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Is Geographical Remoteness an Economic Disadvantage?

Abstract

Is the geographical location of a country deterministic to its level of economic development? Although economic geographers have been searching the answers to this question for decades, incongruities between different opinions still exist. This paper takes both theoretical and empirical approaches to provide a systematic answer to this question. Firstly, this paper uses industry-level gravity model of international trade to demonstrate that not all countries are negatively affected by geographical remoteness. Secondly, it employs a panel data of 83 countries from 2000 to 2017 and substantiates that while geographical remoteness decreases income levels and trade balances in OECD countries, it increases or does not affect them in non-OECD countries. This finding is also confirmed by re-categorizing the countries based on the World Bank's classification of high-income country and by carrying out quantile regressions. These results altogether imply that geographical remoteness is unlikely to be an economic disadvantage for certain groups of countries.

Keywords

Balance of Trade, Economic Geography, Economic Development, Gravity Model

Cover Page Footnote

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I. Introduction

Is the location of a country a key determinant of its economic activities? Economic geographers have been searching the answers to this question for decades. Relying on the paradigms such as the New Economic Geography (NEG), multiple studies have argued that locational disadvantages could exert negative effects on a region's economic development, which has sometimes been named as "the curse/tyranny of distance". Previous works such as Redding and Veneables (2002; 2004), Boulhol *et. al.* (2008) and Boulhol and de Serres (2009) have all found that geographical remoteness negatively impacts a country's output level through using econometric techniques such as log-linear gravity equations. Gallup *et. al.* (1999) has also demonstrated that to some extent geography determines a region's economic policy, which in turn affects the economic development. To further substantiate this argument, there have been a handful of studies analyzing examples of geographically remote countries. For instance, Battersby (2006) has employed the Solow model and inferred that Australian economy has a lower level of productivity in comparison to other developed countries because of its relatively geographical remoteness. Similar conclusion has also been drawn by Dolman *et. al.* (2007). In addition, Limao and Venables (2001) have found that shipping costs for landlocked countries are greater than average, which in turn leads to a smaller amount of trading activities. Breinlich (2006) has also discovered that proximity to markets helps the E.U. countries located in Central Europe become more prosperous than the periphery E.U. countries. Based on these findings, it seems that geographical disadvantage is indeed harmful to economic performances.

However, the studies mentioned above might be exposed to various estimation biases. One of the greatest is that most of the researching efforts regarding this topic have been spent on developed countries, and developing countries have been somehow neglected. As pointed out by Krugman (1980), the home market effect in the international trade substantially differentiates the cross-economic activities conducted by developed and developing economies. Consequently, studies without separated discussions on geographical remoteness among high-income and low-income countries might be theoretically inconsistent with the patterns of international economic interactions. Empirically, there are also many examples in which similar geographical regions have countries with different levels of income. For instance, South Korea and North Korea are next to each other on the Korean Peninsula, but the south is more than twenty times richer than the north in terms of GDP per capita. Similar patterns can be found in the pair of Democratic Republic of the Congo and the Republic of Congo and the pair of the United States and Mexico (Acemoglu and Robinson, 2012). If geographical remoteness indeed exerted a deterministic effect on a country's income level, there should have not been any huge divergence between those countries' economic development. In fact, Acemoglu *et. al.* (2002) and Rodrik *et. al.* (2004) have employed econometric tools to demonstrate that modern global income distribution is weakly connected with geographical factors. To respond to these counterarguments, it becomes necessary to reexamine the impact of locational disadvantages on economic activities through including the situations of developing nations in particular.

According to Head and Mayer (2006) and Boulhol *et. al.* (2008), a country's degree of geographical remoteness has been quantified by two proxies: the sum of distances and the foreign market potential. The former refers to the sum of a country's distances with all other countries, and the latter refers to the sum of all other countries' GDPs weighted by the inverse of the bilateral distance. The larger the sum of distances and the smaller the foreign market potential, the greater the level of geographical remoteness that country would have. Given these two proxies and the findings in these two studies, the primary objective of this paper is to reevaluate the two hypotheses stated as follows:

(1). A country's sum of the distances has a negative effect on the country's GDP.

(2). A country's foreign market potential has a positive effect on the country's GDP.

To facilitate the process of examining these two somehow generalized hypotheses, it is assumed that the main channel of the effect of geographical remoteness on GDP is cross-border trading activities (Nicoletti *et. al.*, 2003). By doing so, unless otherwise noted, the effect on GDP and that on net exports of a country are regarded to be equivalent, especially in the theoretical discussions.

The remainder of this paper is organized as follows. It begins in Section II by providing a theoretical proof against the two hypotheses based on the industry-level gravity model of trade. Section III employs the panel data of 83 countries from 2000 to 2017 to empirically examine the two hypotheses in terms of the effects on output based on data of OECD countries and non-OECD countries separately. Furthermore, the section also evaluates the difference of the effects on trade balance. To confirm these empirical results, Section IV carries out robustness checks by using the World Bank's classification of high-income countries as an alternative categorization for the countries in the panel data, and it also reexamines the model by carrying out quantile regressions. Finally, Section V contains the conclusions.

II. Theoretical Framework

Cross-border trading activities have long been evaluated by way of the gravity model, which assumes that large economies interact with one another more than small ones, and nearby economies interact with one another more than far-off ones (Tinbergen, 1962, p. 263). Recently, the gravity model has been modified to capture the trading patterns of specific industries so as to examine controversies such as the home market effect and the reciprocal dumping (Bergstrand, 1989; Feenstra *et. al.*, 2001; Schumacher, 2003; Hanson and Xiang, 2004; Egger and Bergstrand, 2010). To ensure that the theoretical framework is rigorous and reflects the real-world trade patterns accurately, this section uses industry-level gravity equations to represent bilateral export and import volumes in order to prove the incorrectness of hypothesis (2) in particular, and the proof against hypothesis (1) will follow a similar procedure. Given the objectives of this section, the amount of the exports of goods and services in industry s from country i to country j in year t is evaluated by:

$$X_{ijst} \equiv c_s {Y_{it}}^{\alpha_s} {Y_{jt}}^{\beta_s} {d_{ij}}^{-\vartheta_s} \cdots\cdots\cdots (1)$$

where Y_{it} is the GDP of country i in year t, Y_{jt} is the GDP of country j in year t, and d_{ij} is the geographical distance between country i and country j. α_s, β_s, ϑ_s and c_s are positive parameters specific to each industry. Both empirical and theoretical studies have found that α_s, β_s and ϑ_s are close to one (Anderson and van Wincoop, 2003; Anderson, 2011).

Similarly, the amount of imports of goods and services in industry s of country i from country j in year t is expressed as:

$$M_{ijst} \equiv X_{jist} = c_s {Y_{jt}}^{\alpha_s} {Y_{it}}^{\beta_s} {d_{ij}}^{-\vartheta_s} \cdots\cdots\cdots (2)$$

With equations (1) and (2) as the gravity equations for industry-level bilateral exports and imports, a country's net exports can be obtained by aggregating that country's exports minus imports with all other countries for all industries.

Formally,

$$XM_{it} \equiv X_{it} - M_{it}$$
$$= \sum_{j\in C\setminus\{i\}} \sum_{s\in S} c_s Y_{it}{}^{\alpha_s} Y_{jt}{}^{\beta_s} d_{ij}{}^{-\vartheta_s} - \sum_{j\in C\setminus\{i\}} \sum_{s\in S} c_s Y_{jt}{}^{\alpha_s} Y_{it}{}^{\beta_s} d_{ij}{}^{-\vartheta_s}$$
$$= \sum_{j\in C\setminus\{i\}} \sum_{s\in S} \left[\left(\frac{Y_{it}}{Y_{jt}}\right)^{\alpha_s-\beta_s} - 1\right] c_s Y_{it}{}^{\beta_s} Y_{jt}{}^{\alpha_s} d_{ij}{}^{-\vartheta_s} \cdots\cdots\cdots (3)$$

where C is the set of all the countries in the world economic system, S is the set of all the industries, X_{it} is the total exports of country i in year t, and M_{it} is the total imports of country i in year t. The presence of the industry-specific difference between α_s and β_s is consistent with the concept of comparative advantage in the Ricardian model (Eaton and Kortum, 2002).

As α_s and ϑ_s are parameters close to one, equation (3) can be approximated by:

$$XM_{it} \approx \sum_{j\in C\setminus\{i\}} \frac{Y_{jt}}{d_{ij}} \left\{ \sum_{s\in S} \left[\left(\frac{Y_{it}}{Y_{jt}}\right)^{\alpha_s-\beta_s} - 1\right] c_s Y_{it}{}^{\beta_s} \right\} \cdots\cdots\cdots (4)$$

To decompose equation (4), vectors P_{it}, Q_{it} and U_{it} corresponding to each country i and each year t are invented. Each vector has the same dimension of $dim(C) - 1$, i.e. $\forall it,\ dim(P_{it}) = dim(Q_{it}) = dim(U_{it}) = dim(C) - 1$, and each element of these vectors corresponds to country j, which belongs to all countries in set C except country i itself. Formally, each element of each vector is defined as follows:

$$p_{itj} \equiv \sum_{s\in S} \left[\left(\frac{Y_{it}}{Y_{jt}}\right)^{\alpha_s-\beta_s} - 1\right] c_s Y_{it}{}^{\beta_s} \cdots\cdots\cdots (5)$$

$$q_{itj} \equiv \frac{Y_{jt}}{d_{ij}} \cdots\cdots\cdots (6)$$

$$u_{itj} \equiv 1 \cdots\cdots\cdots (7)$$

Since u_{itj} equals to one for all country j, U_{it} is identical for all country i and all year t, and all of its elements are one.

According to Harris (1954), equations (6) and (7) and hypothesis (2), the foreign market potential faced by country i is mathematically expressed as:

$$MP_{it} \equiv \sum_{j \in C \setminus \{i\}} \frac{Y_{jt}}{d_{ij}} = U_{it} {Q_{it}}^T \cdots\cdots\cdots\cdots (8)$$

With equation (8), the objective of this section turns to discover a mathematical relationship between a country's foreign market potential and its net exports. To this end, scalar projection is employed to appropriately transform equation (4). As a prerequisite, two new trigonometric variables are defined as follows:

$$\omega_{1i} \equiv cos^{-1}\left(\frac{P_{it} {Q_{it}}^T}{\|P_{it}\| \|Q_{it}\|}\right) \cdots\cdots\cdots\cdots (9)$$

$$\omega_{2i} \equiv cos^{-1}\left(\frac{U_{it} {Q_{it}}^T}{\|U_{it}\| \|Q_{it}\|}\right) \cdots\cdots\cdots\cdots (10)$$

where $cos(\omega_{2i})$ is positive because $U_{it} {Q_{it}}^T$, the foreign market potential of country i, is positive and the magnitude of a vector is also positive. In contrast, the sign of $cos(\omega_{1i})$ is determined by $P_{it} {Q_{it}}^T$, which can be either larger or smaller than zero.

Plugging equations (5) through (10) into equation (4) yields:

$$\begin{aligned} XM_{it} \approx P_{it} {Q_{it}}^T &= \frac{P_{it} {Q_{it}}^T}{U_{it} {Q_{it}}^T} MP_{it} \\ &= \frac{\|P_{it}\|}{\|U_{it}\| \, cos(\omega_{2i})} cos(\omega_{1i}) \, MP_{it} \cdots\cdots\cdots\cdots (11) \end{aligned}$$

where $\frac{\|P_{it}\|}{\|U_{it}\| \, cos(\omega_{2i})}$ is positive because $cos(\omega_{2i}) > 0$, and MP_{it} is also greater than zero. Therefore, whether country i has a current account surplus or deficit depends on the sign of $cos(\omega_{1i})$. Acknowledge that the sum of all countries' net exports equals to zero, i.e.

$$\sum_{i \in C} XM_{it} = 0 \cdots\cdots\cdots\cdots (12)$$

Therefore, as long as $cos(\omega_{1i})$ is not zero for each country i, which is almost impossible in the real world, there must simultaneously exist at least one $\omega \in \omega_{1i}$ such that $cos(\omega) > 0$ and at least one $\widetilde{\omega} \in \omega_{1i}$ such that $cos(\widetilde{\omega}) < 0$. Consequently, XM_{it}/MP_{it} cannot be positive for all pairs of country i and year t. In other words, if there is a positive relationship between some countries' foreign market potentials and their net exports, there must exist a negative relationship between some other countries' foreign market potentials and their net exports. Given that the effect on net exports is treated as an equivalent of the effect on GDP, hypothesis (2) is theoretically incorrect.

Similar to the foreign market potential, the sum of distances of a country ought also not to be positively correlated with that country's net exports for all countries as supposed by hypothesis (1) and its corollary assumption. In the context of this subsection, the sum of distances, according to Head and Mayer (2006) and hypothesis (1), is defined as:

$$D_{it} \equiv \sum_{j \in C \backslash \{i\}} d_{ij} \cdots\cdots\cdots (13)$$

Based on equation (13), the procedure of the proof for the foreign market potential could be repeated for $\sum_{j \in C \backslash \{i\}} {d_{ij}}^{-1}$, a proxy for D_{it}, and it would then be discovered that $XM_{it}/\sum_{j \in C \backslash \{i\}} {d_{ij}}^{-1}$ is not always positive, which is equivalent to say that XM_{it}/D_{it} is not always negative. Thus, making full use of equations (1) through (13), it can be substantiated that both hypotheses (1) and (2) are theoretically incorrect unless there exist certain endogenous effects.

Why are the seemingly plausible hypotheses theoretically incorrect? The culprit is the synergy between exports and imports in terms of the impact of distance. While geographical remoteness hinders economic development by reducing the volume of exports, it simultaneously benefits the economy through diminishing the volume of imports. The key determinant of a country's output level is the volume of net exports instead of that of exports. Thus, if the effect on imports is greater than that on exports, geographical remoteness can be positively, rather than negatively, correlated with real GDP. For instance, through imposing high import tariffs, which increased the importing cost but remained the exporting cost unchanged, the United States improved its own industrial competitiveness as well as accumulated the wealth earned from exporting goods and services in the late 19^{th} century, and they in turn accelerated the country's economic growth in the long run (O'rourke, 2000; Clemens and Williamson, 2001). In a similar fashion, the positive economic effect of this type of export-import policy-wise unbalance has also been found in Canada and Argentina in the same era (Irwin, 2002). Therefore, from the theoretical perspective, it is incorrect to contend that geographical remoteness universally exerts a negative exogenous effect on economic development.

III. Empirical Identification Strategy and Data Analysis

After meticulously demonstrating that geographical remoteness has an ambiguous relationship with net exports by the gravity equations, this section aims to confirm this theoretical finding through examining the real-world panel data. The first subsection focuses on the effect of geographical remoteness on output by the augmented Solow model, and the second subsection discusses the effect of geographical remoteness on trade balance. In the meantime, both subsections take advantage of regression techniques to compare the effect on OECD countries and that on non-OECD countries.

1. Geographical Remoteness and GDP: Augmented Solow Model

The augmented Solow model has long been used to estimate a country's output level. According to Mankiw *et. al.* (1992), the model identifies physical capital, human capital, labor and technology as four key determinants of the total output of a country without any government or any cross-border economic activity. Accordingly, a country's output level Y_{it} can be estimated by:

$$Y_{it} \equiv {K_{it}}^{\gamma_1} {H_{it}}^{\gamma_2} (A_{it} L_{it})^{1-\gamma_1-\gamma_2} + G_{it} + XM_{it} \cdots\cdots\cdots\cdots (14)$$

where K_{it} is the physical capital stock of country i in year t, H_{it} is the human capital stock of country i in year t, A_{it} is the level of technology of country i in year t, L_{it} is the labor stock of country i in year t, and G_{it} is the government spending of country i in year t. Y_{it} and XM_{it}, as in the previous section, are the GDP and the net exports of country i in year t respectively. γ_1 is the elasticity of physical capital, γ_2 is the elasticity of human capital, and $1 - \gamma_1 - \gamma_2$ is the elasticity of effective labor. All of them are constants greater than zero but smaller than one.

Moving G_{it} and XM_{it} from the right-hand side to the left-hand side and dividing both sides by L_{it} yield:

$$\frac{Y_{it} - G_{it} - XM_{it}}{L_{it}} = k_{it}^{\gamma_1} h_{it}^{\gamma_2} A_{it}^{1-\gamma_1-\gamma_2} \cdots\cdots\cdots\cdots (15)$$

where $k_{it} = K_{it}/L_{it}$ is the physical capital per labor, and $h_{it} = H_{it}/L_{it}$ is the human capital per labor.

Transforming equation (15) into its logarithmic form yields:

$$ln\left(\frac{Y_{it} - G_{it} - XM_{it}}{L_{it}}\right) = \gamma_1 ln(k_{it}) + \gamma_2 ln(h_{it}) + (1-\gamma_1-\gamma_2) ln(A_{it}) \cdots\cdots\cdots\cdots (16)$$

Suppose that k_{it} is observable and A_{it} and h_{it} are unobservable. Consequently, the steady-state physical capital per labor k_{it}^* can be directly obtained from the dataset, but the steady-state human capital per labor h_{it}^* needs further calculation based on the growth rate of h_{it}. According to Mankiw *et. al.* (1992), the growth rate of h_{it} can be mathematically expressed as follows:

$$\frac{\partial}{\partial t}\left(\frac{h_{it}}{A_{it}}\right) = \zeta_{it}\frac{Y_{it} - G_{it} - XM_{it}}{A_{it}L_{it}} - (n_{it} + g + d)\frac{h_{it}}{A_{it}}$$
$$= \zeta_{it}\left(\frac{k_{it}}{A_{it}}\right)^{\gamma_1}\left(\frac{h_{it}}{A_{it}}\right)^{\gamma_2} - (n_{it} + g + d)\frac{h_{it}}{A_{it}} \cdots\cdots\cdots\cdots (17)$$

where ζ_{it} is the fraction of output invested in human capital of country i in year t, n_{it} is the growth rate of the labor force of country i in year t, g is the growth rate of technology, d is the depreciation rate. g and d are assumed to be constant across all countries and years. k_{it}/A_{it} is the physical capital per effective labor of country i in year t, and h_{it}/A_{it} is the human capital per effective labor of country i in year t. Given equation (17) equal to zero at the steady state, equation (18) solves the steady-state human capital per labor h_{it}^* as follows:

$$h_{it}^* = \zeta_{it}^{\frac{1}{1-\gamma_2}} k_{it}^{\frac{\gamma_1}{1-\gamma_2}} (n_{it} + g + d)^{-\frac{1}{1-\gamma_2}} A_{it}^{\frac{1-\gamma_1-\gamma_2}{1-\gamma_2}} \cdots\cdots\cdots\cdots (18)$$

where $\frac{\partial}{\partial t}\left(\frac{h_{it}}{A_{it}}\right)\Big|_{h_{it}=h_{it}^*} = 0$.

Plugging $k_{it}{}^{*}$ and $h_{it}{}^{*}$ into equation (16) yields:

$$ln\left(\frac{Y_{it} - G_{it} - XM_{it}}{L_{it}}\right) = \frac{\gamma_1}{1-\gamma_2} ln(k_{it}{}^{*}) + \frac{\gamma_2}{1-\gamma_2} ln(\zeta_{it}) - \frac{\gamma_2}{1-\gamma_2} ln(n_{it} + g + d) + \frac{1-\gamma_1-\gamma_2}{1-\gamma_2} ln(A_{it}) \cdots\cdots\cdots (19)$$

Although Section I assumes that geographical remoteness only affects a country's output level through leveraging cross-border trading activities, it, in fact, has been demonstrated to influence the output level through other channels as well, including but not limited to foreign direct investment (FDI) and technology diffusion (Keller, 2002). Furthermore, there are also studies substantiating the potential effect of geographical remoteness on physical capital and human capital directly (Redding and Scott, 2003). However, to avoid overwhelming complexity, following Boulhol *et. al.* (2008) and Bruna *et. al.* (2014), only XM_{it} is removed from equation (19) and geographical remoteness factors D_{it} and MP_{it} are added as the new regressors to evaluate the effect of geographical remoteness on GDP. Formally, the new equation is expressed as:

$$ln\left(\frac{Y_{it} - G_{it}}{L_{it}}\right) = \rho_1 ln(k_{it}{}^{*}) + \rho_2 ln(\zeta_{it}) + \rho_3 ln(n_{it} + g + d) + \delta_1 ln(D_{it}) + \delta_2 ln(MP_{it}) + \rho_0 + \pi_t + \varepsilon_{it} \cdots\cdots\cdots (20)$$

where π_t, corresponding to the log of A_{it} in equation (19) when assuming it to be constant across all country i in a given year, is the fixed effect for year, ρ_0 is the intercept, and ε_{it} is the error term. Theoretically, the sum of ρ_2 and ρ_3 is equal to zero as shown by equation (19). δ_1 and δ_2 are the coefficients used to empirically determine the validity of the two hypotheses stated in Section I because if the two hypotheses hold true, δ_1 should be negative and δ_2 should be positive given that geographical remoteness affects output level only through net exports.

To carry out the regressions based on equation (20), data from various sources are employed as the independent and dependent variables. Y_{it} is the real GDP data from the World Bank, G_{it} is represented by the general government final consumption expenditure data from the World Bank, L_{it} is represented by the labor force data from the World Bank, $k_{it}{}^{*}$ is represented by the gross capital formation data from the World Bank dividing by the labor force, ζ_{it} is represented by the mean years of schooling data from the UNESCO, n_{it} is represented by the annual growth rate of the labor force, and $g + d$ is assumed to be 0.05 according to Mankiw *et. al.* (1992). The range of t is from 2000 to 2017. 83 countries are considered in the regressions as country i, and 24 of them are categorized as OECD countries. As there are eight missing observations for ${k_{it}}^*$ and one missing observation for ζ_{it}, the number of observations for the regressions in this subsection is 1485 when all 83 countries are incorporated. Statistical summary of all the variables employed in the regression analyses is reported in Table 1.

Regression results based on equation (20) are presented in Panel A of Table 2. All six columns contain fixed effect for year. The first three columns do not restrict the relationship between ρ_2 and ρ_3, and the last three columns require the sum of ρ_2 and ρ_3 to be zero as equation (19) implies, i.e. replacing the log of ζ_{it} and the log of $n_{it} + g + d$ with the log of $\zeta_{it}/n_{it} + g + d$ as the regressor. From an alternative perspective, columns (1) and (4) report the results without the incorporation of geographical remoteness factors, columns (2) and (5) report the results with the log of D_{it}, and columns (3) and (6) report the results with the log of MP_{it}. To quantify the statistical relevance of the geographical remoteness factors in the regressions, the ratio of the R^2 value with any of the geographical remoteness factors as an independent variable to the R^2 value without any of them as an independent variable, symbolized by δ, are calculated and presented at the bottom of the panel. Following Altonji *et. al.* (2005) and Oster (2017), this ratio is examined to measure how large the impact of unobserved variables must be to invalidate the identified treatment effect of the geographical remoteness factors (Altonji *et. al.*, 2005; Oster, 2017). Intuitively, δ ought to be at least one so as not to nullify the statistical results. The values of δ are only displayed in columns (2), (3), (5) and (6) because there is no geographical remoteness factors in columns (1) and (4).

As shown in Panel A of Table 2, given that the augmented Solow model holds true with $\gamma_1 \approx 0.75$ and $\gamma_2 \approx 0.15$, both D_{it} and MP_{it} exert positive effects on the output level of country i in year t. However, these two geographical remoteness factors' treatment effects are weak because their corresponding values of δ are one or very slightly above one, which allows us to nullify their levels of statistical significance. Moreover, even if we admit their validity, there is still little support to the hypotheses stated in the introduction section. While the positive coefficient for the log of D_{it} apparently opposes hypothesis (1), the positive coefficient for the log of MP_{it}

might be an effect through, as mentioned above equation (20), foreign direct investment (FDI), technological diffusion, physical capital and human capital rather than through trade-related activities. Despite displaying a contradiction between the effect of D_{it} and that of MP_{it} on output, Panel A of Table 2 does not provide too much conclusive implications.

2. Geographical Remoteness and GDP: OECD Countries versus Non-OECD Countries

To further understand how geographical remoteness might impact a country's output level, countries are split into two groups: OECD countries and non-OECD countries. This division is inspired by previous studies such as Boulhol *et. al.* (2008) and Boulhol and de Serres (2009), which have found that D_{it} negatively affects Y_{it} and MP_{it} positively affects Y_{it} among developed countries. As demonstrated by Section II theoretically, if the effect of geographical remoteness is negative for some countries, there must exist another group of countries among which the effect is positive. As industrialized countries and non-industrialized ones have been substantiated to be fundamentally different in terms of their paths of economic development (De Long, 1988), the panels for OECD and non-OECD countries are created to examine whether the theoretical finding in Section II is empirically supported.

Panel B of Table 2 displays results for OECD countries, and Panel C of Table 2 displays results for non-OECD countries. The restriction about the relationship between ρ_2 and ρ_3, the inclusion of fixed effect for year and the definition of δ are the same as those in Panel A. As shown, there are many great differences between the same columns of the two panels. While the treatment effect of the log of D_{it} is negative for OECD countries, it becomes positive for non-OECD countries. Similarly, while the treatment effect of the log of MP_{it} is positive for OECD countries, it becomes insignificant, i.e. close to zero, for non-OECD countries. The statistical insignificance could be a result of the negative effects of geographical remoteness through trade balance offset by its positive effects through other channels. All values of δ are greater than those in panel A, implying that these statistical results are not invalid. These implications are consistent with the theoretical conclusions drawn in Section II: geographical remoteness has a negative effect on output for OECD countries, but it has a positive effect on output for some non-OECD countries.

As in the end of Section II, after finding some empirical evidence supporting the huge differences between OECD countries and non-OECD countries in terms of the effect of geographical remoteness, one might ask why this divergence exists and why the divergence is between countries with different income levels instead of other criteria. There have been a large number of international macroeconomic literatures discovering the importance of this division since the 1980s, but it does not capture economic geographers' attentions too much, and, to the best of my knowledge, previous studies such as Boulhol *et. al.* (2008) and Bruna *et. al.* (2014) did not realize this issue at all.

In fact, this divergence originates from the observation that OECD countries are more likely to have trade surplus in comparison to non-OECD countries in general. To substantiate this argument, it is necessary to introduce the saving-investment puzzle. Feldstein and Horioka (1980), who raised this issue, found a strong correlation between the ratio of investment to output and the ratio of net saving to output based on data of OECD economies between 1960 and 1974. Mathematically, it can be expressed as follows:

$$\frac{I_{it}}{Y_{it}} = \kappa_0 + \kappa_1 \frac{NS_{it}}{Y_{it}} \cdots\cdots\cdots\cdots (21)$$

where I_{it} is the total investment of country i in year t, and NS_{it} is the net saving of country i in year t. Theoretically, when the current account is zero, total investment should be equal to net saving, which means that κ_0 equals to 0 and κ_1 equals to 1. Additionally, $I_{it} > NS_{it}$ implies trade deficit while $I_{it} < NS_{it}$ implies trade surplus (Romer, 2012, p. 37). According to the regressions conducted by Feldstein and Horioka (1980), κ_0 equals to 0.035 and the standard deviation is 0.018, and κ_1 equals to 0.887 and the standard deviation is 0.074. Given that κ_1 is close to one and there are barriers to capital mobility, taxes on capital income and trade surpluses or deficits, it seems that the one-to-one relationship between total investment and net saving still holds true.

However, this conclusion has been challenged by later studies such as Obstfeld and Rogoff (2000) when they incorporated non-OECD countries' data into the regression. According to their study relying on the data from 1990 to 1997, it seems that κ_1 decreases when the average income level of the countries in the sample decreases, and κ_1 could be as small as 0.41 after 32 non-OECD countries are added into the original sample of 24 OECD countries. Taking advantage of this information, for each group of countries, it becomes feasible to find a condition under which I_{it} is smaller than NS_{it}, which is equivalent to trade surplus. Based on equation (21), if I_{it} is smaller than NS_{it}, NS_{it} has to satisfy the following prerequisite:

$$\frac{NS_{it}}{Y_{it}} > \frac{\kappa_0}{1-\kappa_1} \cdots\cdots\cdots\cdots (22)$$

If this inequality is satisfied, $I_{it} < NS_{it}$; otherwise, $I_{it} \geq NS_{it}$. According to equation (22) as well as the statistical results from Obstfeld and Rogoff (2000), Panel A of Table 3 reports the values of $\kappa_0/(1-\kappa_1)$ corresponding to different groups of countries. Apparently, the value of $\kappa_0/(1-\kappa_1)$ is significantly smaller for OECD countries, which implies that more OECD countries tend to receive trade surplus in comparison to non-OECD countries. Furthermore, as shown in the seventh table of Obstfeld and Rogoff (2000), which is partially replicated in Panel B of Table 3, based on the averages of I_{it}/Y_{it} and the averages of NS_{it}/Y_{it} in different groups of countries, high-income countries are indeed more likely to have $I_{it} < NS_{it}$ satisfied in comparison to low-income countries.

Therefore, in the context of economic geography, suppose that geographical remoteness exerts equivalent negative effects on exports and imports respectively. As industrialized economies are more likely to have trade surplus, i.e. exports more than imports, as implied by Obstfeld and Rogoff (2000) and Table 3, geographical remoteness would eventually exert more negative effects on them in comparison to unindustrialized economies.

3. Geographical Remoteness and Net Exports: Exchange Rate Effect

In the previous subsections, it has been discovered that different groups of countries have different types of relationship between their geographical remoteness proxies and their output levels, but the sources of those differences have yet been discussed. This subsection takes advantage of the model about the relationship between exchange rate and trade balance to examine whether geographical remoteness exerts a negative effect on net exports as hypothesized in the introduction section. Econometrically,

$$XM_{it} = \xi_1 REER_{it} + \xi_2 ln(D_{it}) + \xi_3 ln(MP_{it}) + \xi_0 + \pi_t + \varepsilon_{it} \cdots\cdots\cdots\cdots (23)$$

where XM_{it} is represented by the export minus import data from the World Bank, and $REER_{it}$ is the World Bank's real effective exchange rate index of country i in year t. It is incorporated because, according to the J-curve effect, multilateral exchange rate has been demonstrated to have a positive effect on the net exports in the short run and a negative effect on the net exports in the long run (Rose and Yellen, 1989; Calderon, 2002; Onafowora, 2003). Adding $REER_{it}$ as a control variable is expected to alleviate the omitted variable bias. As the unit of time is year, only long-term effect is considered. And since there are only 954 available observations for $REER_{it}$ from 2000 to 2017, the number of observations shrinks to 954 in this subsection's regression analysis.

Panel A of Table 4 reports the results for all countries. Column (1) does not contain any geographical remoteness factor, column (2) contains the log of D_{it}, and column (3) contains the log of MP_{it}. All specifications include fixed effect for year. δ at the bottom of the panel is the ratio of the R^2 value with any of the geographical remoteness factors as an independent variable to the R^2 value without any of them as an independent variable. Its values are only available in columns (2) and (3) because there is no geographical remoteness factor in column (1). As expected, the effect of the real effective exchange rate index on net exports is significantly negative. Given this negative effect and the large values of δ, the treatment effect of the log of D_{it} is negative and that of the log of MP_{it} is positive, which seems to agree with the two hypotheses. However, these are just average treatment effects, and it does not necessarily demonstrate that the effect of geographical remoteness on all countries is negative.

4. Geographical Remoteness and Net Exports: OECD Countries versus Non-OECD Countries

To further explore the distribution of the effect of geographical remoteness on net exports, countries in the sample are split into two groups as carried out in the second subsection of this section. Accordingly, the statistical results for OECD countries and those for non-OECD countries are displayed in panel B and panel C of Table 4 respectively. The inclusion of fixed effect for year and the definition of δ are the same as those in Panel A. As shown in column (2) of the two panels, the treatment effect of the log of D_{it} is negative for OECD countries and positive for non-OECD countries; similarly, in column (3) of the two panels, the treatment effect of the log of MP_{it} is positive for OECD countries and negative for non-OECD countries. With the large values of δ, it is confident to claim that trade balance of an OECD country is negatively influenced by geographical remoteness and that of a non-OECD country is positively influenced.

IV. Robustness Check

1. Re-categorization Tests

Re-categorization test has been used in empirics to alleviate the presence of the unobservable effects caused by categorization (Neumayer and Plümper, 2017, p. 127). Therefore, to confirm the statistical results obtained by Section III, this section re-categorizes the 83 countries based on the World Bank's classification of high-income country and repeats the regressions conducted for Table 2 and Table 4. In comparison to the 24 OECD countries in the sample, there are 32 countries labeled as high-income countries among the 83 countries with available data. Accordingly, $NonHIC_i$ equals to zero if country i is a high-income country, and it equals to one if otherwise.

The regression results similar to Table 2 but based on the dummy of high-income country are presented in Table 5. Panel A of Table 5 corresponds to high-income countries while Panel B of Table 5 corresponds to non-high-income countries. The restriction about the relationship between ρ_2 and ρ_3, the inclusion of fixed effect for year and the definition of δ are the same as those in Table 2. As shown in columns (2) and (5) of the two panels in Table 5, there is a substantial difference between the treatment effect of the log of D_{it} on a country's output level: the effect is negative on high-income countries and positive on non-high-income countries. In contrast, the treatment effect of the log of MP_{it} is not statistically significant in most columns, but it seems true that it is larger for high-income countries than for non-high-income countries.

Furthermore, the effects of D_{it} and MP_{it} on trade balance are also evaluated in the context of high-income countries versus non-high-income countries to determine whether trade is a key channel for geographical remoteness to exert effects on GDP. Table 6, corresponding to Table 4, shows the results with regard to the relationship between geographical remoteness and trade balance. Panel A of Table 6 displays the results for high-income countries, and Panel B of Table 6 displays the results for non-high-income countries. The inclusion of fixed effect for year and the definition of δ are the same as those in Table 4. In column (2) of the two panels, the treatment effect of the log of D_{it} is statistically significantly negative for high-income countries, but it is close to zero for non-high-income countries. In contrast, in column (3), the treatment effect of the log of MP_{it} is statistically significantly positive for high-income countries and statistically significantly negative for non-high-income countries.

In summary, implications drawn from Table 5 and Table 6 are almost the same as those from Table 2 and Table 4, which demonstrates the robustness of the empirical examinations in Section III at least from the perspective of categorization.

2. Quantile Regression Estimations

As meticulously studied above, OECD countries and high-income countries have been identified as the two groups that can be disadvantaged by geographical remoteness, but the beneficiaries have yet been discovered. Furthermore, it is uncertain whether there exists a general relationship between a country's income level and the extent to which it is affected by geographical remoteness. Thus, quantile regression estimation, firstly introduced by Koenker and Bassett (1978), is employed in this subsection to answer this question systematically, and it is accomplished by minimizing the weighted residual sum of squares whose expression, following Angrist and Pischke (2008, pp. 269-285), is of the following form:

$$RSS_{QUANTILE} \equiv E[\rho_\upsilon(y_i - \boldsymbol{X}_i'\beta)] \cdots\cdots\cdots\cdots (24)$$

where y_i is the dependent variable, $\boldsymbol{X}_i$ is the set of independent variables, and, given $\upsilon \in (0,1)$, ρ_υ is a piecewise function expressed as follows:

$$\rho_\upsilon(u) \equiv \begin{cases} \upsilon u, & u \geq 0 \\ (1-\upsilon)u, & u < 0 \end{cases} \cdots\cdots\cdots\cdots (25)$$

Taking advantage of equation (25), $RSS_{QUANTILE}$ is tilted to the position of υ by penalizing one side's residuals more than the other side's. Throughout this subsection, as the distribution of income level is meaningful and that of trade balance is meaningless, only equation (20) is reexamined by this quantile regression estimation method.

The results based on equations (24) and (25) are reported in Table 7. Columns (1) and (2) present the estimates corresponding to the countries whose income levels are at the lowest decile, columns (3) and (4) present the estimates corresponding to the countries at the median income level, and columns (5) and (6) present the estimates corresponding to the countries whose income levels are at the highest decile.

As shown, given the expected estimates of the coefficients of physical and human capital, the increase of income level decreases the coefficient of D_{it} from significantly positive to slightly negative and increases that of MP_{it} from slightly positive to significantly positive, and this exactly confirms the previous findings that geographical remoteness exerts positive effects on low-income countries and negative effects on high-income countries. Thus, the quantile regression estimates demonstrate the robustness of the theoretical and empirical analyses displayed above.

V. Conclusion

This paper makes substantial contributions to the literatures on spatial economics. Firstly, making full use of industry-level gravity model of international trade, Section II provides a theoretical framework to demonstrate that the existing arguments regarding the negative effect of geographical remoteness are incorrect if both developed and developing countries are taken into account. Secondly, Section III employs the augmented Solow model to substantiate that the effect of geographical remoteness on OECD countries is negative while that on non-OECD countries is negative in terms of both output level and volume of net exports. Section IV confirms this finding through re-categorizing countries in the panel data based on the World Bank's classification of high-income country and carrying out quantile regressions. These two implications altogether lead to the conclusion that geographical remoteness is not an exogenous economic disadvantage for all types of countries both in theory and in reality. Therefore, although Australia's productivity, as pointed out in Section I, is slightly lower than that of the United States partly due to its geographical remoteness, it is still far higher than the productivity of most countries in the regions, such as Middle East and North Africa, where the center of the world is closer in terms of either the sum of distances or the foreign market potential. Similarly, as exemplified by Botswana and its four surrounding countries, inconsistent with the expectations misled by the previous studies mentioned in Section I, some landlocked countries are more industrialized than their coastal neighbors. Simply put, geographical factors are by no means deterministic to economic development.

Although this paper greatly contributes to the understanding of economic geography, there remain unresolved issues that deserve more attentions in the future. One of the most important problems is that the statistical inferences throughout this paper are all based on a very small number of observations for developing economies. If there are more available data disclosed in the future, further studies should endeavor to explore this question so as to help guide those countries to make appropriate economic policies based on their geographical conditions.

In addition, as repeatedly mentioned in different sections of this paper, trade balance is by no means the only channel for the effect of geographical remoteness on a country's output level. However, those other mechanisms have not yet been studied in this paper, and there are few literatures regarding them in the context of developed countries versus developing countries. Moreover, current account balance itself can also be extremely complicated if the endogenous effects of trade demonstrated by Frankel and Romer (1999) are taken in account. Future works focusing on these challenges will be very meaningful.

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Table 1 Descriptive Statistics

Variable	*Obs.*	*Mean*	*Std. Dev.*	*Min*	*Max*	*Unit*
Y_{it}	1494	646.884	1816.167	0.949	17348.626	Billion USD
G_{it}	1494	112.930	301.298	0.141	2519.321	Billion USD
XM_{it}	1494	0.330	80.441	-863.485	276.006	Billion USD
L_{it}	1494	22.040	54.397	0.090	503.366	Million People
D_{it}	1494	1.227	0.338	0.856	2.271	Million Kilometer
MP_{it}	1494	12.262	7.398	3.595	4.351	Billion USD Per Kilometer
K_{it}	1486	147.013	390.858	0.185	3698.080	Billion USD
ζ_{it}	1493	8.574	3.045	1.200	14.100	
$REER_{it}$	954	0.986	0.140	0.541	2.963	
$NonOECD_i$	83	0.711	0.454	0.000	1.000	
$NonHIC_i$	83	0.614	0.487	0.000	1.000	

Notes: "Obs." abbreviates "number of observations" and "Std. Dev." abbreviates "standard deviation". ${k_{it}}^* \equiv K_{it}/L_{it}$. All variables except ζ_{it} and $OECD_i$ come from the World Bank's World Development Index (WDI). ζ_{it} comes from the UNESCO Institute for Statistics (UIS), and $NonOECD_i$ comes from the OECD.

Table 2 Augmented Solow Model and Geographical Remoteness

Explanatory Variables	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: All Countries						
$ln(k_{it}^*)$	0.882***	0.885***	0.872***	0.901***	0.903***	0.894***
	(0.007)	(0.008)	(0.008)	(0.007)	(0.007)	(0.007)
$ln(\zeta_{it})$	0.247***	0.236***	0.251***	0.146***	0.142***	0.141***
	(0.024)	(0.025)	(0.024)	(0.016)	(0.016)	(0.016)
$ln(n_{it}+g+d)$	-0.037	-0.044	-0.019	-0.146***	-0.142***	-0.141***
	(0.025)	(0.026)	(0.026)	(0.016)	(0.016)	(0.016)
$ln(D_{it})$		0.045			0.077**	
		(0.026)			(0.025)	
$ln(MP_{it})$			0.056***			0.042**
			(0.015)			(0.015)
Intercept	-2.392***	-3.057***	-3.508***	-2.721***	-3.807***	-3.584***
	(0.086)	(0.389)	(0.317)	(0.062)	(0.359)	(0.321)
Fixed Effect for Year	Yes	Yes	Yes	Yes	Yes	Yes
Is the sum of ρ_2 and ρ_3 zero?	No	No	No	Yes	Yes	Yes
Number of Observations	1485	1485	1485	1485	1485	1485
F-statistic	13932	10465	10541	20480	13735	13717
R^2	0.964	0.964	0.964	0.963	0.964	0.963
δ		1.000	1.000		1.001	1.000
Panel B: OECD Countries						
Explanatory Variables	(1)	(2)	(3)	(4)	(5)	(6)
$ln(k_{it}^*)$	0.729***	0.674***	0.708***	0.780***	0.772***	0.774***
	(0.018)	(0.018)	(0.018)	(0.015)	(0.014)	(0.015)
$ln(\zeta_{it})$	0.481***	0.633***	0.526***	0.284***	0.282***	0.282***
	(0.047)	(0.048)	(0.047)	(0.026)	(0.025)	(0.025)
$ln(n_{it}+g+d)$	-0.199***	-0.129***	-0.176***	-0.284***	-0.282***	-0.282***
	(0.030)	(0.029)	(0.030)	(0.026)	(0.025)	(0.025)
$ln(D_{it})$		-0.175***			-0.091***	
		(0.022)			(0.021)	
$ln(MP_{it})$			0.047***			0.028*
			(0.011)			(0.011)
Intercept	-1.166***	1.900***	-1.992***	-1.661***	-0.268	-2.226***
	(0.211)	(0.429)	(0.286)	(0.191)	(0.371)	(0.295)
Fixed Effect for Year	Yes	Yes	Yes	Yes	Yes	Yes
Is the sum of ρ_2 and ρ_3 zero?	No	No	No	Yes	Yes	Yes
Number of Observations	432	432	432	432	432	432
F-statistic	1565	1372	1225	2209	1543	1493
R^2	0.918	0.929	0.921	0.914	0.917	0.915
δ		1.012	1.003		1.003	1.001
Panel C: Non-OECD Countries						
Explanatory Variables	(1)	(2)	(3)	(4)	(5)	(6)
$ln(k_{it}^*)$	0.855***	0.859***	0.853***	0.884***	0.884***	0.883***
	(0.010)	(0.010)	(0.010)	(0.009)	(0.009)	(0.009)
$ln(\zeta_{it})$	0.257***	0.226***	0.256***	0.124***	0.113***	0.123***
	(0.028)	(0.028)	(0.028)	(0.018)	(0.018)	(0.018)
$ln(n_{it}+g+d)$	0.035	0.019	0.040	-0.124***	-0.113***	-0.123***
	(0.031)	(0.031)	(0.031)	(0.018)	(0.018)	(0.018)
$ln(D_{it})$		0.189***			0.224***	
		(0.035)			(0.035)	
$ln(MP_{it})$			0.025			0.012
			(0.024)			(0.025)
Intercept	-1.917***	-4.599***	-2.450***	-2.444***	-5.517***	-2.702***
	(0.122)	(0.510)	(0.534)	(0.090)	(0.486)	(0.542)
Fixed Effect for Year	Yes	Yes	Yes	Yes	Yes	Yes
Is the sum of ρ_2 and ρ_3 zero?	No	No	No	Yes	Yes	Yes
Number of Observations	1053	1053	1053	1053	1053	1053
F-statistic	5742	4431	4307	8279	5749	5515
R^2	0.938	0.940	0.938	0.936	0.938	0.936
δ		1.002	1.000		1.002	1.000

Notes: Standard errors are included in parentheses. Significance level: $^* p < 0.05$, $^{**} p < 0.01$, $^{***} p < 0.001$.

Table 3 Saving-Investment Puzzle: Implications for Economic Geography

Panel A: Threshold Value of Saving-Investment Balance	
Country Group	$\kappa_0/(1-\kappa_1)$
All Countries	0.254
Countries with GNP Per Capita > $2,000	0.233
OECD Countries	0.200

Panel B: Saving-Investment Comparison		
Country Group	Average NS_{it}/Y_{it}	Average I_{it}/Y_{it}
All Countries	0.19	0.22
Countries with GNP Per Capita > $2,000	0.21	0.23
Countries with GNP Per Capita > $5,000	0.21	0.22
Countries with GNP Per Capita > $18,000	0.22	0.21

Notes: Results in both panels are obtained by author's own calculations based on Table 2 and Table 7 of Obstfeld and Rogoff (2000).

Table 4 Net Exports and Geographical Remoteness

Explanatory Variables	Panel A: All Countries		
	(1)	(2)	(3)
$REER_{it}$	-106.565***	-112.297***	-117.075***
	(23.360)	(23.088)	(22.755)
$ln(D_{it})$		-56.627***	
		(11.219)	
$ln(MP_{it})$			42.061***
			(5.661)
Intercept	106.619***	903.218***	-859.985***
	(23.268)	(159.482)	(132.048)
Fixed Effect for Year	Yes	Yes	Yes
Is the sum of ρ_2 and ρ_3 zero?	No	No	No
Number of Observations	954	954	954
F-statistic	21	23	39
R^2	0.022	0.047	0.076
δ		2.136	3.455
	Panel B: OECD Countries		
Explanatory Variables	(1)	(2)	(3)
$REER_{it}$	-314.481***	-319.395***	-340.789***
	(67.919)	(65.153)	(60.859)
$ln(D_{it})$		-137.738***	
		(23.175)	
$ln(MP_{it})$			111.284***
			(11.191)
Intercept	305.359***	2227.645***	-2281.778***
	(68.416)	(330.028)	(267.281)
Fixed Effect for Year	Yes	Yes	Yes
Is the sum of ρ_2 and ρ_3 zero?	No	No	No
Number of Observations	414	414	414
F-statistic	21	29	63
R^2	0.053	0.130	0.242
δ		2.453	4.566
	Panel C: Non-OECD Countries		
Explanatory Variables	(1)	(2)	(3)
$REER_{it}$	-19.821*	-18.913*	-19.530*
	(8.837)	(8.824)	(8.797)
$ln(D_{it})$		10.038*	
		(5.030)	
$ln(MP_{it})$			-7.267*
			(2.992)
Intercept	29.392***	-112.060	196.464**
	(8.720)	(71.419)	(69.326)
Fixed Effect for Year	Yes	Yes	Yes
Is the sum of ρ_2 and ρ_3 zero?	No	No	No
Number of Observations	540	540	540
F-statistic	5	5	5
R^2	0.014	0.021	0.028
δ		1.500	2.000

Notes: Standard errors are included in parentheses. Significance level: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 5 Robustness Check: Augmented Solow Model and Geographical Remoteness

	Panel A: HIC Countries					
Explanatory Variables	(1)	(2)	(3)	(4)	(5)	(6)
$ln(k_{it}^{*})$	0.849***	0.831***	0.838***	0.864***	0.852***	0.857***
	(0.017)	(0.017)	(0.018)	(0.015)	(0.015)	(0.016)
$ln(\zeta_{it})$	0.298***	0.298***	0.301***	0.183***	0.153***	0.174***
	(0.067)	(0.066)	(0.067)	(0.033)	(0.034)	(0.034)
$ln(n_{it}+g+d)$	-0.142***	-0.098*	-0.125**	-0.183***	-0.153***	-0.174***
	(0.039)	(0.040)	(0.040)	(0.033)	(0.034)	(0.034)
$ln(D_{it})$		-0.114***			-0.104***	
		(0.028)			(0.028)	
$ln(MP_{it})$			0.024			0.019
			(0.014)			(0.014)
Intercept	-2.278***	-0.315	-2.647***	-2.336***	-0.556	-2.641***
	(0.238)	(0.533)	(0.323)	(0.236)	(0.527)	(0.324)
Fixed Effect for Year	Yes	Yes	Yes	Yes	Yes	Yes
Is the sum of ρ_2 and ρ_3 zero?	No	No	No	Yes	Yes	Yes
Number of Observations	576	576	576	576	576	576
F-statistic	1310	1015	986	1953	1338	1305
R^2	0.876	0.880	0.876	0.875	0.879	0.876
δ		1.005	1.000		1.005	1.001
	Panel B: Non-HIC Countries					
Explanatory Variables	(1)	(2)	(3)	(4)	(5)	(6)
$ln(k_{it}^{*})$	0.803***	0.810***	0.802***	0.828***	0.827***	0.829***
	(0.011)	(0.011)	(0.011)	(0.011)	(0.010)	(0.011)
$ln(\zeta_{it})$	0.266***	0.206***	0.266***	0.140***	0.117***	0.142***
	(0.027)	(0.027)	(0.027)	(0.018)	(0.017)	(0.018)
$ln(n_{it}+g+d)$	0.016	-0.014	0.017	-0.140***	-0.117***	-0.142***
	(0.030)	(0.030)	(0.031)	(0.018)	(0.017)	(0.018)
$ln(D_{it})$		0.285***			0.329***	
		(0.038)			(0.037)	
$ln(MP_{it})$			0.006			-0.021
			(0.032)			(0.032)
Intercept	-1.374***	-5.427***	-1.504*	-1.863***	-6.350***	-1.405*
	(0.130)	(0.553)	(0.699)	(0.107)	(0.514)	(0.714)
Fixed Effect for Year	Yes	Yes	Yes	Yes	Yes	Yes
Is the sum of ρ_2 and ρ_3 zero?	No	No	No	Yes	Yes	Yes
Number of Observations	909	909	909	909	909	909
F-statistic	3407	2730	2552	4876	3564	3249
R^2	0.914	0.919	0.914	0.910	0.918	0.911
δ		1.005	1.000		1.009	1.001

Notes: Standard errors are included in parentheses. Significance level: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 6 Robustness Check: Net Exports and Geographical Remoteness

	Panel A: HIC Countries		
Explanatory Variables	(1)	(2)	(3)
$REER_{it}$	-272.036*** (55.533)	-277.168*** (54.161)	-282.489*** (52.239)
$ln(D_{it})$		-96.926*** (18.657)	
$ln(MP_{it})$			71.022*** (8.691)
Intercept	266.227*** (55.424)	1620.258*** (266.178)	-1388.017*** (209.043)
Fixed Effect for Year	Yes	Yes	Yes
Is the sum of ρ_2 and ρ_3 zero?	No	No	No
Number of Observations	522	522	522
F-statistic	24	26	47
R^2	0.044	0.093	0.159
δ		2.114	3.614
	Panel B: Non-HIC Countries		
Explanatory Variables	(1)	(2)	(3)
$REER_{it}$	-29.426** (9.616)	-29.728** (9.645)	-26.581** (9.561)
$ln(D_{it})$		-3.102 (6.384)	
$ln(MP_{it})$			-15.498** (5.002)
Intercept	36.745*** (9.549)	80.563 (90.681)	390.012*** (114.413)
Fixed Effect for Year	Yes	Yes	Yes
Is the sum of ρ_2 and ρ_3 zero?	No	No	No
Number of Observations	432	432	432
F-statistic	9	5	10
R^2	0.027	0.027	0.056
δ		1.000	2.074

Notes: Standard errors are included in parentheses. Significance level: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 7 Quantile Regression: Augmented Solow Model and Geographical Remoteness

Explanatory Variables	Quantile Regression Estimates					
	10%		*50%*		*90%*	
$ln(k_{it}{}^{*})$	0.923***	0.910***	0.883***	0.870***	0.850***	0.835***
	(0.017)	(0.017)	(0.008)	(0.008)	(0.014)	(0.014)
$ln(\zeta_{it})$	0.289***	0.304***	0.233***	0.248***	0.189***	0.201***
	(0.061)	(0.058)	(0.029)	(0.028)	(0.049)	(0.048)
$ln(n_{it} + g + d)$	0.006	0.036	-0.047	-0.022	-0.089	-0.072
	(0.059)	(0.058)	(0.028)	(0.028)	(0.047)	(0.048)
$ln(D_{it})$	0.118*		0.041		-0.021	
	(0.050)		(0.024)		(0.040)	
$ln(MP_{it})$		0.040		0.056***		0.070**
		(0.026)		(0.013)		(0.022)
Fixed Effect for Year	Yes	Yes	Yes	Yes	Yes	Yes
Number of Observations	1485	1485	1485	1485	1485	1485

Notes: Standard errors are included in parentheses. Significance level: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.