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INCREASING RETURN TO SMART CITIES

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Abstract

Increased urbanization, global warming and sustainable growth belong to the major contemporary policy challenges. Today cities are home to more than 50% of the world population, the largest 600 urban centers generate about 60% of global GDP, and the agglomerated areas are responsible for 75% of world carbon emissions. The UN estimates that 70% of the world's growing population will live in cities by 2050. At the same time the world population is expected to increase from 7 billion people to 9 billion. Thus, the total number of people living in cities will be almost doubled within a period of less than 4 decades. This paper discusses two hypotheses on how this will affect climate change and economic growth.

JEL classification: R11, O18, O31, Q54, Q55
Key words: Agglomeration economies, climate change, innovation, growth

1. INTRODUCTION

Cities are home to 50% of the world's population. The UN estimates that 70% of the world's growing population will live in cities by 2050. At the same time the world population is expected to increase from 7 billion people to about 9 billion. Thus, the total number of people living in cities will almost be doubled within a period of less than 4 decades.[1] The present article discusses how this will affect two of the major contemporary challenges.

Two hypotheses are investigated. The first consider the ongoing climate change. The global atmospheric concentration of carbon dioxide, which is the most important greenhouse gas, increased from a pre-industrial value of about 280 particles per million metric tons (ppm) to 379 ppm in 2005 (IPCC 2011). A substantial fraction of the carbon emission is linked to transportation and energy use. In the U.S., almost 40 percent of the total carbon dioxide emission is associated with housing and cars (Glaeser and Kahn 2008).

There is consensus among the majority of the world's climate scientists that, without drastic changes in transportation, housing and production methods, the concentration of greenhouse gases will increase by between 100 and 200 percent in this century. At worst, we risk a phenomenon of the tragedy of the commons (Hardin 1968) with an average temperature on earth at least 5 degrees higher than today. How can this be avoided? We formulate the following hypothesis:

Hypothesis 1: The fact that a larger share of the growing world population lives in cities will facilitate policy measures to reduce global warming.

Cities are also "nurseries" for economic growth (Duranton and Puga 2001). There is broad consensus among urban economists that the existence of agglomeration leads to

[1] It should be noted that urban population growth is largely explained by the movement of center of gravity of the urban world to the east and south, rather than a dramatic increase of population in western cities. By 2025, 136 new cities are expected to enter the top 600 urban centers, according to McKinsey Global institute. All of them are coming from the developing world, mainly China.
http://www.mckinsey.com/insights/mgi/research/urbanization/urban_world

increased productivity. Transport costs, the rate of return on human capital and innovation will benefit from the increased proximity. We speculate that future economic growth might be more linked to knowledge spillovers, ideas and innovations and with the second hypothesis:

Hypothesis 2: The fact that a larger share of the growing world population lives in cities will create better conditions for long-run growth.

Based on selected evidence from the literature and empirical evidence from Swedish data, the paper cannot reject any of the hypotheses.

The rest of the paper is organized as follows. Section 2 briefly reviews the literature on greenhouse gases and climate-friendly environments and presents statistics on the ongoing outmigration of manufacturing from metro cities. Section 3 discusses agglomeration economics, growth and provide empirical evidence on the link between geographical location, innovation and performance using extensive Swedish firm level data and Section 4 concludes.

2. GREENHOUSE GAS EMISSIONS AND URBAN CITIES

World cities are not generally good examples of climate-friendly environments, but this does not mean that a greater proportion of the population in cities automatically will increase global warming. Let us take New York as an illustrative case. The forecast is that 9 million people will live in New York in 2030, compared to 8.2 million in 2010. The way to accommodate the high population growth in this already dense and developed city has to be innovative. How?

New York is a member of the C40 group that represents around 300 million people and 18% of global GDP, but interestingly the group accounts for only 10% of global carbon emissions. Currently, the group comprises 58 large cities from around the world. In order to be a member of the group, a city must be committed to implement meaningful and sustainable climate-related measures locally that will help address climate change globally. These

measures include improving public transport, cycling and walking infrastructures and congestion management.[2]

One important lesson from the C40-project, however, is that cities are different; what works in one may not work in another. In Portland, for instance, there is a plan that 90% of its citizens should be able to walk or cycle to meet all daily non-work basic needs by 2030. Other large cities try to spread out city centers or make better use of waterways for transportation.

Transportation costs are at the heart of core theories of urbanization and agglomeration economies. Cities are ultimately nothing more than proximity, so the returns to urban concentration can be reduced costs of moving goods across space (Glaeser and Gottlieb 2009, Krugman 1991). However, transportation also emits several harmful pollutants, for example carbon dioxide.

Interestingly, many metropolitan cities such as New York have per capita transportation emissions that are remarkably low compared to other cities.[3] This is partly because of a relatively small share of commuters in personal automobiles (which also reduces the need for car parks, parking lots and extensive road systems).

Another reason for the relatively low pollution is the ongoing process of moving manufacturing firms out of the metro cities. Instead, there has been a growing concentration of manufacturing in small and medium-sized cities, and of business services in larger cities in many countries. Recent data from Sweden captures this trend, see Table 1. Between 1997 and 2008 more than 60,000 manufacturing jobs disappeared from the three metro cities Stockholm, Gothenburg and Malmo. At the same time, about 40,000 new manufacturing jobs were created in regions neighbouring the metro cities and 20,000 in other parts of the country.

[2] http://www.arup.com/Home/Homepage_Cities_Climate_Change.aspx

[3] Ranking 66 of the largest metropolitan areas in the U.S. Glaeser and Kahn (2008) show that the New York metropolitan area uses the least gasoline, reflecting a high degree of employment and population concentration and a relatively heavy use of public transportation.

The outmigration of industrial workplaces provides increased opportunities for housing supply in the cities, which typically have high demand and relatively tight restrictions.

Table 1: Number of employees in Swedish manufacturing firms 1997 and 2008 by geographic location.

	1997	2008	Change 1997-2008, %
Metro cities (Stockholm, Gothenburg, Malmo)	301 407	237 627	-21.2
Metro regions outside metro cities	142 322	185 705	30.5
Rest of Sweden.	483 519	501 842	3.8

In this sector, we have briefly reported a number of attempts to adapt to the modern city development to reduce the burden on the environment. The expected rapid growth in the number of people living in cities will lead to a considerable strain on the endowment of natural resources and ecosystems. A changing spatial distribution of the population driven by the urban growth makes the transition to a more green economy increasingly important. But at the same time, this development also creates opportunities. For example cities can provide more efficient solutions for an infrastructure including energy, housing, water, sanitation and transport. However, realization of the potential benefits on energy consumption and pollutions requires proactive policy planning.[4] Thus, we find some support for the hypothesis that a larger share of the growing world population living in cities will facilitate policy measures in order to reduce greenhouse gas production.

3. AGGLOMERATION ECONOMICS, INNOVATION AND GROWTH

Spatial concentration of population, firms or human capital enhances productivity is at the core of agglomeration literature (Rosenthal and Strange 2008). In addition to reduced transportation and communication costs, theories of agglomeration economies include

[4] For a detailed discussion, see United Nations Environment Programme 2011

accumulated knowledge, Marshallian or Jacob externalities, and the thickness of the labour market. Firms and industries benefit in a pronounced way from each other's knowledge and innovation activities. The presence of external knowledge flows should reveal itself in social return to investments in addition to the private returns. In a recent analysis based on technology flows across industries, Wolff (2012) finds that the direct rate of return to R&D in the US over the years from 1958 to 2007 is 22% and the indirect rate of return to R&D is 37%. Wolff also shows that technological spillover effects may have become more important over time with IT. The main reason is that IT speeds up the process of knowledge transfer and makes these knowledge spillovers more effective.

A long range of empirical studies have shown that the social rate of return differs across locations and that knowledge flows reduce in volume and intensity as the distance between origin and destination grows. A dense nearby environment with a wide spectrum of knowledge resources, and qualifications and competence profiles of the labour supply provides rich opportunities for knowledge exchange and creative interaction between firms and individuals in the region. Knowledge interaction takes the form of face-to-face contacts and the opportunities for such interaction is clearly facilitated when the interacting parties are located in the same functional region, and especially when they dwell in the same local economy (e.g. Jaffe, 1986; Audretsch and Feldman 1996; Andersson and Beckmann, 2009). Glaeser and Mare (2001), for instance, report a wage premium in the U.S of 33% between the largest metropolitan areas and non-urban locations.

However, with reference to Wolff (2012), one can ask whether there is a reason to reconsider the traditional agglomeration economics theories, given that IT can reduce the significance of physical proximity? If so, then we might not be able to confirm our second hypothesis that a larger share of the growing world population living in cities will create better conditions for long-run growth.

Gaspar and Glaeser (1998) argue that the key-issue is whether face-to-face communication and electronic communication are substitutes or complements. This differs from industry to industry. While IT has facilitated the dispersion of manufacturing activities, the effect may be the opposite on business services and other knowledge-intensive activities characterized by sophisticated, complex and timely interactions (Leamer and Storper 2001). According to Glaeser and Ponzetto (2007), changes in information and transportation technologies increase the returns to new ideas particularly in densely populated areas, which make cities more important, at least when they specialize in creating ideas.

Our second hypothesis has an implicit assumption that firms' absorption capability is crucial to identify and leverage the knowledge in the increasingly dense cities. Moreover, this implicit assumption is associated to innovation activities. Modern economics assumes that innovation is the primary driving force behind growth (See for instance Dusenberry 1956, Solow 1956, Romer 1990, Aghion and Howitt, 1998). A large literature has also shown a close relationship between agglomeration and innovation (Jakobs 1970, Duranton and Puga, 2001, Martin and Ottaviano 2001, Agrawal et al. 2008, Gerlach et al. 2009). Glaeser and Gottlieb (2009) stress that agglomeration advantages are primarily created by a higher intensity of knowledge flows and exchange of ideas in dense urban areas.

In order to make some test of the second hypothesis, we conduct an analysis in two steps. Using Swedish firm level data from about 6,000 unique firms, we first investigate the relationship between innovation and spatial proximity, and between productivity and proximity respectively. We then run regressions on the relationship between location and productivity for firms with different innovation strategies, and the wage dispersion within different regions.

Staring with the link between innovation measured as patent application per employee, and the concentration of employees in Sweden's 72 labour market regions between 1997 and

2008, Figure 1 report a correlation coefficient of 0.20. This suggest that innovation activities are an increasing function of spatial proximity.

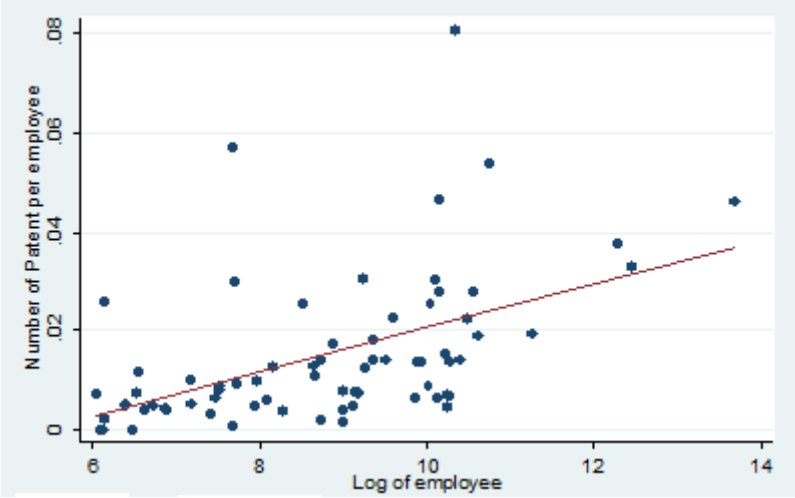

Figure 1
Population density and innovativeness (number of patent application per employee) in 72 functional labour market regions in Sweden 1997-2008. The correlation (R2) is 0.20

Based on a consistent finding in the literature briefly referred above, we also expect a close link between concentration of employees and labour productivity. This is also confirmed in Figure 2, which employs the same firm level data set as Figure 1. Firms' productivity is an increasing function of the density population expressed as both firms and people.

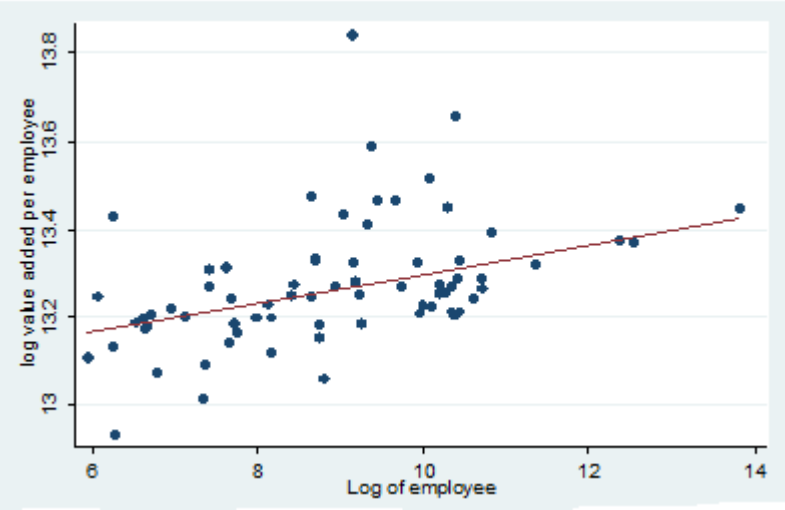

Figure 2:
Population density and productivity (value added per employee) in 72 functional labour market regions in Sweden 2008. The correlation (R2) is 0.20

In Table 2, we deepen our analysis somewhat by including the ceteris paribus condition in the regression, and distinguish between different innovation strategies and location alternatives. Thus, a firm can chose to conduct innovation on regular or occasional basis, or chose to not be engaged in innovation (measured by patent applications) at all. Moreover, a firm can choose to be located in a rural area, in a small city area or a large city area.

According to the hypothesis and the discussion above, we would expect that only firms which commit themselves to accumulation of internal knowledge benefit from being located in places with a large mass of external knowledge. With non-innovative firms in rural areas as the reference group, the upper part of the table shows that non-innovators do not benefit from presence in the knowledge intensive milieu characterizing large cities. The coefficient estimates are not significantly different from the reference group. Regarding occasional innovators, however, the middle section of the table indicates (at 10% level) a productive premium from spatial proximity.

Consider the bottom part of the table 2, we find significant, positive and rather substantial productivity premium for persistent innovators from locations with access to external knowledge. According to the theories briefly reviewed above, we expect additional productivity benefits from moving from small cities to large cities. But for persistent innovators we observe only a minor and not statistically significant difference between such firms in small cities and large cities. One possible interpretation is that persistent innovators have a very high absorptive capacity which means that they can benefit from agglomeration economies despite longer time-distances. Another conceivable explanation is that these firms can benefit from local clusters or localization economies in medium-sized urban regions.

Table 2: Dependent variable is log value added employee. Real prices. GMM-panel data.

Non-Innovative	
Rural locations	Reference
Small cities	-0.011 (0.014)
Large cities	0.014 (0.022)
Occasionally innovative	
Rural locations	0.036 (0.027)
Small cities	0.034 (0.031)
Large cities	0.070 (0.040)*
Persistent Innovative	
Rural locations	0.088 (0.061)
Small cities	0.151 (0.073)**
Large cities	0.171 (0.080)**

Notes:
*** p<0.01, ** p<0.05, * p<0.1, Windmeijer corrected standard error within parentheses.
Controls: Productivity level lagged, human capital, physical capital, firm size, ownership, sector and year

Table 3 provides more evidence of the potential benefits of cities. Using employment data for Swedish manufacturing workers, we compare the conditional wage dispersion (conditional on age, education and sector) in the three geographical areas. The results from the multinomial regression show that, controlling for heterogeneity in individual and firm characteristics, the wage dispersion is significantly larger in large cities compared to small cities and rural areas. Thus, although large cities have superior average productivity performance compared to other places, which is reflected in average higher wages, there is substantial heterogeneity among businesses in the larger cities which creates a wider income-gap compared to the rest of the country.

Table 3: Wage dispersion and localization. Multinomial model.

	Rural areas	Small cities	Large cities
Wage dispersion.	-0.077**	-0.038***	0.115***
	(0.008)	(0.025)	(0.010)
Observations	346,672	346,672	346,672

Notes
*** p<0.01, ** p<0.05, * p<0.1, standard deviation within parentheses. The regressions control for different firms characteristics (6 dummies), sectors (11 dummies) and year (11 dummies).

The summarizing finding in this section is that we, based on extensive Swedish firm-level data for a 12 year period, can confirm the hypothesis that agglomeration areas have better conditions for long-run growth than other geographical areas. Moreover, the literature provides robust evidence that the importance of innovation increases over time. This also means that the economic importance of technological spillover, human capital externalities and innovation may have become more important over time. Since all these three factors are positively related to proximity, the implication is that the city's economic importance as a growth engine has become even stronger.

4. CONCLUSION

This paper considers two hypotheses related to the predictions that the city-population will be almost doubled within less than two generations. The hypotheses test postulates on how even larger cities and increased population in the already large cities affect two of today's most topical issues: global warming and economic growth.

The keyword in both hypotheses is smart cities. With increased spatial density of both companies and people, the chances for long-term growth as a combination of external knowledge and knowledge of the local environment increase. The policy challenge here is to create the conditions so that a growing percentage of companies choose to engage in innovative activities, since it is these companies that best can take advantage of the big city environment with rich and varied range of knowledge.

With an almost doubling of urban populations in just four decades, the environment will be exposed to great stress. Today, the city accounted for 75% of total emissions of carbon dioxide. Transport is a major cause. But due to its own dynamic, the dramatic increase of urban population makes the transition to a more environmentally friendly economy necessary. Examples from various cities also show that this is possible and that it is taking place in growing scale and the examples include climate-smart homes and workplaces, and infrastructure for transportation which minimizes carbon emissions.

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