Asia's Geographic Development

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This paper studies the impact of spatial frictions on Asia's long-term spatial development. Using the framework provided in Desmet, Nagy, and Rossi-Hansberg (2016), we analyze the evolution of Asia's economy and the relative performance of specific regions and countries. We then perform a number of counterfactual experiments and find that a worldwide drop in transport costs of 40% increases the present discounted value of real income by 70.7% globally and 78% in Asia. These figures are much larger than those found in standard quantitative trade models because they include dynamic effects and take into account intracountry transport costs. We also perform exercises in which we upgrade Asia's road network or relax migratory restrictions between locations in Asia. These exercises emphasize the important role of spatial frictions in the development of Asia's economy.

Keywords: economic geography, economy of Asia, growth and development, international migration, quantitative trade models
JEL codes: F11, F22, F43, O10, O40, O53, R42

I. Introduction

Spatial frictions, such as trade costs and migratory restrictions, are key to understanding geographic differences in income and welfare. Consumers residing in the port of Mumbai pay much lower prices for imported goods than consumers living in a small rural village in Kashmir. Similarly, firms in big cities on the eastern seaboard of the People's Republic of China (PRC) find it much easier to reach a large number of customers than firms in the remote western province of Xinjiang. And while per capita income may be much higher in Japan than in the Lao People's Democratic Republic, people cannot freely move from one country to another. Even within countries, migratory frictions persist in the form of moving costs, imperfect

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information, and even legal restrictions. As an example of the latter, the PRC's *hukou* (household registration) system makes it difficult to move from poor, rural areas in the western provinces to the burgeoning cities of the eastern PRC.

Spatial frictions that affect the geographic distribution of people and economic activity also affect productivity and its evolution. There is a well-established literature in urban and regional economics that emphasizes the importance of agglomeration economies. The spatial concentration of economic activity tends to have positive effects on productivity. Hence, keeping people from moving to the PRC's high-density megacities may reduce not just the level of per capita income in those cities, but also aggregate per capita income in the PRC. Perhaps even more important, the concentration of economic activity in geographic space generates incentives to invest in and improve the production capabilities of economic clusters. A larger market size makes firms more willing to invest in technology since they can use these innovations more intensively. The replicability of technology implies that a firm's local market size (geographic concentration of expenditure on its goods) affects its investment decisions. The aggregation of these investment decisions across firms and locations determines local, and ultimately, aggregate growth.

This logic suggests that spatial frictions should play a central role in any theory of long-term growth and development. Policies or shocks that change these spatial frictions are crucial determinants of the development process. Examples include trade, infrastructure, and migration policies. They also include technological improvements in transport, the information and communications technology revolution, and the decline in global oil prices. Fully understanding the complex relationship between spatial frictions and development requires a spatial-dynamic model that allows us to quantify this link and compute counterfactual exercises. In previous work, we developed such a framework (Desmet, Nagy, and Rossi-Hansberg 2016). In this paper, we use this framework to evaluate the long-term geographic development of Asia. In doing so, we pay special attention to the role played by transport costs and migratory restrictions.

Our benchmark analysis uses a calibrated version of Desmet, Nagy, and Rossi-Hansberg (2016) to predict the future spatial development of Asia under the assumption that spatial frictions remain unchanged. That is, we maintain today's trade and migration costs into the indefinite future. We take a very long-term approach, starting in the year 2000 and running the model forward to the year 2600.[1] The model predicts that Asia, starting out with a higher growth rate in real per capita income, eventually converges to the rest of the world, both in terms

[1]In this paper, Asia comprises the economies of "developing Asia" as defined by the Asian Development Bank. This grouping excludes the Russian Federation and Turkey; the Persian Gulf states; and Australia, Japan, and New Zealand. For a complete list of developing Asian economies, see section III.

of growth rates and level of development. This process is driven by the positive relationship between population density and innovation. The calibrated version of our theory predicts that as countries develop, the correlation between density and productivity becomes stronger. Some Asian countries, such as India, start with high levels of population density. This leads to more innovation, which in turn attracts more people, fomenting further innovative activity. In terms of individual countries, we find that in the very long term, India and Indonesia become Asia's economic leaders, while the Republic of Korea surpasses Japan.

We then evaluate what would change if we were to reduce spatial frictions. Our first exercise focuses on trade costs. We find that a worldwide drop in transport costs by 40% would increase the present discounted value of real income by 70.7% globally and by 78% in Asia. These figures are much larger than those found in standard quantitative trade models because they include dynamic effects and take into account intracountry transport costs. One reason for Asia's slightly bigger gain is the poor initial state of its transport infrastructure. Apart from estimating the effect of a worldwide drop in transport costs by 40%, we also evaluate what would occur if that decline only happened in Asia. We also run an additional counterfactual policy experiment that upgrades all minor roads in Asia.

A second exercise focuses on the role of migratory restrictions. We find that a worldwide reduction in the cost of migration by 25% would increase the present discounted value of real income by 30.6% globally and by 9% in Asia. While in the case of reducing trade costs Asia is predicted to gain more than the rest of the world, in the case of reducing migration costs Asia is predicted to gain less than the rest of the world. Lower migration costs imply that people would move from Asia to more attractive locations. The reduction in the continent's population density would have a dampening effect on innovative activity, although on balance the continent still gains because of trade and the diffusion of technology from the rest of the world. If instead the 25% reduction in migration restrictions were only to happen in Asia, the results are different. The present discounted value of real income would decrease by 12.9% globally and by 3.7% in Asia. However, Asia's welfare would increase by 7.9% as people would move to less congested and more desirable locations. At the same time, world welfare would decline. The finding that the world becomes worse off points to distortions deriving from liberalizing migration restrictions in some places but not in others. Compared to a worldwide drop in migration costs, we no longer have the effect of outmigration from Asia.

The rest of the paper is organized as follows. Section II provides a summary of the framework developed in Desmet, Nagy, and Rossi-Hansberg (2016). Section III analyzes the geography of development in Asia under the assumption that transport costs and migration restrictions remain unchanged. Section IV evaluates the importance of trade costs and section V assesses the impact of migratory restrictions on Asia's spatial development. Section VI concludes.

II. A Spatial Development Framework

To analyze how Asia's economic geography is likely to evolve over the next centuries, we need a spatial-dynamic growth model with a rich and realistic geography that can be taken to the data. Desmet, Nagy, and Rossi-Hansberg (2016) develop such a framework. Here we limit ourselves to briefly describing the main elements of the theory, giving an overview of how to solve the model, and showing that the model is a reasonable approximation of reality.

Main elements of the model. The world consists of a continuum of locations in two-dimensional space. Having a location characterized by both its latitude and longitude is necessary to provide a link between the theory and the world's actual geography so that we can make predictions about particular places or regions.[2] Each location has firms that produce different goods and trade with other locations, subject to transport and trade costs. Each location is unique in terms of its productivity, amenities, and geography. A location's productivity is initially given, but it evolves over time because of innovation. We will provide more details about innovation when we describe the dynamics of the model later in this section. A location's amenities are partly exogenous—such as a nice beach or a beautiful mountain—but may suffer from congestion. A location's geography refers to its location relative to other markets. A well-connected place—either because of its proximity to markets or lower transport costs—gives local consumers cheaper access to goods and local firms easier access to other markets.

Individuals have idiosyncratic preferences with regard to different locations. People generally prefer living in places with higher real incomes and superior amenities, but there is heterogeneity across individuals. Although a temperate climate may be superior to an arctic climate, some people may feel attracted to Siberia for idiosyncratic reasons. This implies that, even if they could, not all Siberians would want to move to a place with higher real income and better amenities. Of course, another reason that keeps people in Siberia is the difficulty to move to other places given mobility restrictions. One of our main interests in this paper will be to see how Asia's future spatial growth patterns might look different depending on how easy or how difficult it is for people to move across locations, both within and across countries.

A location's productivity depends partly on the productivity it inherits from the previous period, both from itself and from the rest of the world through spatial diffusion; partly on static agglomeration economies as measured by local density;

[2] Previous spatial growth models either had two or three regions (see, for example, Baldwin and Martin 2004) or a continuum of locations in a one-dimensional space (see, for example, Desmet and Rossi-Hansberg 2014). While the latter approach is useful to analyze issues that can be reduced to one spatial dimension, such as global warming where distance to the equator is the main concern, general quantitative work in economic geography requires both latitude and longitude. In a recent paper, Allen and Arkolakis (2014) developed a spatial model with a continuum of locations in two-dimensional space, but without introducing dynamics and growth.

and partly on local innovation. Locations that have easy access to more (and preferably richer) customers innovate more because innovations can be applied more intensively. Locations with high population density therefore benefit from dynamic agglomeration economies. The evolution of productivity over time and space determines, in turn, the distribution of people and utility over time and space. Of course, how many people move as a result of changing productivity levels depends on mobility restrictions and on heterogeneity in locational tastes.

Desmet, Nagy, and Rossi-Hansberg (2016) show that a solution to this spatial-dynamic model exists and is unique if agglomeration forces are not too strong compared to dispersion forces. In this model, agglomeration economies come from both the direct effect of local density on local productivity and from the indirect effect of local density on the returns to local innovation, while dispersion forces come from decreasing returns to land, congestion that reduces the level of amenities, and taste heterogeneity across locations. The intuition for the uniqueness result is straightforward: if agglomeration forces are not strong enough to overcome dispersion forces, the marginal product of labor in a given location continues to be decreasing so that there is no reason for multiple equilibria to emerge. Desmet, Nagy, and Rossi-Hansberg (2016) also show that if the spatial diffusion of productivity is sufficiently strong, then this unique solution will lead to a balanced growth path in which all locations grow at the same rate. Again, the intuition for this result is easy to understand. Since the densest locations innovate more, they are likely to attract more people and become even more dense, thereby generating more innovation. In the absence of spatial diffusion, economic activity would end up concentrating in one location. In contrast, if the productivity of high-productivity locations diffuses, this extreme form of concentration will not occur and the economy will converge to a balanced growth path. In a balanced growth path, the growth rate of real gross domestic product (GDP) per capita in the world economy depends on the distribution of economic activity across locations.

Calibration and simulation. One advantage of the approach in Desmet, Nagy, and Rossi-Hansberg (2016) is that the model can be solved by iterating a system of equations that are guaranteed to converge to a spatial equilibrium in any given period. Another advantage is that the data requirements are not overwhelming. We discretize the world into 64,800 cells of 1° by 1°.[3] Values of structural parameters are partly taken from the literature and partly estimated using a variety of data. Again, we refer the reader to our original paper for a full description of the quantification of the model.

For the year 2000, we use data on the geographic distribution of population and wages from G-Econ 4.0 and on bilateral transport costs to recover local

[3]At the equator, 1° by 1° corresponds to 111 kilometers (km) (latitude) by 111 km (longitude). At the 45th parallel north or south of the equator, this corresponds to 111 km (latitude) by 79 km (longitude).

productivity measures and local measures of the ratio of amenities to utility.[4] In a world with perfect mobility, having information on the initial distribution of population and wages would be enough to recover local amenities. For example, if you had a low-productivity place with a high population density despite everyone being free to move, we would conclude the location has good amenities. Of course, in a world with mobility restrictions, such a low-productivity, high-density location might also be a place that is hard to leave. This explains why the procedure we have described so far only identifies the ratio of amenities to utility.

To separate amenities from utility, we use data on subjective well-being from the Gallup World Poll. Subjective well-being is measured on a scale from 0 to 10, where 0 represents the worst possible life and 10 the best possible life an individual can imagine for himself. Deaton and Stone (2013) have found a relationship between subjective well-being and the log of real income which is very similar across countries and across states within the United States. We use this relationship to transform subjective well-being into a cardinal measure of utility. Together with the amenity-to-utility ratios identified above, this allows us to determine the actual level of amenities for each cell of the world.

The one piece of information we still need before we can simulate the model forward is migration costs. With initial technology, amenities, and utility, we use the evolution of population between 2000 and 2005 to get estimates of the cost of moving in and out of each location. We then identify mobility costs between two locations as the product of an origin- and a destination-specific cost. The idea of using population counts in two periods to estimate moving costs is easy to understand. If a high-utility location experiences an increase in productivity due to innovation but only a small increase in population, it must be a hard place to move to. In contrast, if a low-utility location experiences only a small decrease in population, it must be a difficult place to leave.

Once we have estimates for all the parameters, migration costs, and trade costs—as well as for the initial distributions of population, technology, utility, and amenities—we can simulate the model forward. We update the spatial distribution of technology in every period and then solve by iteration for the spatial distributions of population and utility that are consistent with existing migration costs. This allows us to analyze how the world's economic geography changes over time.

When keeping migration costs unchanged, we find that in the very long term, the world experiences a productivity reversal, with some of today's poor, high-density areas in sub-Saharan Africa, South Asia, and East Asia becoming tomorrow's productivity leaders. The driving force behind this reversal is the increasing correlation between population density and productivity. That correlation

[4]As in Allen and Arkolakis (2014), bilateral trade costs between two locations are computed by assigning a cost of crossing each of the 64,800 cells and then using an algorithm to calculate the least-cost route between any two cells.

goes from being negative at –0.4 today (both in the model and in the data) to becoming positive at around 0.6 in the balanced growth path. The driving force for this change is the agglomeration economies that make high-density locations innovate more. When keeping migration restrictions unchanged, today's poor, high-density regions in Africa and Asia retain their high populations in the future and eventually become the world's productivity leaders. These are, of course, not short-term predictions; rather, these effects are expected to play out over centuries.

In contrast, in a world with free mobility, no such productivity reversals occur. If they were free to move, many people living in poor, high-density areas would migrate to today's high-productivity locations in North America and Europe or to high-amenity places on the coast of Brazil. Although this would impose a short-term cost on these regions, by accepting migrants they could ensure their long-term technological leadership. More importantly, in terms of the present discounted value of real per capita income, free mobility leads to a world gain of 125.8%. When taking into account amenities, the gain in welfare rises to 305.9%.

External validity of the model. The usefulness of this model in predicting the future and conducting policy analysis depends on both the theoretical choices made in its design and the parameters we use. To externally validate the model, we followed a three-pronged approach in Desmet, Nagy, and Rossi-Hansberg (2016). First, we took data from 2000 and instead of running the model forward, we ran the model backward until 1870 to compare the predictions on the distribution of population with the data. This exercise should be understood as an overidentification check of the model since we did not use past population data in the quantification. The correlations between country-level population in the data and in the model are larger than 0.96 going back until 1950 and still stand at 0.68 in 1870. The correlations between growth rates are lower, but are still quite high. For example, the correlation between the population growth rate in the model and the data between 1950 and 2000 is 0.74.

Second, recall that in the simulation of the model we do not use direct measures of amenities. Instead, the entire structure of the model, together with our use of subjective well-being as a way of measuring utility, identifies a location's level of amenities. As an additional overidentification check, we compared the amenities (as estimated by the model) to commonly used measures of amenities such as temperature, precipitation, and proximity to water. When doing so, we generally found highly significant correlations with the correct sign. For example, our estimates of amenities are positively correlated with proximity to water and with warm, stable temperatures.

Third, one of the key predictions of our model is that the correlation between density and productivity is greater in areas with higher levels of per capita income. We analyzed these correlations across zip codes in the United States and across cells in different areas of the world. The evidence is consistent with our model's predictions. In the year 2000, using 1° by 1° cells as our geographic unit of observation, the correlation was –0.11 in Africa, 0.33 in western Europe, and 0.5 in North America.

III. Asia over the Next Centuries

In this section, we analyze the model's predictions for the evolution of Asia over the next centuries, assuming there are no changes in spatial frictions. That is, we suppose that both migration costs and transport costs do not change over time. Nevertheless, because the world economy is not in its balanced growth path in the year 2000 (our initial period), the world economy and therefore Asia's economy evolves over time until it reaches a balanced growth path with constant growth and a stable distribution of population sometime around the year 2300. We use the exact same calibration as in Desmet, Nagy, and Rossi-Hansberg (2016).

We start by looking at the world in the year 2000. Focusing on Asia, the left-hand panel in Figure 1 displays productivity in different regions. As already mentioned, we use a resolution of 1° by 1°. As expected, Japan and the Republic of Korea show up as highly productive regions, as does the PRC's eastern seaboard and the largest cities in some of Asia's poorer countries (e.g., Delhi).

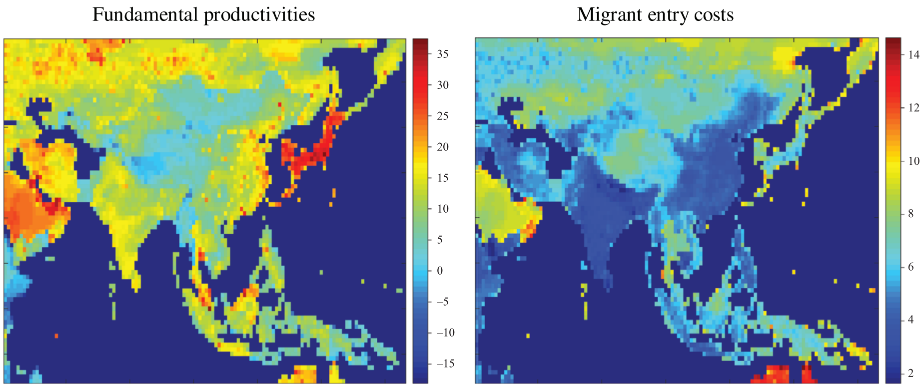
Since in the following sections we evaluate how spatial frictions will affect the future development of Asia, the right-hand panel of Figure 1 shows the migration costs of entering different areas. These estimates suggest that countries such as the PRC and India are easy to migrate to (or, equivalently, are costly to leave), while richer countries such as Japan and the Republic of Korea are hard to migrate to (or, equivalently, are easy to leave). Northern Siberia, Mongolia, and Tibet appear as places that are hard to migrate to, likely reflecting the difficulty for immigrants to acclimatize to the high altitude of Tibet and the harsh climates of Siberia and Mongolia. Although a challenging climate negatively affects amenities, the effect is greater for immigrants than for the local population; this difference manifests itself as a region being costly to move to.[5]

Figure 2 shows the evolution of GDP per capita and utility in Asia and the world (including Asia) over the next 600 years.[6] The top two panels display growth rates and the bottom two display average levels. Asia's per capita real GDP growth is faster than the world's, especially in the first 150 years, but it slows down over time

[5] We are likely overstating the cost of migrating to regions such as Siberia given that our measure of subjective well-being is national, not local, and so the lack of migration flows to these regions might partly be the result of lower amenities than the ones we estimate (for example, due to undesirable temperatures and weather). This distinction is, however, of limited importance for this exercise: whether because of high migration costs or because of a lack of amenities, few people decide to live in the northern part of the Russian Federation.

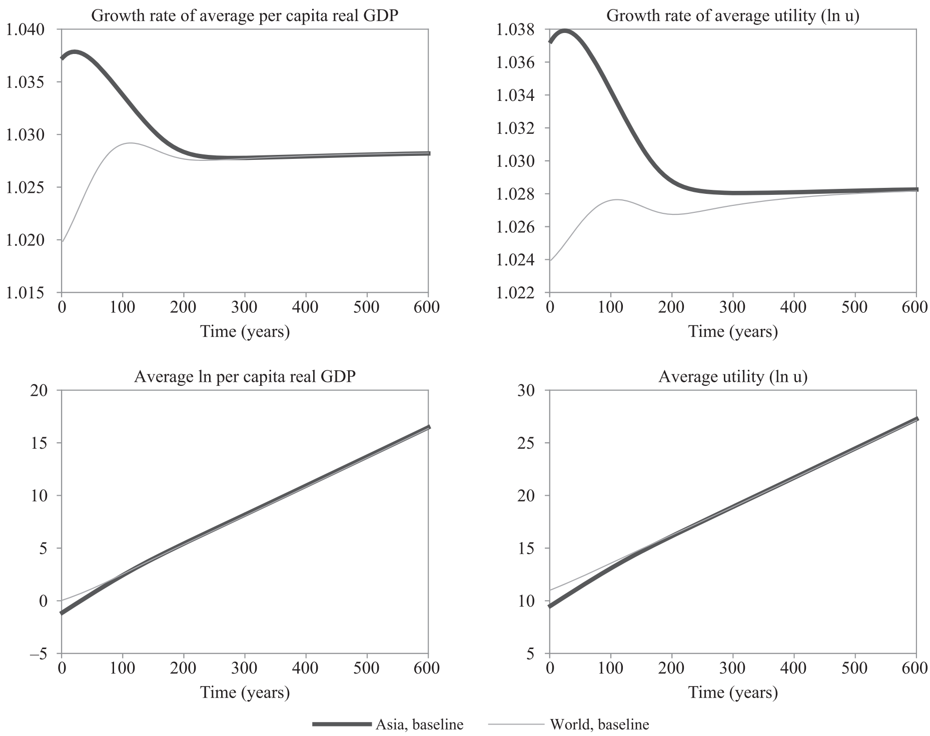
[6] Developing Asia includes the following regions and economies: Central Asia (Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyz Republic, Tajikistan, Turkmenistan, Uzbekistan); East Asia (Hong Kong, China; Republic of Korea; Mongolia; People's Republic of China; Taipei,China); South Asia (Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, Sri Lanka); and Southeast Asia (Brunei Darussalam, Cambodia, Indonesia, Lao People's Democratic Republic, Malaysia, Myanmar, Philippines, Singapore, Thailand, Viet Nam). It also includes Pacific Islands such as the Federated States of Micronesia.

Figure 1. **Productivity and Migrant Entry Costs in 2000**



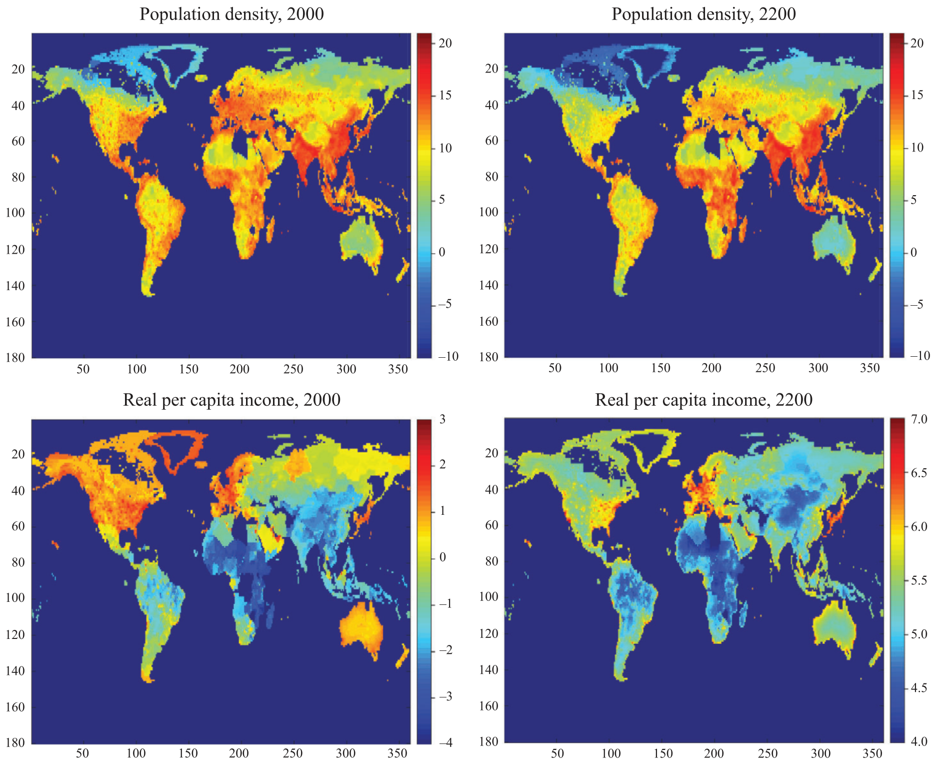
Source: Authors' calculations.

Figure 2. **Growth in Asia versus the World**



GDP = gross domestic product.
Source: Authors' calculations.

Figure 3. **Benchmark Calibration, 2000 and 2200**

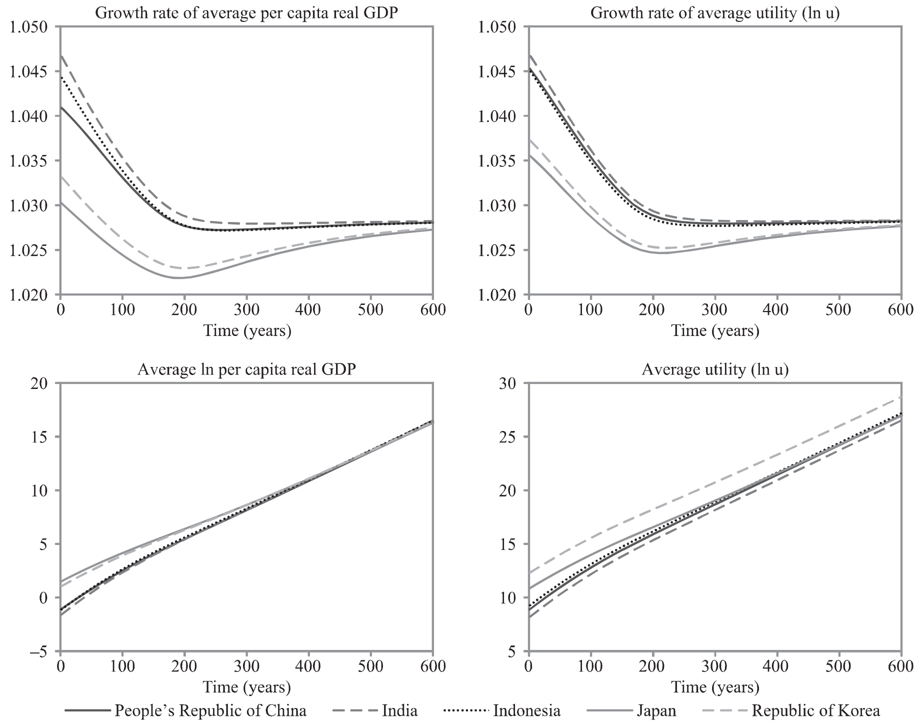


Source: Authors' calculations.

and converges to the world's per capita real GDP growth rate by 2200. The faster growth is due to Asia's higher population density, which over time increases market size and the incentives for local innovation. This attracts more people to Asia, leading to a dynamic agglomeration effect: a virtuous circle between density and growth. However, increasing density also means more congestion, which eventually puts a break on growth. Compared to real per capita income, it takes longer for Asia's growth in utility to converge to the world's. By the year 2100, Asia's GDP per capita and utility levels are already very similar to the world's. In the very long term, Asia slightly outperforms the world as a whole: by the year 2600, Asia's real GDP per capita and utility levels are predicted to be 111% and 110% of the world average.

Figure 3 shows a world map of the evolution of population density and real per capita income between 2000 and 2200. Today's high-density locations in South and East Asia further increase their population densities over the next 200 years. Their real per capita income relative to that of North America, and to a lesser extent relative to Europe, increases. In contrast, some of the medium-density places in Japan experience population decline. As explained above, the model predicts that

Figure 4. **Benchmark Calibration—Levels and Growth Rates in Individual Countries**



GDP = gross domestic product.
Source: Authors' calculations.

the correlation between population density and per capita income becomes stronger over time. Many of today's high-density locations have low per capita incomes; but because higher density implies more innovation, these high-density locations eventually improve their productivity, and hence their income levels. This explains, for example, why India's real per capita income improves relative to that of North America.

When comparing the growth rates of real per capita income of individual countries, Figure 4 shows how Indonesia and India grow faster than the PRC, though over time their growth rates converge. As can be seen in Table 1, Indonesia is predicted to overtake the PRC before the year 2200, while India's per capita income converges to the PRC's. In 2600, India and Indonesia will have become the richest of the large countries in Asia, surpassing both the PRC and Japan. The Republic of Korea is also poised to overtake Japan, although it falls behind some of the other major Asian countries. Starting as a medium-density country in 2000, Japan experiences relatively slow productivity growth, leading to future population loss and slower long-term growth.

Table 1. **Real Income per Capita and Welfare (World = 100)**

	2000		2200		2600		PDV	
World = 100	**GDP pc**	**Welfare**	**GDP pc**	**Welfare**	**GDP pc**	**Welfare**	**GDP pc**	**Welfare**
Developing Asia	31	22	109	90	111	110	78	57
PRC	32	12	112	71	99	84	81	42
India	19	6	109	41	116	53	70	23
Indonesia	30	17	131	93	114	104	91	56
Republic of Korea	268	361	259	721	101	477	321	604
Japan	426	85	287	138	93	83	426	126

GDP pc = gross domestic product per capita, PDV = present discounted value, PRC = People's Republic of China.
Note: PDV is based on the years 2000–2600 with a discount factor of 3.5%.
Source: Authors' calculations.

Why is it that in the very long term India is predicted to become Asia's leader, surpassing the PRC? One reason is the country's higher population density. Another is India's better connectivity, as the western PRC suffers from being landlocked. These predictions are, of course, for the very long term. In present discounted value terms, Japan is still by far the richest country in Asia, followed by the Republic of Korea and (much farther behind) by Indonesia and the PRC.

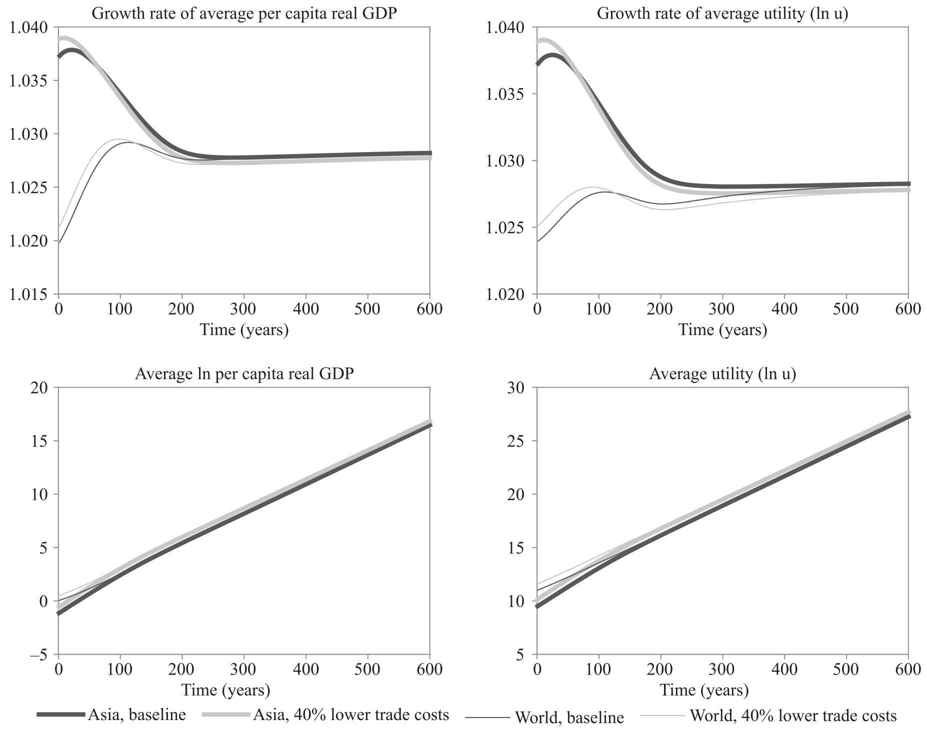
In terms of welfare, the picture looks quite different. Recall that any difference between real per capita income and utility comes from amenities. Table 1 shows that both in 2000 and in the very long term, the Republic of Korea is the country with the highest welfare. Although it loses positions in terms of per capita income, its attractive amenities and relatively low congestion ensure that the country sustains a high level of utility.[7] In spite of becoming Asia's richest country in the very long term, India's welfare improves only marginally during the period of investigation because of a combination of high density and poor amenities. High population density is a double-edged sword: on one hand, it incentivizes innovation and growth, but on the other hand, it causes congestion, lowering the utility that residents derive from already-poor amenities.

IV. Reducing Trade Costs

This paper aims to study the role of spatial frictions in shaping the world's development, with a focus on Asia. In this section, we analyze how a drop in transport (or trade) costs changes the spatial evolution of the world economy in general and of Asia in particular. To that end, we evaluate the effects of three different changes: (i) a worldwide reduction in transport costs by 40%, (ii) a reduction in transport costs by 40% that is limited to Asia, and (iii) a policy that upgrades all minor roads to major roads in Asia.

[7]Subjective well-being is substantially higher in the Republic of Korea than in Japan. This translates into a large utility difference between the two countries. Given that real income is not higher in the Republic of Korea, the model interprets this difference as reflecting better exogenous amenities.

Figure 5. **Lowering Worldwide Trade Costs by 40%**



GDP = gross domestic product.
Source: Authors' calculations.

We start by analyzing the impact of a 40% drop in transport costs across the globe. The top left-hand panel of Figure 5 displays the growth rates of real GDP per capita in Asia and the world, comparing the baseline to the case of lower transport costs. In Asia, lower transport costs increase growth in the short term, but slightly decrease growth in the medium and the long term. In the world as a whole, the result is similar. There are several forces at work. Lower transport costs have a direct positive effect because fewer resources are devoted to transport and firms and consumers gain greater market access. This causes a positive level effect at impact that is noticeable in the bottom left-hand panel of Figure 5. However, lower transport costs also change the spatial distribution of economic activity, hence affecting productivity and innovation. Locations that become more dense will gain, while those that become less dense will lose. How exactly these different forces play out over time and space determines the evolution of growth rates in Asia and the world.

When looking at the level of real per capita income in the bottom left-hand panel of Figure 5, the overall effect is clearly positive. In fact, a decline in transport

Table 2. **Increase in Real per Capita Income and Welfare under Different Counterfactuals**

Increase in PDV of real GDP per capita compared to baseline	**World**	**Asia**	**PRC**	**India**	**Indonesia**	**Republic of Korea**	**Japan**
1. 40% lower trade costs in the world	70.7%	78.0%	79.1%	81.9%	78.1%	65.1%	61.3%
2. 40% lower trade costs in Asia	38.5%	73.8%	74.7%	77.3%	72.9%	57.2%	−0.5%
3. Upgrade minor roads to major roads in Asia	2.8%	7.2%	10.3%	3.5%	6.0%	4.9%	0.0%
4. 25% lower migration costs in the world	30.6%	9.0%	3.9%	6.9%	4.6%	−0.7%	−1.3%
5. 25% lower migration costs in Asia	−12.9%	−3.7%	−8.3%	−6.2%	−7.9%	−11.0%	2.5%

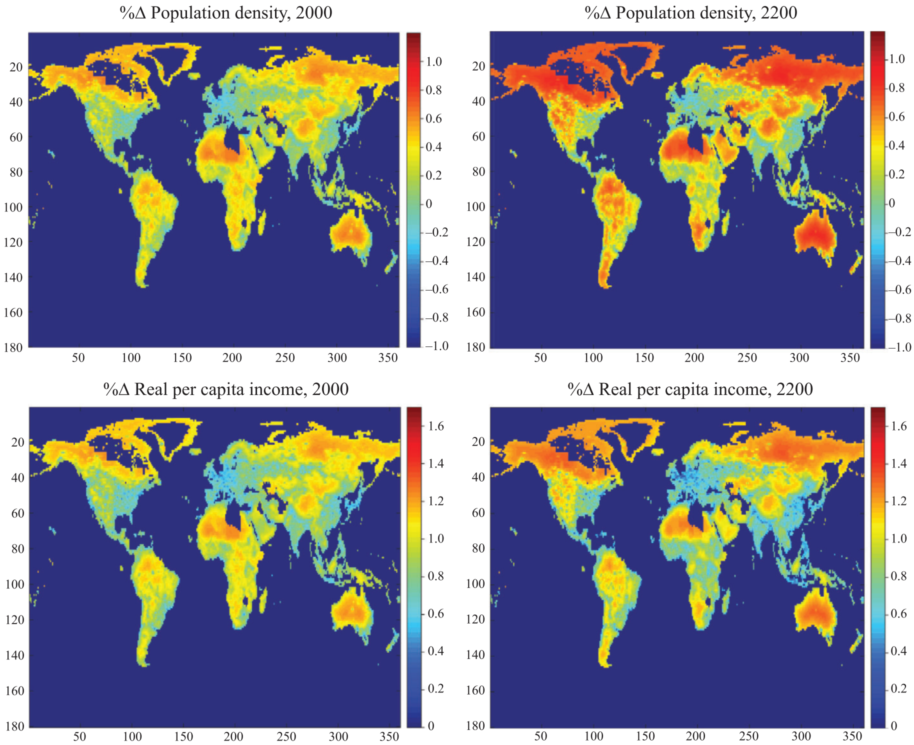
GDP = gross domestic product, PDV = present discounted value, PRC = People's Republic of China.
Note: PDV is based on the years 2000–2600 with a discount factor of 3.5%.
Source: Authors' calculations.

costs by 40% increases the present discounted value of the world's real GDP per capita by 70.7%. The gain in Asia is even larger: real GDP per capita increases 78% in present discounted value terms. These gains are much larger than those found in standard quantitative international trade models. For example, Costinot and Rodríguez-Clare (2014) estimate that eliminating a worldwide tariff of 40% would increase welfare by just around 3%.[8] Two reasons explain the greater gains we find. First, the reduction in transport costs affects both international and domestic trade. In countries that comprise large land masses—such as Australia, India, and the Russian Federation—this additional effect is substantial. Second, the reduction in trade costs not only has static effects, it also has dynamic effects on market size and agglomeration. Giving firms easier market access increases their incentive to innovate. In addition, regions that gain density will innovate more, though there will of course be other regions that lose density and hence innovate less. Given that in equilibrium, and due to the replicability and diffusion of technology, the level of local innovation is always suboptimal, this redistribution in general leads to dynamic gains. Furthermore, the gain from a worldwide drop in transport costs is greater in Asia than in the world as a whole. One reason is that Asia starts with relatively poor transport infrastructure, therefore a 40% improvement would have a big effect. Similarly, Table 2 reports that among the largest countries in developing Asia the one that gains the most is India, the country with arguably the region's worst transport infrastructure, and the one that gains the least is the Republic of Korea, the country with arguably the best transport infrastructure.

Figure 6 shows how a worldwide drop in trade costs by 40% affects the changes in population density and real per capita income across the globe. Not

[8]In another exercise that assesses the welfare gains of removing all international trade frictions, they find effects between 4% and 40%, depending on the particular model used and whether tariffs are reduced and rebated or

Figure 6. **Reducing Worldwide Trade Costs by 40%, 2000 and 2200**



Source: Authors' calculations.

surprisingly, lower trade costs increase population density in some of the world's landlocked areas such as Central Asia and the interior of Australia. At a more local level, we see that population density in the hinterlands of large cities such as Delhi and Bangkok declines, but the densities of large cities themselves do not. When transport costs are lower, proximity to large cities buys less in terms of market access, though large cities continue to benefit from local agglomeration economies. As a result, exurbs decline, while cities themselves thrive. Not surprisingly, the same areas that gain in terms of population density are also the ones that gain in terms of real per capita income. In general, the interior of countries gain per capita income relative to the coasts. This effect is especially apparent in those areas that experience large increases in population density.

We now assess the effect of reducing trade costs by 40% only in Asia.[9] The results are displayed in Figures 7 and 8. Of course, many of the results are similar

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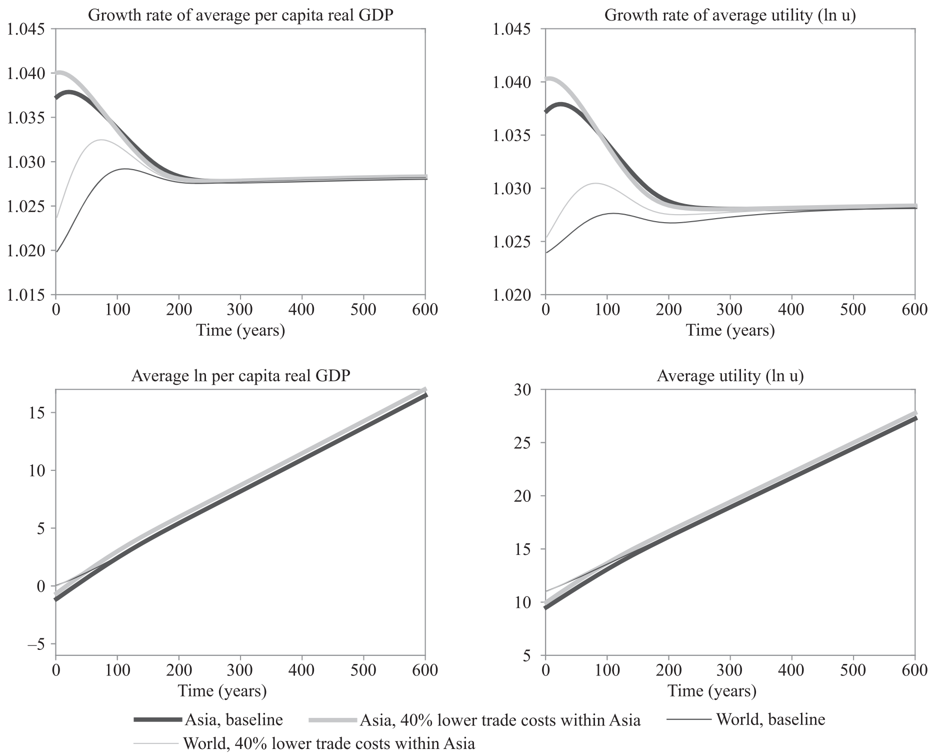
actual physical costs are reduced. Independently, all these numbers are substantially lower than the ones we calculate in this exercise.

[9]We do so by reducing the cost of trading between any two cells belonging to developing Asia by 40%.

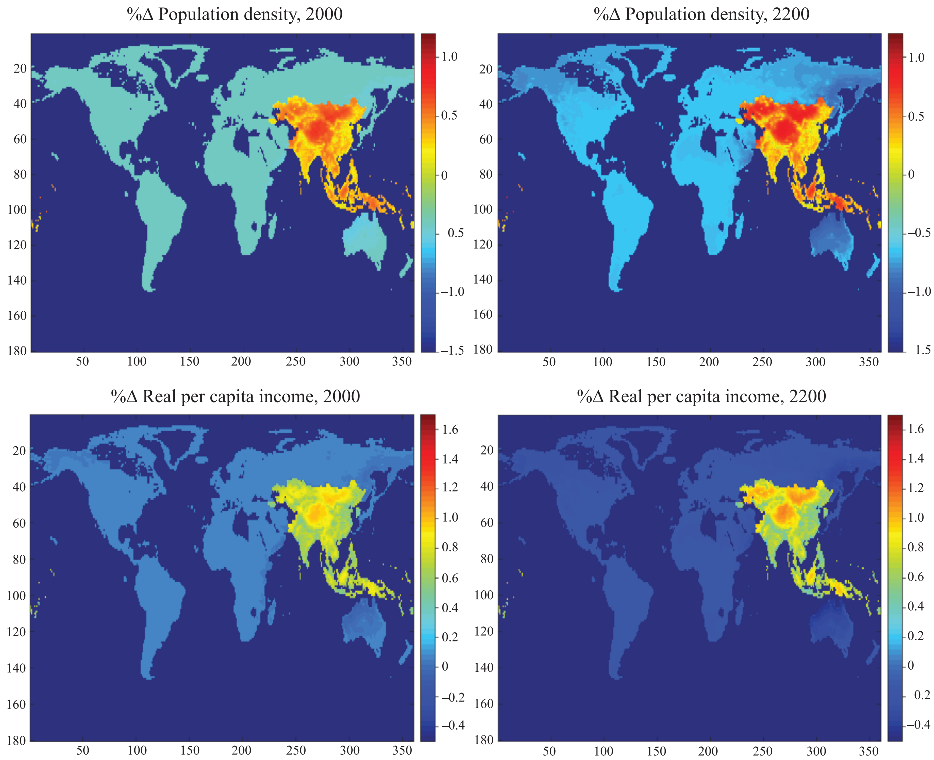
Figure 7. **Lowering Asia's Trade Costs by 40%**



GDP = gross domestic product.
Source: Authors' calculations.

to those we found when evaluating a worldwide drop in transport costs. Asia's coastal regions lose relative to the interior regions, while overall there are substantial gains from lowering transport costs: world real per capita income increases 38.5% compared with a gain in Asia of 73.8%. Among the countries of developing Asia, Table 2 shows India gaining the most and the Republic of Korea gaining the least. But there are also notable differences when compared to a global drop in transport costs. The long-term growth effects, both in Asia and in the rest of the world, are now positive. Lowering trade costs in Asia attracts more people to Asia, compared to a worldwide drop in trade costs. This has the advantage of increasing population density in areas that already had high density, leading to greater long-term growth in Asia. This positive effect extends to the world as a whole. One reason is that Asia is physically large and expands its share of the world economy over time. Another is that technology diffusion from fast-growing regions eventually benefits everyone. An exception is Japan, where real per capita income drops 0.5% in present

Figure 8. **Reducing Asia's Trade Costs by 40%, 2000 and 2200**



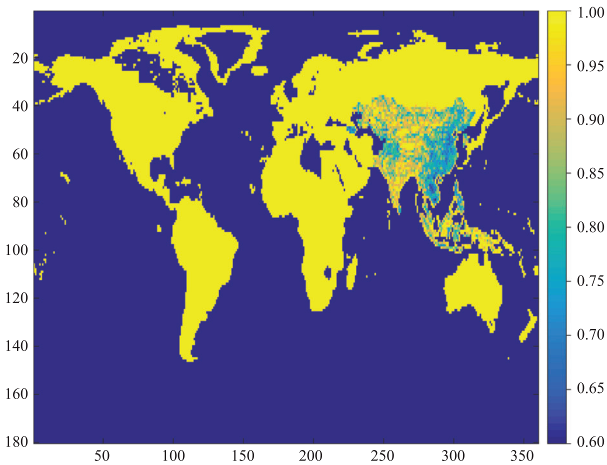
Source: Authors' calculations.

discounted value terms. Since Japan is not part of developing Asia, it does not experience a direct benefit from reduced transport costs in developing Asia. Instead, it loses population and initially has little to gain from higher productivity in the rest of Asia.

A reduction in transport costs by 40% could be due to several reasons, including trade liberalization, improvements in transport technologies, reductions in gas prices, or improvements in road infrastructure. When focusing on infrastructure, improving transport equally across all locations may not be the most natural or efficient policy. It is easy to use our framework to estimate the impact of more focused alternative policies, such as upgrading all minor roads in Asia to major roads. Figure 9 displays the decline in transport costs across Asia given the upgrading of existing roads. Areas with a dense network of minor roads—such as the eastern PRC (excluding the seaboard itself) and some of the interior regions of Cambodia, Pakistan, and Thailand—gain the most.

Figure 10 shows that, not surprisingly, these are also the regions that gain in terms of population density and real per capita income. The overall increase in

Figure 9. **Upgrading Minor Roads to Major Roads in Asia**
(Transport costs after upgrading relative to before upgrading)



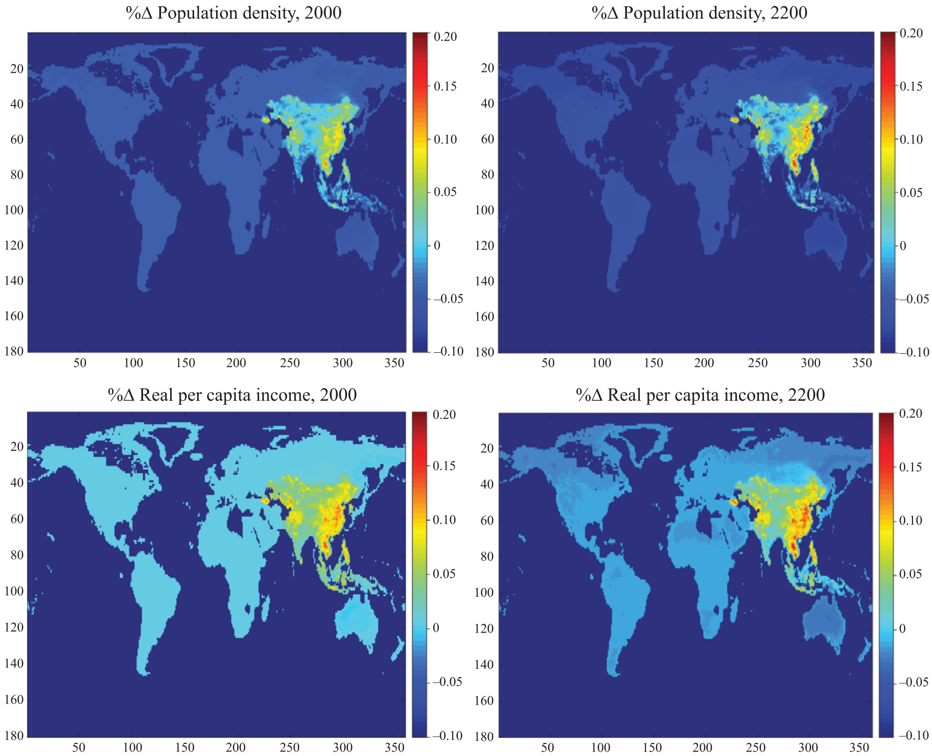
Source: Authors' calculations.

world real GDP per capita is 2.8% in present discounted value terms; this number rises to 7.2% in the case of Asia. Although we have no direct estimate of the cost of upgrading roads, this investment is likely to be more profitable than an across-the-board uniform improvement in transport infrastructure. One of the key differences with a uniform improvement is that many of the regions that benefit are already in close proximity to developed areas. This is the case with the parts of the PRC located near its eastern seaboard. In contrast, the western PRC benefits less from the improvement of minor roads, but this is an area where the cost–benefit analysis of infrastructure investment is likely to be less favorable anyway. Of course, some areas exhibit small or even negative gains, even though there might be large returns to infrastructure investment. One possible example is the interior of India, where the absence of gains may simply reflect the absence of minor roads. What is needed in this case is new roads, rather than upgrading existing roads.

V. Liberalizing Migration Costs

In addition to transport costs, restrictions on the free movement of people represent another key spatial friction. In this section, we analyze how lowering migratory restrictions changes the spatial evolution of Asia's economy and the world economy. We start by analyzing the effects of a worldwide reduction in mobility restrictions by 25%. This reduction implies that 21% of the total population

Figure 10. **Upgrading Minor Roads to Major Roads in Asia, 2000 and 2200**



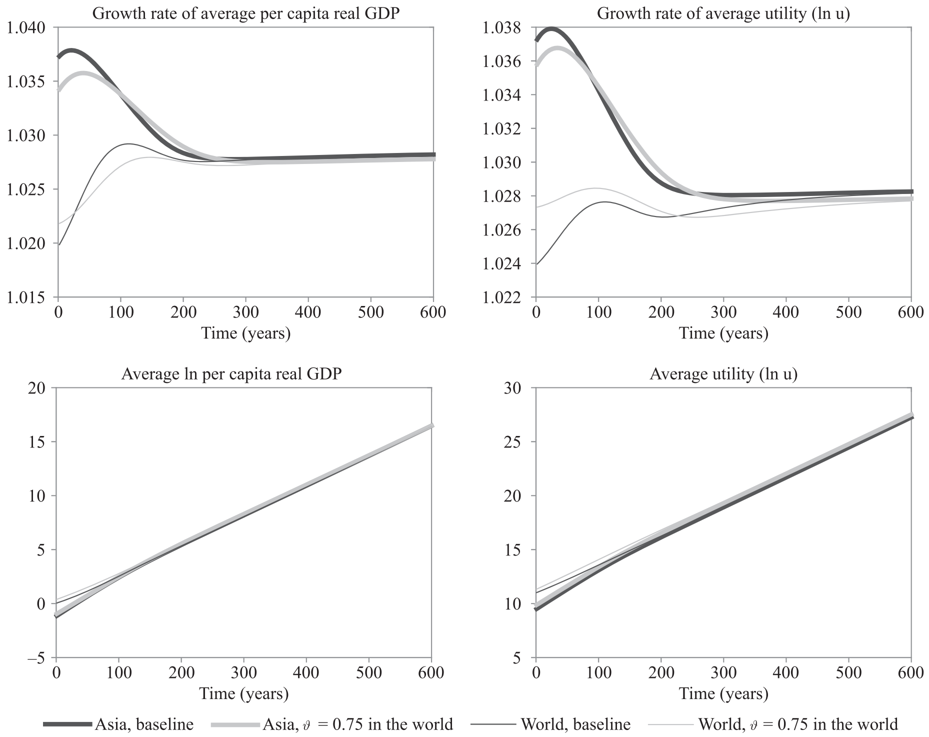
Source: Authors' calculations.

migrates in the year 2000 when the policy is first implemented.[10] Figure 11 reports the effect on real per capita income and on utility in Asia and the world. Figure 12 shows maps that display the changes in population density and real per capita income across the world's geography.

When lowering worldwide migration restrictions, we find that in Asia the growth of per capita income is slower in the first 100 years, faster in the next 200 years, and slower again in the very long term. In contrast, growth in per capita income in the world as a whole is faster in the first 50 years and then slower over the remainder of the period of investigation. This positive short-term effect is more drawn out when focusing on utility: the world growth rate is higher during the first 200 years, reflecting the additional positive effects of people moving to high-amenity places.

[10]When discussing the influx of migrants, adaptation costs might also be considered. In as far as those adaptation costs are borne by migrants, they are implicitly included in migratory barriers. This, of course, implies that completely eliminating migration costs may be impossible.

Figure 11. **Lowering Worldwide Migration Restrictions by 25%**

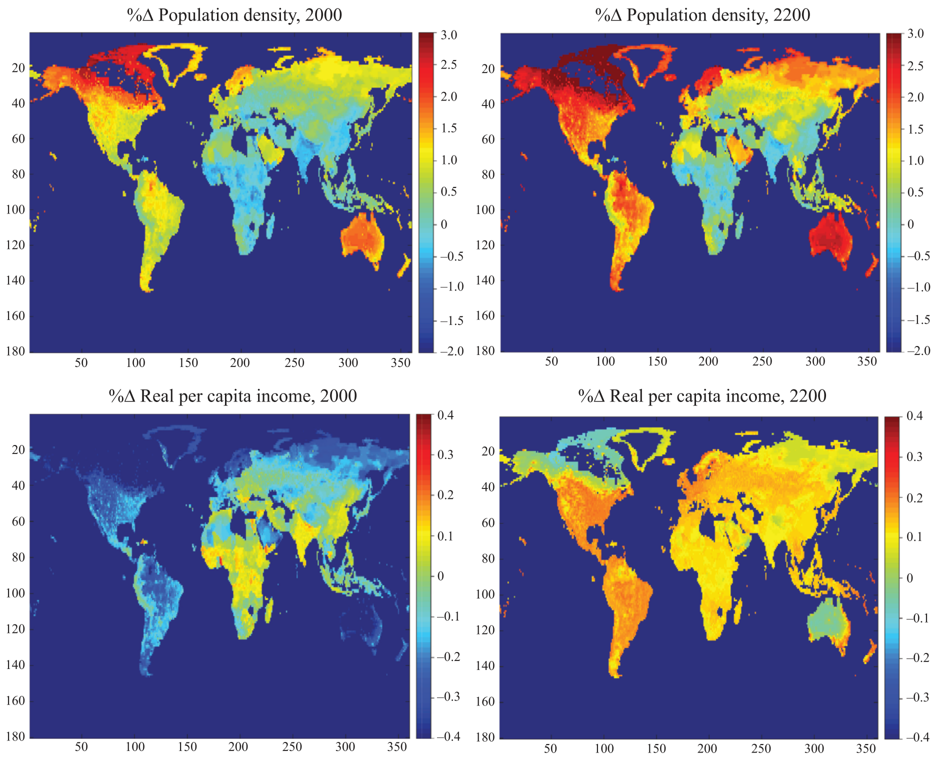


GDP = gross domestic product.
Source: Authors' calculations.

These complex dynamic effects are the outcome of the confluence of different forces. On one hand, reduced migratory frictions allow people to move to high-productivity or high-amenity locations. This may enhance innovation in locations that are already highly productive. On the other hand, as can be seen in Figure 12, some of this spatial reallocation may lower the overall geographic concentration of economic activity. Population density increases in Australia, northern Canada, and Scandinavia, while it decreases in India and most of the PRC. This lower degree of spatial concentration dampens innovation. In Asia, which loses population in the short term, this negative effect dominates initially.

Since these different forces pull in opposite directions, it is important to evaluate the overall effect in present discounted value terms. Lowering worldwide migration costs by 25% increases the present discounted value of the world's real GDP per capita by 30.6%. The gain in Asia is only one-third as large at 9%. While Asia's gain was greater than the world's in the case of reducing transport costs, here we find the opposite. Greater mobility lowers Asia's population density. This weakens local agglomeration economies and slows innovation, which explains

Figure 12. **Lowering Worldwide Migration Restrictions by 25%, 2000 and 2200**

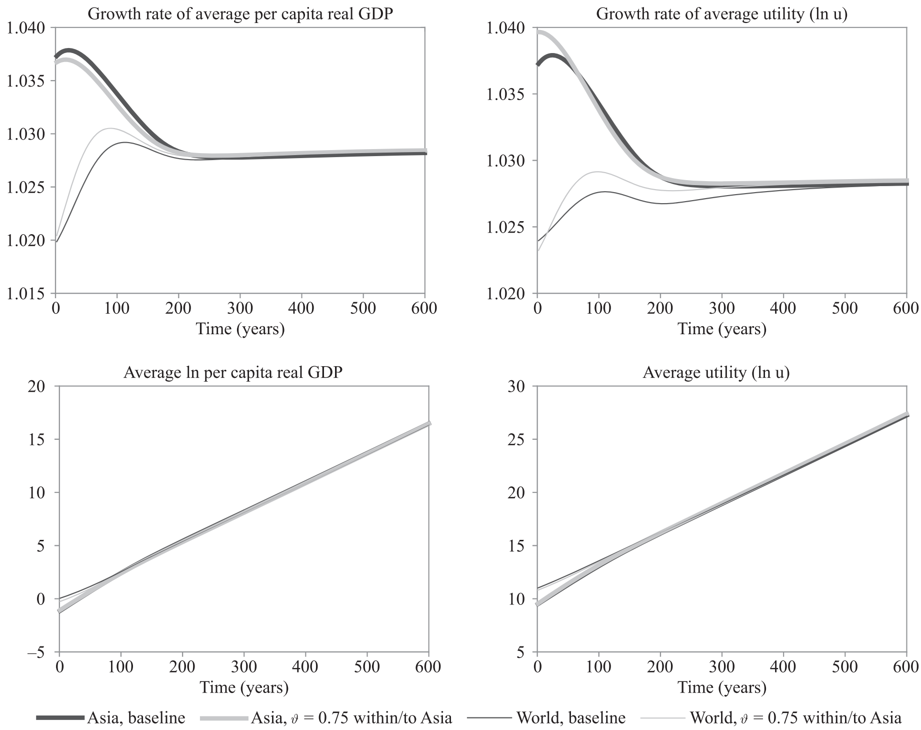


Source: Authors' calculations.

Asia's smaller gains. The overall effect is still positive though because some regions in Asia become more agglomerated and because productivity spillovers from the rest of the world ensure that Asia benefits from the world's increased growth.

We now look at the impact of lowering migratory restrictions by 25% only in Asia. The results are shown in Figures 13 and 14. Since this makes it easier to move to Asia, it has the effect of attracting more people to Asia. Given the positive link between density and innovation, we would expect higher population density to be good for Asia's GDP. However, growth declines and real per capita income drops by 3.7% in Asia in present discounted value terms. One reason is that the reduction in migratory restrictions not only makes it easier to enter Asia, it also facilitates migration within Asia, especially toward those regions that were costly to migrate to previously. As a result, the decline in mobility costs attracts people to places such as Central Asia, Mongolia, and Tibet. This may have the unintended consequence of hurting some of the highly innovative regions of Asia, thus lowering long-term growth. Another reason is that higher innovation in regions such as Mongolia and Tibet is slow to compensate for the initial drop in real per capita income due to their

Figure 13. **Lowering Asia's Migration Restrictions by 25%**



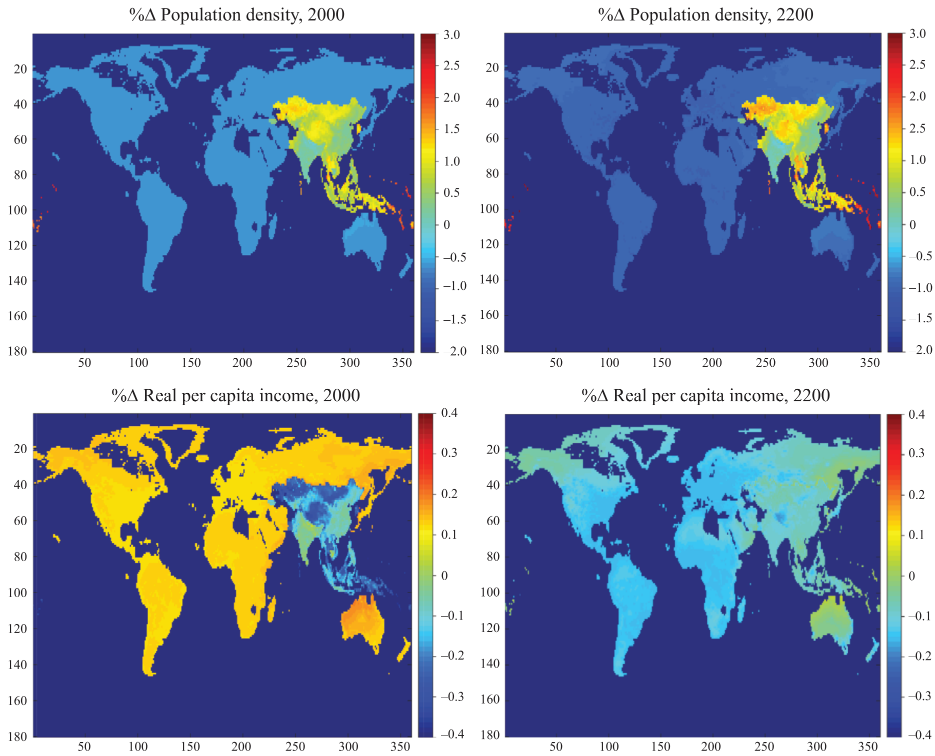
GDP = gross domestic product.
Source: Authors' calculations.

initial low levels of technology. As can be seen in Figure 14, even after 200 years, real per capita income is lower in Mongolia and Tibet relative to the benchmark. Overall, however, the population reallocation within Asia implies that agents prefer to locate in less congested areas, compensating for the negative effect on GDP. As a result, welfare in Asia increases by 7.9%.

The effect on global real GDP of reducing migratory restrictions in Asia is also negative: the world's real per capita income drops by 12.9%. Figure 13 shows that world growth increases, however.[11] The overall negative effect on real income is the result of a negative level effect at impact. The reallocation of people toward Asia has the immediate effect of lowering average market access. World welfare also drops. This example illustrates that regional liberalization may introduce distortions and lead to local welfare gains but aggregate welfare losses.

[11]The world growth rate initially increases because Asia makes up a larger share of the world economy and its growth rate is larger than that of the rest of the world.

Figure 14. **Lowering Asia's Migration Restrictions by 25%, 2000 and 2200**



Source: Authors' calculations.

VI. Concluding Remarks

This paper has analyzed the spatial evolution of Asia over the next centuries, focusing on the role of spatial frictions in shaping Asia's future economic geography and development. Five results stand out. First, if spatial frictions remain unchanged, Asia's development stands to converge to the global average and eventually slightly overtake the rest of the world. Second, within Asia, India and Indonesia do particularly well in the very long term, with Japan falling behind. Third, reducing trade and transport costs could lead to huge gains in per capita income and welfare. This is especially true in Asia, where transport infrastructure is still poor. Isolated and landlocked locations improve the most, often at the expense of coastal areas. By taking into account dynamics and domestic trade costs, the gains are more than an order of magnitude larger than those found in static quantitative trade models. Fourth, lowering worldwide migration barriers also leads to important gains, but less so in Asia than in the rest of the world. Greater mobility reduces density in Asia, dampening long-term productivity gains. Fifth, unilaterally reducing migration barriers in Asia is likely to benefit the continent (although not in terms of output) and hurt the world. A multilateral transition to a world with fewer migration restrictions is more desirable.

Our results illustrate that spatial frictions have a potentially huge impact in shaping Asia's future economic geography. Not only do they affect where development happens, but they are also a key determinant of aggregate growth. This underscores the importance of understanding the role of physical space for both local and global development. Compared to more developed countries, which have well-established road and transport networks, Asia is at an earlier stage of development in which many of the big infrastructure investments still have to happen. Since differences in per capita income are on the rise in Asia, migration is also likely to become a more pressing concern. Having a spatial-dynamic quantitative framework that allows counterfactual policy analysis should prove useful to policy makers intent on shaping Asia's spatial development. While we have provided examples of the type of policy experiments that can be pursued, our framework is amenable to evaluating a variety of other, more specific, policy concerns in different countries.

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