Spatial Growth: Comparing India, China and the U.S.*

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1 Introduction

As economies grow and develop, their spatial distribution of economic activity changes dramatically. The most visible sign of this transformation is rapid urbanization. In recent decades the developing world has seen an explosion in the number of mega-cities, and this trend is bound to continue. By 2025 about 630 million people are predicted to live in cities of more than 10 million. China already has more than 150 urban areas with a population of over a million. Cities do not only become more important as countries grow and develop, their roles also change. During the early stages of development, cities often serve as manufacturing hubs. Later, as manufacturing matures, it moves to less congested areas, turning cities into service clusters.

Understanding how the spatial distribution of economic activity is likely to evolve is of keen interest to policy makers. According to a recent study by the United Nations (2009), more than 80% of governments are concerned about the geographic distribution of their countries' population. In the least developed economies, this figure is even higher, exceeding 95%. This is not surprising. When deciding on where to invest in infrastructure, policy makers need to have an idea of which locations are likely to grow faster and of how development will spread across space. Urban planners need to identify which cities of today will become the service centers of tomorrow. They also have to take a stand on whether their countries' mega-cities are becoming too large and whether to spur growth and investment in medium- or smaller-sized locations.

In this chapter we attempt to make some headway in identifying the spatial barriers to growth in India and China. We take two approaches to this. A first approach, based on the work by Desmet, Ghani, O'Connell and Rossi-Hansberg (2014), compares the spatial growth of

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India, China and the U.S., with a particular focus on the service industry. Existing studies on the geographic distribution of economic activity often limit their attention to manufacturing. However, cities across the globe are becoming increasingly specialized in services, so that zooming in on the service industry is of particular interest. By analyzing differences with the U.S., we hope to identify the particular barriers that may be hampering economic development.

In contrast to the U.S., where service employment growth is greatest in medium-density service clusters, we find that in India it is greatest in high-density service clusters. As for China, the spatial growth pattern of the service industry looks more similar to that of the United States. The slower relative growth of India's medium-density locations, compared to both the U.S. and China, suggests that India's medium-density are facing certain barriers to growth. Maybe medium-sized cities in India have poor infrastructure, a problem less prevalent in China. We present evidence in favor of this hypothesis. In particular, we find that limited access to telecommunications and a low share of highly educated workers puts a break on growth in medium-density locations. That is, if all Indian cities had equal access to telecommunications, the disadvantage of medium-density locations, relative to high-density locations, would disappear.

Although China resembles the U.S. in the sense of its medium-density clusters performing well, the differences in growth rates across space in China are an order of magnitude larger. One possible reason is that the geographic allocation of resources in China may not be efficient. The *hukou* system, which acts to keep some of the country's mega-cities from becoming even larger, certainly points to the existence of spatial inefficiencies. To explore this question in further detail, we take a second approach to identifying spatial barriers to growth. Based on Desmet and Rossi-Hansberg (2013), we quantitatively analyze not just how greater mobility would affect China's mega-cities, but maybe more important, whether well-being would increase or decrease under different policies. We are not only interested in the existence of mega-cities *per se*; we also want to understand whether there are any welfare gains from reducing the size of mega-cities and increasing that of intermediate-sized cities, or if on the contrary, we should focus on making mega-cities more liveable rather than slowing down their growth.

Our main finding is that China's largest cities face barriers to growth. Liberalizing migratory restrictions would provide an important boost to the growth of its mega-cities. In contrast to the commonly held view that many of the world's metropolises are already too large, our quantitative framework predicts that the further expansion of some of China's biggest cities would bring substantial welfare gains. This suggests that China stands much to gain from a more efficient spatial allocation of its resources.

The rest of the chapter is organized as follows. Section 2 compares the spatial growth patterns of the service industry in the U.S., India and China, and discusses the barriers to growth in India's medium-sized cities. Section 3 discusses barriers to growth in China's largest cities. Section 4 concludes.

2 Spatial Growth in the Service Industry

Before analyzing spatial growth patterns, it is important to understand why we might expect growth to differ across locations. Our starting point is the link between technological change and geographic clustering. Whenever a general technological breakthrough occurs, it takes time for firms and individuals to discover the different uses of the new technology. During that period of experimentation, firms benefit from proximity to others that are experimenting with the same technology. This is what Marshall (1920) referred to as localized knowledge spillovers. The idea is that learning often occurs through random and unorganized interaction, which is more likely to happen in geographically dense environments. Of course, once technologies or industries mature, such knowledge spillovers lose importance, as their main uses and applications become well understood by everyone.

As we argued in Desmet and Rossi-Hansberg (2009), we should therefore expect geographic clustering to be more important in sectors that benefit more from a given technological breakthrough. In addition to electricity, which made its big impact in the early decades of the 20th century, the other major technological breakthrough of the last one hundred years is information technology (IT). In contrast to electricity, which had its biggest effect on manufacturing, IT is disproportionately benefitting services. In a study of the U.S., Hobijn and Jovanovic (2001) find that IT intensity — the share of IT equipment in total equipment — was in 1996 about 25 percentage points higher in services than in manufacturing.

In light of these facts, in our earlier work we qualified services in the U.S. to be a "young" sector (as it is still discovering the benefits of IT) and manufacturing to be a "mature" sector (as it benefitted mainly from previous technological breakthroughs such as electricity). Consistent with this, in the last decades services have become more concentrated in space, in contrast to manufacturing, which has become geographically more dispersed. When we say that services have become more clustered, we have not said where that clustering is occurring. In addition, the finding of increasing concentration holds for the U.S. and Europe; it remains to be seen whether it also holds for other countries. In the next paragraphs, we will analyze where the spatial clustering of services is happening in the U.S., and we will compare it to that of India and China.

United States. To better understand which locations have benefitted the most from service growth, Figure 1 uses data of U.S. counties between 1980 and 2000 and plots the annual growth in service employment as a function of initial service employment density. Technically, the dark curve is based on a nonlinear kernel regression, and the lighter curve represent the 95% confidence intervals. The upward-sloping part of the curve shows that medium-density locations grew faster than low-density locations. This implies increasing geographic concentration, since those with more density grew more than those with less density. In contrast, for the high-density locations the curve becomes downward-sloping. This is evidence of congestion: these high-density locations are growing slower, implying geographic dispersion.

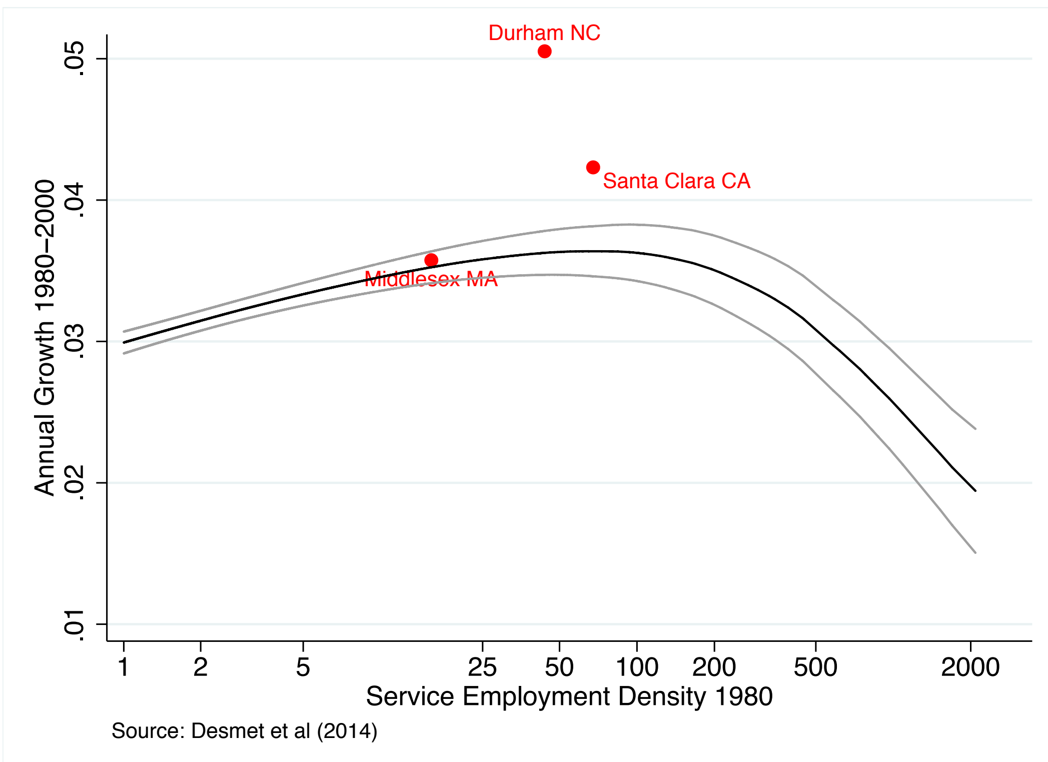

Figure 1: Services Employment Density: U.S. Counties, 1980-2000

Taken together, although services are becoming more concentrated, this increased clustering is not happening in very high-density places like New York, but in medium-density places, with an employment density in the range of 50 to 100 employees per square kilometer. This is the case of three of the most well known high-tech clusters, represented in Figure 1: Santa Clara, Calif. (Silicon Valley), Middlesex, Mass. (Route 128) and Durham, NC (Research Triangle). Congestion is too high in the high-density areas and knowledge spillovers too low in the low-density areas. This is what makes the medium-density locations the most attractive for growth. We next compare the U.S. situation to that in India and China to see if we uncover the same patterns.

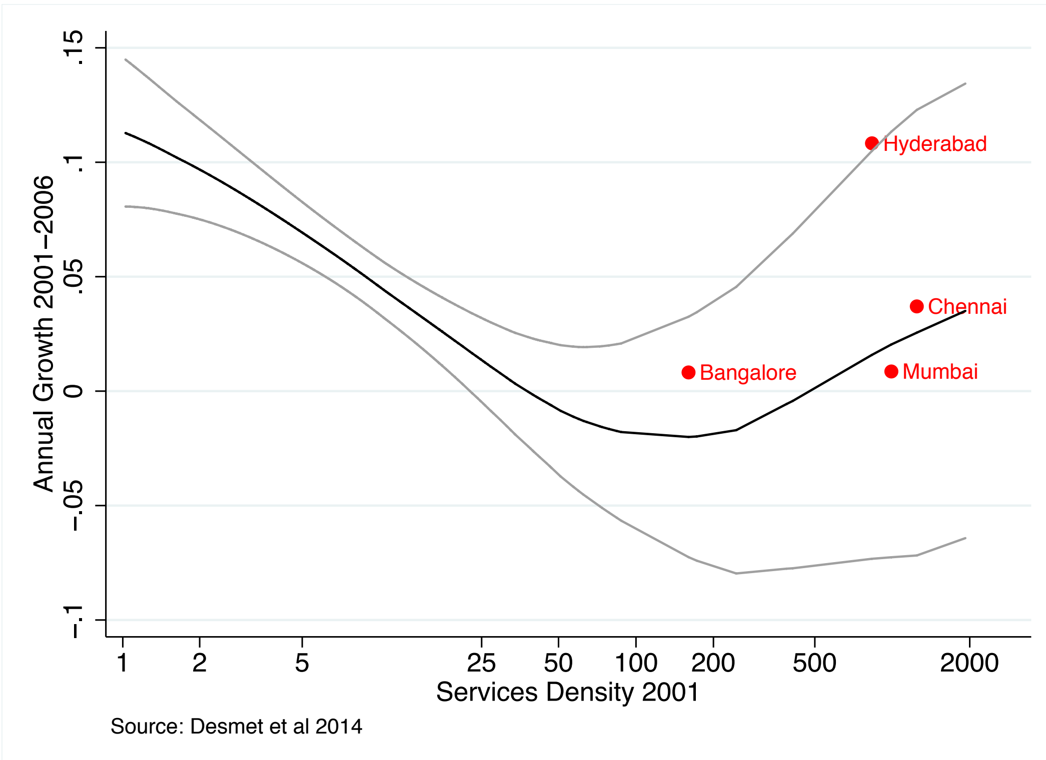

Figure 2: Services Employment Density: Indian Districts, 2001-2006

India. A similar exercise for India reveals very different patterns. Using district-level data from India for the period 2001-2006, Figure 2 plots annual services employment growth as a function of initial services employment density. Whereas in the U.S. growth is *maximized* in locations with a density between 50 and 100 employees per square kilometer, in India growth is *minimized* in the same type of locations. There is no evidence of congestion in India's highest-density locations, which continue to grow faster than their medium-density counterparts. This is consistent with the observation that many of India's high-tech clusters are located in the country's largest and densest areas. As shown in Figure 2, with the exception of Bangalore, many of India's high-tech hubs, such as Hyderabad and Chennai, are fast-growing, in spite of having densities of more than 1000 service workers per square kilometer.

Another difference between India and the U.S. becomes more obvious when we represent both countries on the same plot, as we do in Figure 3. The difference between the fastest-growing and the slowest-growing locations in India is more than 20 percentage points. This is huge compared to the United States, where the difference does not surpass 2 percentage points. This is not surprising: there is much evidence that spatial differences in, for example, productivity are much greater in developing countries than in developed countries. As India further develops and technology diffuses across space, we would expect differences in growth rates across locations to become smaller. The large difference between India and the U.S. may also be related to the important geographic reallocation of people in India as urbanization progresses.

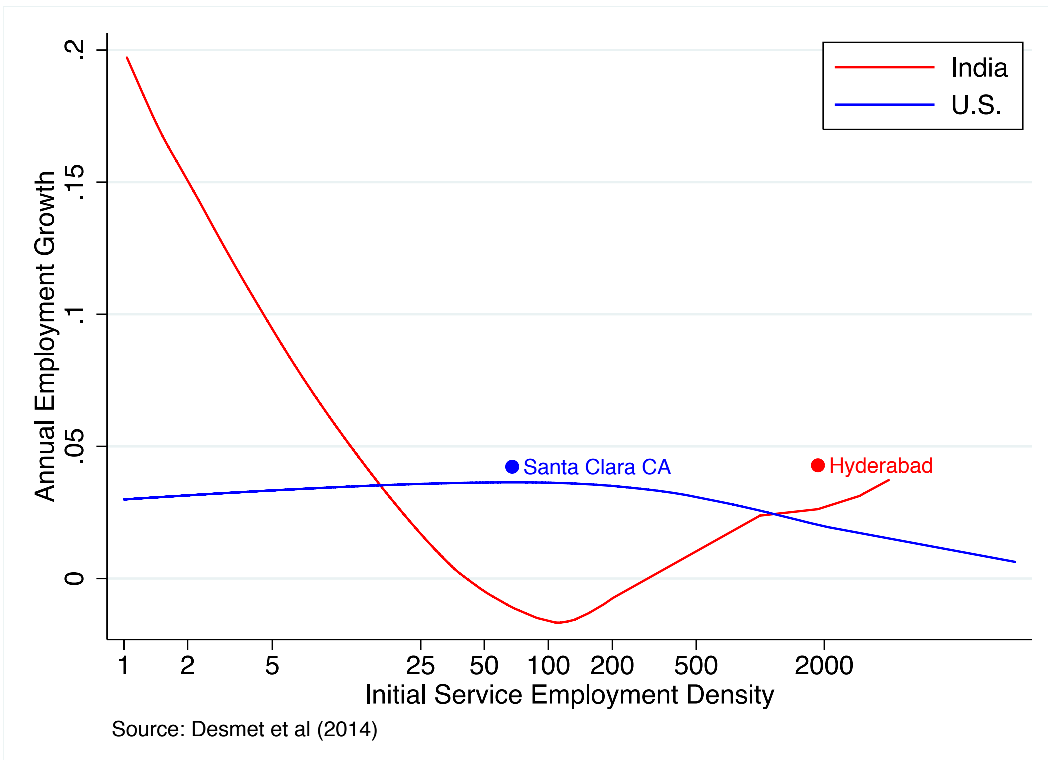

Figure 3: Services Employment Density: U.S. Counties and Indian Districts

China. We now turn to China to analyze whether the underperformance of medium-density locations is common to other fast-growing developing countries. Using data from Chinese prefecture-level cities for the period 2000-2007, Figure 4 displays the growth rate in service employment as a function of initial service employment density.[1] In contrast to India, service employment growth in China does not tend to occur in its densest clusters. Some of the country's largest cities, such as Shanghai, experience relatively low growth in the service industry. This is not the case of Beijing though, which has a fast-growing high-tech industry. The relevant difference with India is that some of China's medium-density service clusters are attracting high growth. Though less pronounced, this makes China more similar to the United States. Chengdu is a case in point: with a service employment density similar to that of Silicon Valley, it is becoming one of China's IT centers. It currently already produces one fifth of the world's computers.

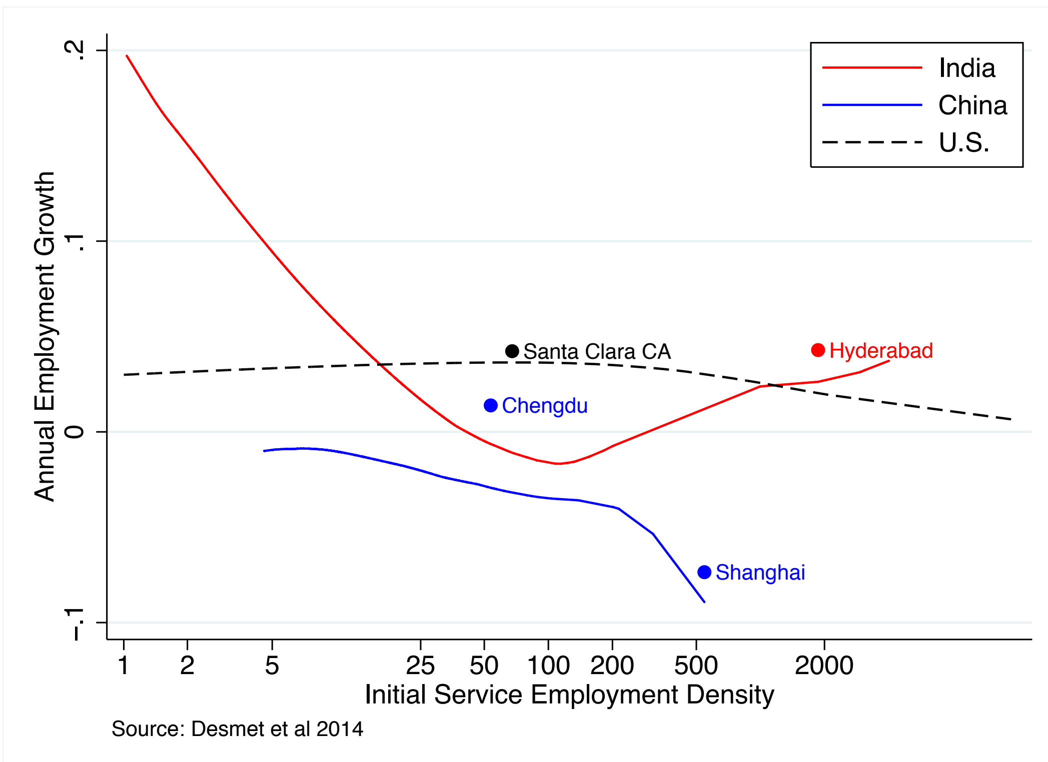

Figure 4: Services Employment Density: Chinese Prefecture-Level Cities and Indian Districts

There is one dimension though where China and India look similar to each other, and different from the U.S. The difference between fast-growing locations and slow-growing locations is around 10 percentage points, not quite as big as in the case of India, but much larger than in the U.S. Again, this likely reflects the still large productivity differences across space in China, and the magnitude of the country's rapid urbanization process which is still underway. It may also point

[1]Employment figures pertain to "staff and workers", also referred to as "formal employment", rather than total employment. This leads to underreporting. It also explains the overall drop in service employment.

to a certain degree of misallocation of resources across space in China.

Barriers to growth in India's medium-density cities. When comparing India to the U.S., the evidence suggests that India's medium-sized cities are facing barriers to growth. What might those frictions be that keep India's medium-density cities from growing faster? Maybe they suffer from poor infrastructure. Another problem could be a lack of highly-educated workers. Or they might be badly connected to the country's larger cities.

To identify what those barriers might be, Desmet et al. (2014) analyze what the growth patterns would look like if certain differences between cities were eliminated. To that purpose they run the same type of nonlinear regressions that generated Figure 1, but they now control for (i) the percentage of the population with a high school degree or more and the percentage of the population with post-secondary education; (ii) household access to infrastructure (percentage of households with electricity, percentage of households with toilet, percentage of households with telecommunication services, percentage of households with tap water); (iii) travel time to a top-10 city; and (iv) distance to a top-7 or a top-3 city.

Most of these potential barriers are unable to explain the apparent disadvantage of medium-sized cities. For example, being close or being far from a top-3 city has no effect on the desirability of these locations. The two exceptions are the percentage of the population with post-secondary education and the percentage of households with access to telecommunication services. If all districts had the same percentage of highly educated workers, then the relative unattractiveness of medium-density locations would disappear. The same is true if all districts had the same access to telecommunications. These results suggest that if India wants to unleash growth in its medium-density cities, it should improve its telecommunication services in these places. It should also make those cities more attractive for highly educated workers to move to, or alternatively, improve higher education in those locations.[2]

As discussed before, China does not seem to be experiencing the same barriers to growth in its medium-density cities. Given that China has been investing heavily in physical and educational infrastructure in the last decades, it is not surprising that it does not face the same growth frictions. In comparison, it is well known that India has been suffering from a chronic lack of infrastructure

[2] A word of caution is in order when expressing these policy recommendations: they are only valid if the empirical results in Desmet et al. (2014) can be interpreted as causal. More particularly, it is likely that the choice of residence and the quality of telecommunications are not orthogonal to the density of a location, in which case having more highly educated workers or having better internet access would not by themselves lead to more growth in medium-density locations.

investment.

3 Barriers to Growth in China's Largest Cities

Our basic finding so far is that medium-density places in India perform worse than their counterparts in the U.S., whereas the same is not true in China. Although this may tempt us to conclude that the spatial allocation of resources is efficient in China, the huge difference in growth rates between fast-growing and slow-growing locations in China seems to point in the other direction. Another indication of possible growth frictions is China's *hukou* system which restricts geographic mobility and puts a break on the growth of some of its mega-cities. Relaxing the *hukou* system would probably make China's largest cities even larger, a point made in work by Au and Henderson (2006a,b).

To analyze how liberalizing migration restrictions or other policy changes would affect Chinese cities, in Desmet and Rossi-Hansberg (2013) we developed a quantitative model of a system of cities. For each city, we estimated three characteristics: productivity, amenities and governance. A city's productivity refers to the efficiency with which firms are able to produce; a city's amenities refer to any characteristic that makes a city a more or less attractive place to reside; and a city's governance refers to how efficiently it provides urban infrastructure that deals with congestion. Not surprisingly, cities will be larger if they have higher productivity, more attractive amenities, or better governance. More importantly, this model can then be used to run counterfactual policy analysis to answer questions such as: How would the city size distribution change if spatial productivity differences fell? Would people become better off? And what would happen to the country's mega-cities? In what follows, we start by discussing the effect of lowering internal migration restrictions in China. We then explore the effect of the expected spatial diffusion of technology as the country further grows and develops.

Migratory restrictions. The spatial dispersion in amenities is substantially higher in China than in the United States. To be more precise, the standard deviation of amenities across cities in China is about double that in the United States. This is partly the result of many of the largest cities in China having poor amenities. One possible reason for this is the *hukou* system that often restricts the flow of migrants to the country' s largest cities. Indeed, if large cities are kept artificially small through mobility restrictions, this will show up as low amenities in our model. The intuition is as follows. A city that restricts immigration will be too small compared to what its productivity would imply. If so, in the model some other feature of that city must keep it from becoming larger. That other feature will be poor amenities. Compared to China, the U.S. does not have any formal restrictions to internal migration, which could explain why the dispersion in amenities is smaller. This logic then implies that reducing the spatial dispersion in amenities to the level observed in the U.S. is akin to liberalizing migratory frictions. There may of course be other reasons for why many of China's largest cities have poor amenities, a caveat we will return to later.

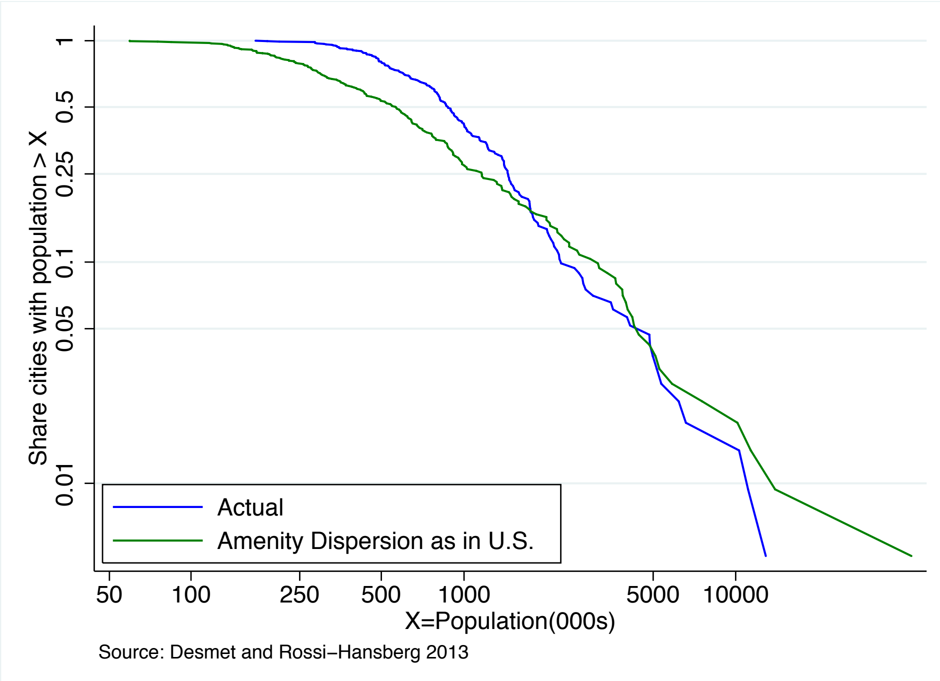

Figure 5: City Size Distribution of China: Counterfactual with U.S. Amenity Dispersion

Figure 5 shows China's actual city size distribution and its counterfactual city size distribution if we were to reduce the dispersion in amenities to the U.S. level. To implement this counterfactual experiment, we essentially normalize the dispersion in amenities across cities in China so that it has the same standard deviation as the one in the U.S. We then input these alternative amenity levels into the model, and use the full structure of our framework to see what happens to city sizes. For a given city size on the horizontal axis, the vertical axis shows the share of cities that are larger than that size. For example, a little less than 5 percent of China's cities have a population of more than 5 million. A steeper slope implies a less dispersed city size distribution, with the smaller cities being larger and the larger cities being smaller. If all cities had the same size, we would have a vertical line.

The main result is that lowering the dispersion in amenities in China to the one observed in the U.S. makes the slope smaller, implying a greater dispersion in China's city size distribution. That is, with an amenity distribution as the one in the U.S., the country's mega-cities would become even larger. This finding is consistent with the larger cities facing barriers to growth. Many of the highly efficient eastern coastal cities are smaller than their productivity would predict them to be. As argued before, some other force in our model must keep their size down. That counteracting force are worse amenities. Reducing the dispersion in amenities to the U.S. level would improve those cities' amenities, thus providing an important boost to their growth. For example, Shenzhen would reach a size of 27 million, and Guangzhou would experience a population increase of 64 percent.

But would the further growth of some of China's mega-cities be good? Our answer is a resounding 'yes': we find that welfare would go up by 23 percent. This may run counter the often-held view that the world's mega-cities are becoming too large. One important shortcoming in the standard debate on the desirability of mega-cities is that it fails to take into account the general equilibrium effects. That is, when discouraging the growth of larger cities, one is encouraging the growth of smaller cities. One therefore needs a model of a country's entire system of cities to assess the welfare implications of any policy change. This is exactly what the model in Desmet and Rossi-Hansberg (2013) provides.

While Figure 5 shows that larger cities are facing barriers to growth, to what extent are these related to migratory restrictions? To answer this question, it is useful to remember that the *hukou* system in China is not equally restrictive everywhere. Although most large cities try to keep migrants out, some actively pursue population growth. If the barriers we have identified are related to migratory restrictions, then reducing the dispersion in amenities should have opposite effects in cities that keep migrants out compared to cities that try to attract them. Although we lack hard data on the variation of migratory restrictions across Chinese cities, we can get suggestive evidence by focusing on Chongqing and Chengdu, two examples of large cities that have gone the other way by implementing "an unabashedly urbanization-based growth strategy" (World Development Report 2009, p.221). Using the same logic as before, if those cities had actively been promoting immigration, this will show up as those cities having high amenities. Hence, reducing the dispersion in amenities across Chinese cities would make them lose in relative terms. Consistent with this, we find that Chongqing would lose 83% of its population and Chengdu 46%.

Although this suggests that migratory restrictions are keeping China's largest cities from growing even larger, of course those cities may also face other barriers to growth. Other urban problems that afflict many mega-cities, but more so in China than in the U.S., include, for example, severe air pollution. Again, in our model such pollution will show up as a negative amenity, making cities such as Beijing less desirable places to reside. In that sense, the low amenities of the larger Chinese cities might also be due to environmental problems.

Either way, if we take the view that there is no a priori reason why the dispersion in natural amenities should be much different in China than in the U.S., then the greater dispersion in China must be due to a greater dispersion in man-made amenities. What our results then suggest is that the greater dispersion in man-made amenities in China may be partly driven by migratory restrictions, but other aspects, such as environmental problems, may play a role too. As Figure 5 has shown, this puts a break on growth in some of the country's largest cities.

Productivity differences. Using a similar methodology, we now analyze what would happen to the city size distribution if the spatial dispersion of productivity in China were to drop to the level observed in the United States. As is often the case with fast-growing countries, development in China has not happened uniformly across space. Development started in some particular clusters on its eastern seaboard, then spread to the rest of its coastal regions, and is now gradually moving to the interior of the country. Using data of 2005, in China the city at the 80th percentile is 71 percent more productive than the city at the 20th percentile. This is more than double the corresponding figure in the U.S., which stands at 32 percent. As China continues to grow and develop, technology is likely to diffuse across space, making its spatial productivity dispersion more similar to the one of the U.S.

It may not be immediately obvious why spatial differences in productivity should be related to the question of barriers to growth of China's mega-cities. Since China's largest cities also tend to be the more productive ones, a drop in the spatial dispersion of productivity should, if anything, lower their growth. That is, it would seem that greater spatial diffusion of technology should help the country's smaller cities. Indeed, we would expect that making cities more equal in terms of productivity would make the larger cities smaller and the smaller cities larger. Hence, mega-cities should become less prominent.

Figure 6, which compares China's actual city size distribution to what it would look like if the spatial dispersion of productivity were the same as in the United States, indicates the contrary.

Although we were expecting the city size distribution to become less dispersed, the opposite happens: reducing differences in productivity makes China's largest cities larger and its smallest cities smaller. Does this imply that cities such as Shanghai would become much larger? The answer is no. In fact, we find that Shanghai would lose nearly 90 percent of its population, and so would Beijing. In fact, most of the country's large cities would lose population, with the notable exception of Chongqing.

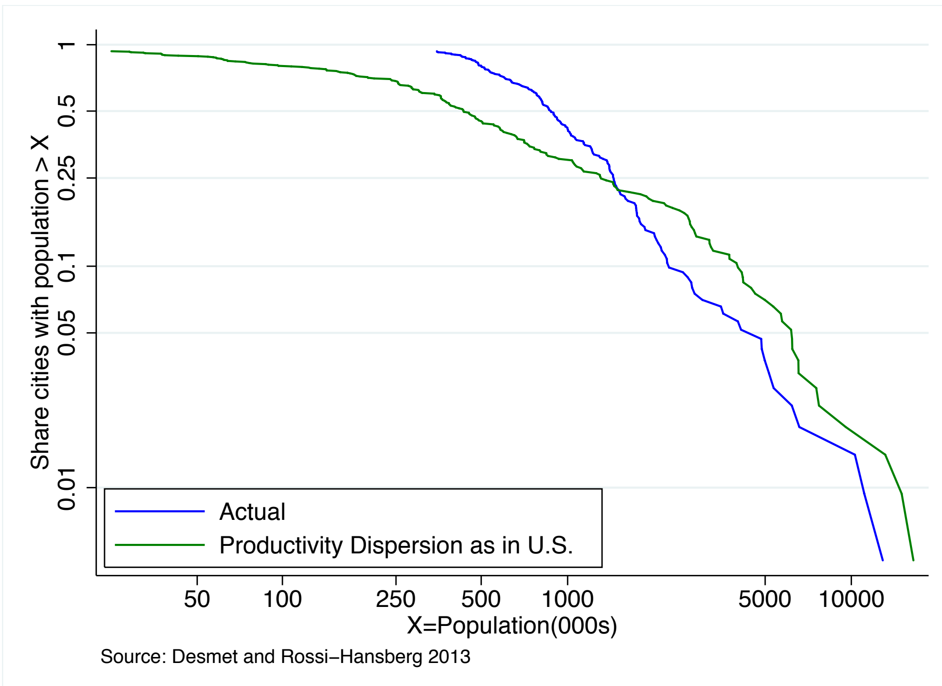

Figure 6: City Size Distribution of China: Counterfactual with U.S. Productivity Dispersion

These results seem contradictory. On the one hand, the model predicts that a more equal spatial distribution of productivity would make mega-cities more prominent. On the other hand, we find that most of China's large cities would decline in size. The solution to this apparent contradiction is that some of today's medium-sized cities with good amenities but low productivity would become the new mega-cities of tomorrow. They would grow so much that they would become larger than present-day Beijing or Shanghai. The country's three largest cities would become Liuan in Anhui province (predicted population 16 million), Chongqing (predicted population 15 million) and Bazhong in Sichuan province (predicted population 13 million). Cities such as Liuan or Bazhong currently have populations between one and two million. But because they have high amenities, improving their productivity turns them into mega-cities.

This unexpected result illustrates the fact that cities are multi-dimensional objects. If the size of a city only depended on its productivity, then reducing the spatial dispersion in productivity should obviously reduce the dispersion in city sizes, and thus spell the demise of mega-cities. But once we take into account that city sizes also depend on other characteristics, such as amenities, the picture becomes more complex and we can no longer trust this simple-minded logic. Having a model of a system of cities with multiple determinants of city sizes is therefore key.

Taken together, we can therefore conclude that one reason why China does not have high growth in some of its largest cities may be related to barriers those cities face. Those barriers may have to do with migratory restrictions, problems of severe air pollution and large differences in productivity across space. It is not obvious how China compares along those dimensions with India. Although the Constitution of India does not restrict internal migration, access to social services is often restricted for migrants, because they lack proof of identity and local residence (Unesco, 2012).

Maybe more importantly, a reduction in the barriers faced by China's largest cities would be a good thing. We already mentioned that a reduction in the dispersion of amenities would imply a 23 percent gain in welfare; the corresponding figure for a reduction in the dispersion of productivity is 18 percent. The debate on growth in developing countries often focuses on the need for adequate macroeconomic policies. What our results suggest is that a country such as China stands much to gain from a more efficient spatial allocation of its resources.

4 Conclusion

In this chapter we have compared the spatial growth in the service industry in India, China and the United States. While in the U.S. service employment growth is greatest in medium-density service clusters, in India those same medium-density locations fare worst. In contrast, there is no indication of China's medium-density service clusters experiencing lower growth. The weak performance of India's medium-sized locations seems to be related to a lack of access to telecommunication services and to a low percentage of their population that has post-secondary education. If all Indian districts had the same access to telecommunications and the same percentage of highly educated workers, then the relative disadvantage of India's medium-density locations, relative to its high-density clusters, would disappear.

The finding that medium-density service clusters in China do not face the same issue as their counterparts in India does not imply that the spatial allocation of resources in China is efficient though. Based on a model of China's urban system, we discuss evidence of certain growth barriers faced by China's largest cities. In particular, we argue that a liberalization of the *hukou* system is likely to make China's mega-cities even larger. We find that such a liberalization would yield substantial gains in well-being. This suggests that quantitative models of urban systems should become part of the standard toolbox of any policy maker interested in reaping the benefits from a more efficient spatial allocation of economic activity.

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