Countries with the lowest border effects included Hong Kong, Taiwan, Kazakhstan and the ASEAN countries (Table 40.1).

The presence of a joint border between a foreign country and a Chinese region contributed to a significant increase in bilateral trade—almost 16 times more ($e^{2.83} - 1 \approx 15.95$), reducing trade barriers in the ad valorem equivalent by 51%. This may explain some disproportionality in Russia's trade with Chinese regions, given the long land border between the two countries.

The estimates indicate a negative effect of distance on Chinese regions' trade; however, its magnitude is not large. On the one hand, the premise of a lesser effect of transportation costs (distance) on trade has already been included in the model used

Table 40.1 Border effects of Chinese regions, 2017–2019

Variables	β	Robust standard errors	Border effect (%)
$CN \times CN$	-2.06^{***}	0.12	**67.5**
$CN \times RU$	-6.72^{***}	0.25	**437.1**
$CN \times JP$	-7.03^{***}	0.18	**479.8**
$CN \times KR$	-6.84^{***}	0.17	**453.2**
$CN \times USA$	-6.92^{***}	0.20	**463.9**
$CN \times EU$	-6.85^{***}	0.21	**453.7**
$CN \times HK$	-5.41^{***}	0.17	**286.6**
$CN \times TW$	-6.68^{***}	0.17	**431.9**
$CN \times AUSNZ$	-6.86^{***}	0.19	**455.8**
$CN \times AFRICA$	-6.82^{***}	0.22	**450.6**
$CN \times SAMERICA$	-6.72^{***}	0.22	**436.8**
$CN \times CAN$	-6.93^{***}	0.20	**465.9**
$CN \times MEX$	-6.82^{***}	0.20	**450.4**
$CN \times KZ$	-6.66^{***}	0.18	**429.1**
$CN \times PAK$	-6.75^{***}	0.20	**440.4**
$CN \times IND$	-7.11^{***}	0.19	**491.3**
$CN \times GULF$	-6.88^{***}	0.20	**458.4**
$CN \times ASEAN$	-6.27^{***}	0.19	**379.6**
$CN \times OTHERS$	-7.17^{***}	0.17	**500.4**
$CONT$	2.83^{***}	0.05	**−50.7**
$\ln(DIST)$	-0.13^{***}	0.03	
Constant	-26.38^{***}	0.23	
Obs	43,244		
$PseudoR^2$	0.82		

Note $^{***}p < 0.01$. The tariff equivalent of the border effects (in %) is shown in bold assuming an elasticity of substitution $\sigma = 5$

for evaluation in comparison with the OLS [9]. On the other hand, there is no clear evidence of bilateral distance between trading regions/counties leading to higher trade costs and, accordingly, border effects. This circumstance requires additional evaluation.

Our findings suggest that a common language increases bilateral trade by a factor of 5 ($e^{1.76} - 1 \approx 4.81$), and colonial ties—by almost 100% ($e^{0.67} - 1 \approx 0.95$), reducing the average trade barriers by 36% and 15%, respectively (Table 40.2).

For Russia, this means that the presence of an associated transport infrastructure (mainly the railways) in Northeast China and partially in Xinjiang, built during Tsarist/Soviet control over these territories, facilitates, ceteris paribus, the concentration of Russian–Chinese trade within these Chinese regions.

It is worth mentioning that the estimation of border effect by distance ranges is conditional, since the physical distance is not included in the model due to multicollinearity. To determine the conditional border effect, a group of countries and Chinese regions were adopted as a benchmark, the distance between which does not exceed 750 km. In fact, this group covers intra-regional and part of the inter-regional trade interactions of China. The results indicate a surge in cost with increasing distances but if distance between a Chinese region and its trading partner exceeds 6,000 km, and the conditional border effects are lower. In other words, if a Chinese region and a foreign country are at a considerable distance from each other, then the conditional border effect between them might be lower than with trading partners that are closer by. This, to some extent, explains the low levels of border effects, especially for Russia, estimated via Eq. (40.2).

Table 40.2 Results for model (4) estimation

Variables	β	Robust standard errors	Border effect (%)
DIST (751–1500)	-3.07^{***}	0.05	**115.1**
DIST (1501–3000)	-4.43^{***}	0.05	**203.2**
DIST (3001–6000)	-5.05^{***}	0.06	**253.3**
DIST (>6000)	-4.94^{***}	0.09	**244.1**
LANGUAGE	1.76^{***}	0.10	**−35.9**
COLONY	0.67^{***}	0.04	**−15.4**
Constant	-34.94^{***}	0.19	
Obs	43,244		
$PseudoR^2$	0.33		

Note $^{***}p < 0.01$. The tariff equivalent of the border effects (in %) is shown in bold assuming an elasticity of substitution $\sigma = 5$

40.5 Conclusions

Trade interactions between Chinese regions and Russia are unevenly distributed. Trade within Chinese regions exhibits the lowest border effects compared to inter-regional trade and trade with foreign countries. The border effects for trade between Russia and Chinese regions are comparable to South American countries and Pakistan, but are higher than for Hong Kong, Taiwan, Kazakhstan and Southeast Asia. If a Chinese region shares a border with a foreign country, bilateral trade increases significantly compared to other regions. This pattern might explain a certain disproportionality in the trade of Chinese regions with Russia.

Other institutional factors—common language and colonial ties—contribute to an increase in bilateral trade and a reduction in trade barriers. For Russia, this means that the presence of transport infrastructure built during the Tsarist/Soviet control of these territories contributes to the concentration of Russian–Chinese trade within these Chinese regions.

The findings indicate a reduction in trade costs with increasing distances due to the process of globalization and an increase in the overall economies of scale. Therefore, the costs of trade between a Chinese region and a distant foreign country can end up being similar to those with neighboring countries, which, to some extent, explains the estimated trade barriers with Russia.

References

1. McCallum, J.: National borders matter: Canada-U.S. Regional trade patterns. Am. Econ. Rev. **85**, 615–623 (1995)
2. Leamer, E.E., Levinsohn, J.: International trade theory: the evidence. Handb. Int. Econ. **3**, 1339–1394 (1995)
3. Fan, S.C., Wei, X., Wu, J.: Border effect between Hong Kong and Mainland China. Pac. Econ. Rev. **21**, 3–12 (2016)
4. Wang, D., Wang, Z., Xie, Y.: How large is the border effect between the United States and China? Asian Econ. Finan. Rev. **9**, 851–863 (2019)
5. Saleh, S., Lu, Q., Sokvibol, K.: Determinants of exports in China's meat industry: a gravity model analysis. Emerg. Mark. Finan. Trade **55**, 2544–2565 (2019)
6. Ke, S.: Domestic market integration and regional economic growth–China's recent experience from 1995–2011. World Dev. **66**, 588–597 (2015)
7. Zhao, Y., Ni, J.: The border effects of domestic trade in transitional China: local governments' preference and protectionism. Chin. Econ. **51**, 413–431 (2018)
8. Yotov, Y.V., Piermartini, R., Monteiro, J.-A., Larch, M.: An Advanced Guide to Trade Policy Analysis: The Structural Gravity Model. United Nations and World Trade Organization (2016). https://www.wto.org/english/res_e/booksp_e/advancedwtounctad2016_e.pdf
9. Santos Silva, J., Tenreyro, S.: The log of gravity. Rev. Econ. Stat. **88**, 641–658 (2006)
10. Santos Silva, J., Tenreyro, S.: Further simulation evidence on the performance of the Poisson pseudo-maximum likelihood estimator. Econ. Lett. **112**, 220–222 (2011)
11. Olivero, M.P., Yotov, Y.V.: Dynamic gravity: endogenous country size and asset accumulation. Can. J. Econ. **45**, 64–92 (2012)
12. Anderson, J.A., Van Wincoop, E.: Gravity with gravitas: a solution to the border puzzle. Am. Econ. Rev. **93**, 170–192 (2003)

13. Taglioni, D.: Exchange rate volatility as a barrier to trade: new methodologies and recent evidence. Economie Internationale **89–90**, 227–259 (2002)
14. Hummels, D.L., Schaur, G.: Time as a trade barrier. Am. Econ. Rev. **103**, 2935–2959 (2013)
15. Mi, Z., Meng, J., Zheng, H., Shan, Y., Wei, Y., Guan, D.: A multi-regional input-output table mapping China's economic outputs and interdependencies in 2012. Sci. Data **5**, 1–12 (2018)
16. Baldwin, R., Taglioni, D.: Gravity for Dummies and Dummies for Gravity Equations. NBER Working Paper No. 12516 (2006). https://www.nber.org/papers/w12516.pdf
17. A Practical Guide to Trade Policy Analysis. WTO and UNCTAD Co-Publication (2012). https://www.wto.org/english/res_e/publications_e/wto_unctad12_e.pdf
18. Urry, J.: Offshoring. Polity, Cambridge (2014)
19. Anderson, J.E., Yotov, Y.V.: Gold Standard Gravity. NBER Working Paper No. 17835 (2012). https://www.nber.org/papers/w17835
20. Eaton, J., Kortum, S.: Technology, geography, and trade. Econometrica **70**, 1741–1779 (2002)
21. Okubo, T.: Trade bloc formation in inter-war Japan: a gravity model analysis. J. Jpn. Int. Econ. **21**, 214–236 (2007)