OECD INTERNATIONAL CONFERENCE

"COMPETITIVE CITIES AND CLIMATE CHANGE"

2ND ANNUAL MEETING OF THE
OECD ROUNDTABLE STRATEGY FOR URBAN DEVELOPMENT

OCTOBER 9-10, 2008, MILAN, ITALY

CLIMATE CHANGE, URBAN INFRASTRUCTURE AND ECONOMIC DEVELOPMENT*

by

Gianmarco I.P. Ottaviano

University of Bologna and FEEM

ABSTRACT

Cities promote economic development as they allow agglomeration economies to materialise. These benefits can be seized provided that effective urban infrastructure fosters knowledge spillovers, labour market pooling, input sharing as well as demand and cost linkages. Currently climate change is increasing the costs associated with the geographical concentration of economic activities in cities while urban sprawl is weakening social and economic interactions through which agglomeration economies work. Urban sprawl is also weakening the economic and social viability of large infrastructural investments that are needed to tackle the twin challenges of climate change and urbanisation. In this respect, a crucial prerequisite for climate-proof urban infrastructure is the implementation of integrated land use and transport policies allowing for compact cities to develop.

INTRODUCTION

How can cities both bolster economic activities and effectively respond to climate change? In particular, what are the inherent trade-offs and possible synergies between climate protection goals and other goals that are central to urban economic development?

This paper addresses the foregoing questions from the specific angle of infrastructure. In so doing, it adopts the general definition of infrastructure provided by the U.S. National Research Council (NRC), according to which the term “public works infrastructures” includes “both specific functional modes - highways, streets, roads, and bridges; mass transit; airports and airways; water supply and water resources; wastewater management; solid-waste treatment and disposal; electric power generation and transmission; telecommunications; and hazardous waste management - and the combined system these modal elements comprise. A comprehension of infrastructure spans not only these public works facilities, but also the operating procedures, management practices, and development policies that interact together with societal demand and the physical world to facilitate the transport of people and goods, provision of water for drinking and a variety of other uses, safe disposal of society's waste products, provision of energy where it is needed, and transmission of information within and between communities”.[2]

The paper is organised in four additional sections. Section 2 discusses the role of cities as engines of economic development through productivity growth. Section 3 discusses the impact of infrastructure on productivity through its impact on urbanisation. Section 4 discusses the implications of climate change for urban infrastructure and economic development. Section 5 concludes.

Economic development and the city

1. Urbanisation on the one hand and economic development on the other hand are parallel processes. Indeed, the emergence and dominance of spatially concentrated economic activities is one of the facts that have been traditionally associated with modern economic growth.[3] This strong positive correlation between development and urbanisation has been documented by economic historians, in particular in relation to the industrial revolution in Europe during the nineteenth century.[4] Another example is China where the sharp increase in the growth rate of the country during the past twenty years

has been accompanied with an increase in the disparity between coastal urban areas and inland rural regions. [5]

2. How does urbanisation contribute to economic development? "Primitive though it may be, every stable society feels the need to provide its members with centres of assembly, or meeting places. Observance of religious rites, maintenance of markets and political and judicial gatherings necessarily bring about the designation of localities intended for those who wish or who must participate therein".[6] While religious, political and judicial services may still be important contributions to cities, from an economic point of view their crucial role is to boost productivity by hosting a spatially concentrated mass of suppliers and customers: *metropolises are mega-markets and mega-factories*.

3. Spatial concentration may help productivity in two ways. First of all, the market size and production cost advantages of cities may simply reflect respectively the relative advantage that a certain location has in terms of local consumption and production amenities deriving from climatic conditions, natural resources and natural means of communication. However, while places do have different abundance of natural resources, proximity to natural means of communication, and climatic conditions, these features (a.k.a. 'first nature') provide only a partial explanation of the pronounced differences in urbanisation existing even between areas that are fairly similar in terms of such exogenous characteristics. For this reason it has been argued that urbanisation should also be linked to other additional advantages (a.k.a. 'second nature') that are inherent to the functioning of economic interactions and are able to cause uneven development even across ex-ante identical places.[7] In this second perspective, the market size and production advantages of cities are endogenously generated by the scale of economic activities taking place in a certain location.

4. Through the years a rich list of 'second nature' forces has been proposed by geographers, regional scientists and urban economists.[8] These forces are also called 'agglomeration economies' and exist as long as the scale of the local environment adds to the performance of local firms. They are 'external economies' as long as the benefits of localised interactions are not fully reflected in the prices of market transactions.

5. An important common implication of agglomeration economies is that they are able to generate self-sustaining clustering insofar as the movements of firms and workers, attracted to places with larger local markets and lower production costs, end up reinforcing these differences and thus spatial imbalances ('cumulative causation). In this respect, agglomeration economies give strength to 'second nature' against 'first nature', detaching the emerging economic landscape from the physical attributes of its underlying geography. Thus, while there is a priori great flexibility on where particular activities locate, once the agglomeration process has started, spatial differences take shape and become quite rigid ('putty clay geography').[9]

6. While sharing this common characteristic of making the spatial concentration of economic activities self-sustaining, agglomeration economies nonetheless differ substantially from one another in terms of two crucial features: their 'scope' and their 'source'.[10]

The scope of agglomeration economies

7. Agglomeration economies may extend along three main dimensions and the notion of 'scope' refers to the corresponding extents.

8. First, agglomeration economies may extend across industries in a certain location or be confined inside them. This difference in 'industrial scope' is the most familiar one in urban economics where specific names have been assigned to the two polar cases. When agglomeration economies spread across

industries, they are called ‘urbanisation economies’. When they are confined inside them, they are called ‘localisation economies’.

9. The second dimension along which agglomeration economies may extend is the spatial one. This is the ‘geographic scope’ and refers to the extent to which external economies depend on the proximity between firms and thus decay with distance.

10. Finally, there is the ‘temporal scope’ that refers to the external economies generated by the interactions among firms located in the same place but in different times. A typical example is knowledge creation through cumulated local learning.

The sources of agglomeration economies

11. The notion of ‘source’ refers to a microeconomic explanation of the existence of agglomeration economies. Four explanations have attracted special attention.[11] Three are known as the ‘Marshallian triad’: ‘knowledge spillovers’, ‘labour market pooling’ and ‘input sharing’.[12] The fourth explanation highlights ‘demand and cost linkages’.

12. ‘Knowledge spillovers’ arise when knowledge is transferred between agents thanks to sheer physical proximity irrespective of market transactions between them. Knowledge, ideas and above all, tacit information, can be considered as impure public goods that generate spillover effects from one firm or institution to another. Consequently, if economic agents possess different pieces of information, pooling them through informal communication channels can benefit everyone, hence the importance of proximity.[13] In this perspective, agents co-locate to take advantage of knowledge that is somewhere ‘in the air’, which makes them more efficient. Accordingly, the cost advantage of a location becomes an increasing function of the relative number of its resident agents.

13. ‘Labour market pooling’ refers to two related phenomena that arise when firms and workers face search and matching frictions. On the one side, the spatial concentration of workers with different skills and firms with different needs increases the likelihood of good matches.[14] On the other side, if matches face an idiosyncratic risk of destruction, spatial concentration reduces the duration of unemployment spells and unfilled vacancies. Co-location allows firms and workers to benefit from both opportunities. Through these channels, both the cost production advantage and the market size advantage of a location become increasing functions of the relative number of its resident agents.

14. ‘Input sharing’ generates agglomeration economies when the production of intermediate inputs faces increasing returns to scale and their transportability is limited. When this is the case, the input producing sector is able to reach an efficient scale of production only when its local market is large enough, which requires the spatial concentration of downstream customers. Accordingly, the cost advantage of a location becomes an increasing function of the relative number of its resident agents.

15. ‘Urban consumption opportunities’ are sometimes considered an additional explanation of urban primacy. They are, however, partly a variation on the theme of input sharing and partly a variation on the theme of knowledge spillovers. On the one hand, when the supply of final goods and services faces increasing returns to scale and their transportability is limited, large local demand associated with the spatial concentration of people allows final production to achieve an efficient scale. On the other hand, the spatial concentration of people fosters social interactions that may be valuable per se even in the absence of knowledge transmission. A similar argument is readily applied to the provision of all sorts of goods and facilities characterised by some relevant degree indivisibility (road, schools, etc.). As long as some of these are publicly provided through local funds, the spatial concentration of economic activities generates the tax

base needed to finance them ('fiscal externality'). Once more, the market size advantage of a location becomes an increasing function of the relative number of its resident agents.

16. Turning to demand and cost linkages, three scenarios have received particular attention. All stress the impact of firms' locations decisions on other firms' profits. The first scenario considers the effect of firm relocation when matched by labour migration ('demand linkage').[15] In this case, as the firm moves, it reduces demand in the place of origin while increasing it in the place of destination. In so doing, as profits rise with demand, the firm harms competitors in the former place and benefits competitors in the latter. Hence, the market size advantage of a location becomes an increasing function of the relative number of agents residing there.[16] In the second scenario, firms are linked by input-output linkages: what is output for a firm is input for the others and vice versa ('cost linkage').[17] Here, when a firm relocates, it depresses both final demand and intermediate supply in the location of origin, whereas it reinforces them in the location of destination. Accordingly, other firms' profits suffer in the former country and thrive in the latter. The production cost advantage of a location becomes an increasing function of the relative number of its resident agents.

Taking stock

17. To summarise, cities promote economic development as they allow for agglomeration economies to materialise. Several sources of agglomeration economies have been highlighted by economic geographers, regional scientists and urban economists: knowledge spillovers; labour market pooling; input sharing; consumption amenities; demand linkages; cost linkages. The fact that all these are external economies implies that market forces generate a geographical distribution of economic activities that is generally inefficient from a social point of view.

Infrastructure and the urban economy

18. The empirical relevance of infrastructure for global and local economic development can be hardly overstated.[18] In particular, its role has been stressed along two main dimensions: its effects on economic growth and its effects on income inequality.[19] Along the first dimension, most studies focus on the impact of infrastructure on aggregate output, finding it positive.[20] In particular, they identify positive and significant impacts on output of three types of infrastructures (telecommunications, transport and energy) and show that such impacts are significantly higher than those of non-infrastructure capital.[21]

19. The link between infrastructure and long-run growth is much less explored. Some studies find that public expenditures in transport and communications foster growth.[22] This finding is also confirmed in the case of physical infrastructure and in the case of communications (telephone density).[23] On the other hand, it is argued that sometimes the inefficiency of infrastructure provision can curb and even reverse the sign of its impact on long-run growth.[24]

20. Turning to the effects on income inequality, the issue is whether infrastructure has a disproportionate impact on the income and welfare of the poor.[25] The presence of a disproportionately positive impact finds some support in the existing evidence.[26] Several studies point at the effects of infrastructure on human capital accumulation: better transportation and safer roads promote school attendance; electricity allows more time for study and the use of computers; access to water and sanitation reduces child and maternal mortality. Infrastructure also connects poor people in underdeveloped areas to core economic activities, thus expanding their employment opportunities.[27] Finally, better infrastructure in poorer regions reduces production and transaction costs.[28]

21. The analytical framework put forth in the previous section suggests that a key channel through which infrastructure may affect growth is its impact on the evolution of the economic landscape in terms of market size asymmetries (market seeking) and production costs asymmetries (cost saving).[29]

Attraction and accessibility

22. To understand the impacts of different types of infrastructure on market size and production cost asymmetries one has to figure out the specific sources of agglomeration economies they affect. In so doing, one can exploit the fact that different sources naturally map into different geographical scopes.

23. An important distinction between the Marshallian triad on the one side and demand-and-cost linkages on the other is in terms of their geographical scope. In particular, the relative relevance of the two types of forces depends on the scale of the analysis.[30] Cities are replete with technological externalities.[31] The same holds in local production systems.[32] Thus, to explain geographical clusters of somewhat limited spatial dimension such as cities and industrial districts, it seems reasonable to appeal to technological externalities that are the hallmark of Marshallian sources. However, when one turns to a larger geographical scale, it seems reasonable to think that direct physical contact provides a weaker explanation of interregional agglomerations such as the 'Manufacturing Belt' in the US and the 'Hot Banana' in Europe. This is the realm of market-mediated linkages between firms and consumers/workers.

24. Hence, while in the Marshallian perspective market size and production cost asymmetries only reflect the economic scale of local economic activity, in the linkages perspective those parameters also reflect the economic scale of all other connected locations from which inputs can be sourced and to which products can be sold. Two concepts can be usefully borrowed from spatial interaction theory to clarify this point.[33] In particular, if one visualises the spatial economy as a network of interconnected markets, then the appeal of a market as a production site for firms depends on both its relative size (attraction) and its relative centrality in the network of trading markets (accessibility).[34] In this respect, the market size asymmetry and the production cost asymmetry would respectively measure the 'market seeking' and 'cost saving' dimensions of both attraction and accessibility.[35] These two dimensions are embedded in the concept of 'market potential' of a location, high market potential being associated with good attraction and accessibility.

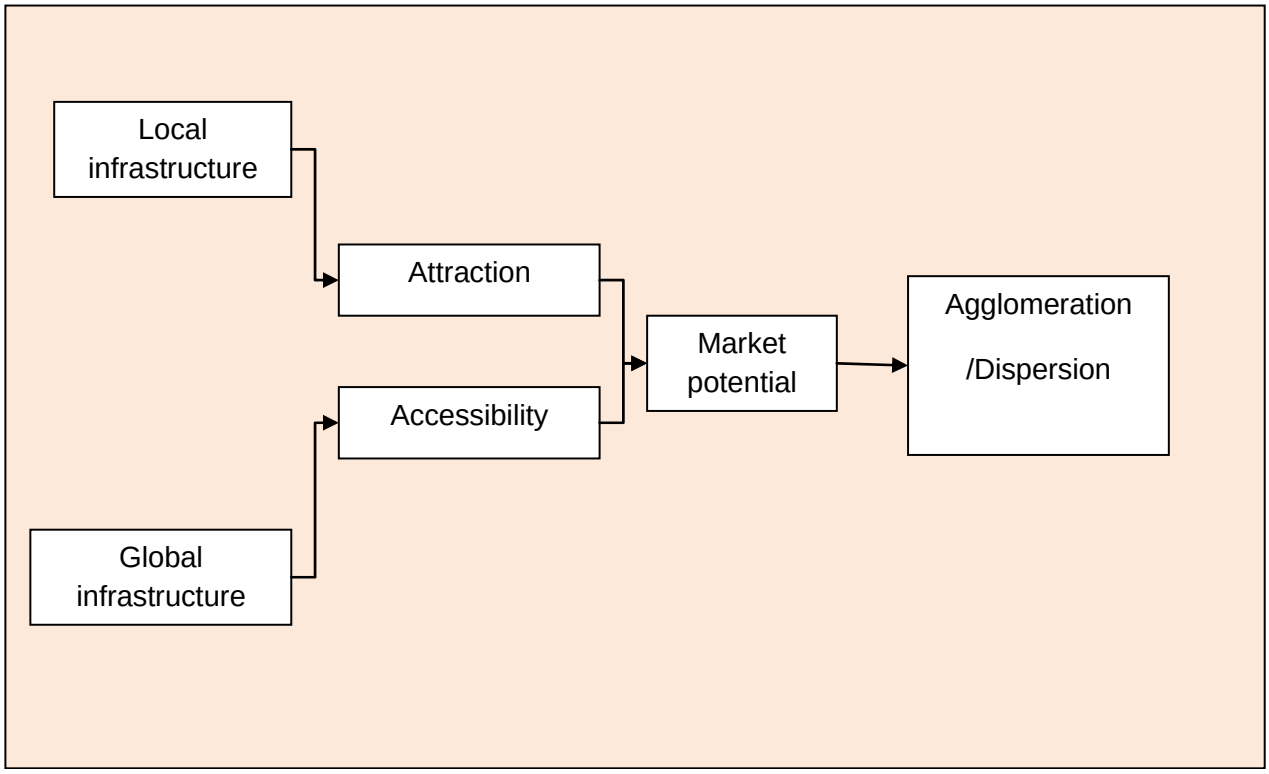
Types of infrastructures

25. The distinction between attraction and accessibility is useful to classify the effects of different types of infrastructures on the differences in market size and production costs between locations.

26. The different types of infrastructures affect the strength of agglomeration economies differently depending on the corresponding sources. A crucial distinction is between 'local infrastructures' that mainly affect short-distance interactions and 'global infrastructures' that mainly affect long-distance interactions. As such, the former mainly alter attraction whereas the latter mainly alter accessibility. While any classification is someway arbitrary, it is tempting to consider the provision of water for drinking and a variety of other uses, the safe disposal of society's waste products, the provision of energy where it is needed, the formation of human capital, etc. as pertaining to local infrastructure, while the transportation of goods and people as well as the trasmission of information as pertaining to both local and global infrastructure.

27. The foregoing considerations are synthetised in Figure 1, which summarises the channels through which infrastructure affects the economic landscape in the economic geography literature.

Figure 1 – Infrastructure and economic geography



Infrastructure and the economic landscape

28. Infrastructural changes may affect the geographical distribution of firms and workers between locations (external geography) or within location (internal geography).[36]

29. When the focus is on 'external geography', as long as demand and cost linkages are concerned, the discussion in Section 3.1 implies that only infrastructural changes improving the market potential of a certain location are able to attract economic activities towards that location.

30. This has important (and somewhat unexpected) consequences. As a first consequence, improved global transport infrastructure between a developed location enjoying a market size advantage and a less developed one can decrease the attractiveness of the latter. This is called the 'straw effect', because economic activities migrate to developed locations through new infrastructure as juice in a glass is sucked up by a straw.[37] In other words, unless the prices of non-tradables is much higher in the developed region, better transportation improves its market potential more than it improves the market potential of its less developed trading partner.

31. Another, even more unexpected consequence is captured by the 'shadow effect', according to which improved local transportation does not necessarily make a location more attractive. This happens when the improved local infrastructure of a location is disproportionately used for shipments to and from some other place, which 'casts a shadow' on the location's attractiveness. That would be the case, for instance, if the other place were a transport 'hub' or 'gate'. A 'hub' is a location with better accessibility to all other locations; a 'gate' is a location through which goods mostly flow in and out of a region.[38] Favourable demand or cost shocks to any other location could result in supply expanding in the hub or in the gate and contracting elsewhere. Hence, clustering is more likely to take place in the presence of and close to hubs and gates.[39]

32. Better global infrastructure may nonetheless reduce geographical disparities. That would happen in three leading cases. First, as already discussed, if the prices of non-tradables are much lower in less developed locations, improved transport connections with developed locations result in firms and workers relocating from the latter to the former.[40] Second, if better global infrastructure allows for long-distance commuting, the concentration of firms in developed regions is partly detached from local market size as workers spend their income elsewhere. This favours some dispersion of economic activities.[41] Third, better global means of communication (*e.g.* improved ICT) foster the diffusion of local knowledge to distance places. Whenever knowledge spillovers are the main source of agglomeration economies, production cost asymmetries fall, thus promoting economic geography even more.[42]

33. Turning to the geographical distribution of firms and workers within locations (internal geography), the presence of gates (*i.e.* sites within locations with a 'geographical advantage' in terms of better access to the other location) makes the internal geographies of locations interdependent. In this more complex scenario, agglomeration within locations is mainly shaped by internal trade impediments. Vice versa, agglomeration between locations is mainly shaped by external trade barriers.[43]

Taking stock

34. To summarise, improved global infrastructure supports a more even distribution of economic activities and reduces urban primacy when the prices of non-tradables (such as housing) are much higher in less developed locations, when it promotes long-distance commuting and when it is conducive of knowledge transmission from developed to less developed locations. In this case, as the agglomeration economies are hampered, increased spatial equity comes at the price of lower productivity and slower economic growth.

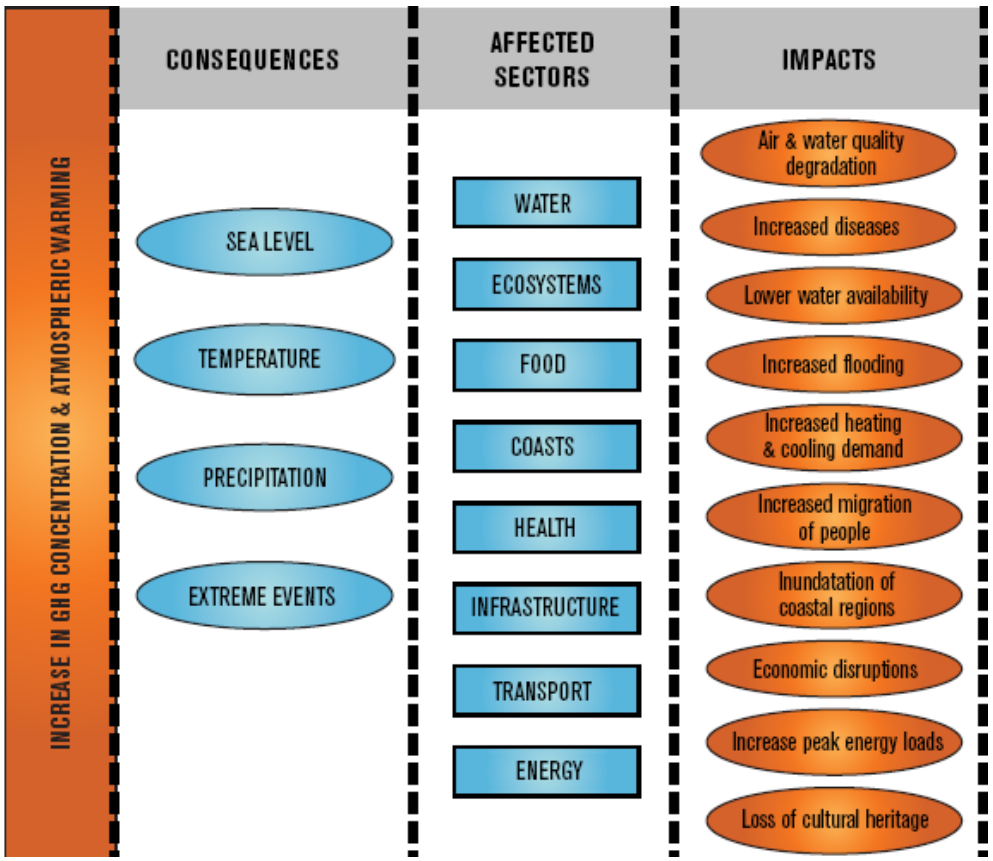
35. Moreover, when improved local infrastructure affects the economic landscape within a location, this can indirectly change the internal landscape in other locations. As a result, to avoid a beggar-thy-neighbour type of outcome, not only global but also local infrastructure policies should be globally coordinated.[44]

Climate change, infrastructure and agglomeration economies

36. Cities foster economic development because the geographical concentration of economic activities enhances productivity and consumption opportunities. This is due to 'first nature' and 'second nature' advantages. The former derive from climatic conditions, natural resources and natural means of communication. The latter are inherent to the functioning of economic interactions. Infrastructure shapes 'second nature' by altering the 'market potentials' of cities.

37. Infrastructure also affects the impact of 'first nature'. On the one hand, it promotes cities' access to natural resources and means of communication, thus relaxing the constraint of physical proximity on economic development. On the other hand, it can reduce the dependency of economic activities on climatic conditions and natural disasters. However, due to human induced climate change, this has become an increasingly difficult task as increasing heat in the atmosphere is affecting weather patterns, temperatures, sea levels, and storm frequencies with disruptive impacts on economic activities (Figure 2).

Figure 2 – Impact of climate change on cities



Source: World Bank (2008).

Vulnerable cities

38. Against this background the economic benefits of agglomeration enjoyed in cities have to be weighed against mounting costs.

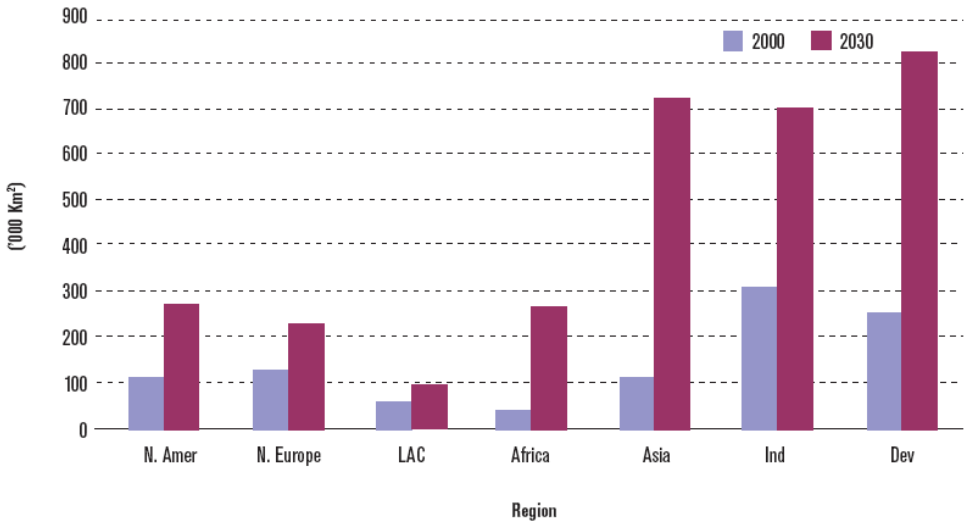
39. On the cost side, the most adverse impacts of climate change are likely to be in urban areas where people and economic activities are concentrated. Urban concentration is currently on the rise as developing countries grow. By 2030 at least 61% of the world's population will be living in cities up from 50% today. With 95% of all urban growth happening in developing countries, their cities will become home to almost 4 billion people, roughly 80% of the global urban population. The concentration of people and firms in cities increases the vulnerability of economic activities to climate change impacts.

Urban sprawl

40. On the benefit side, as discussed in the previous sections, urbanisation fosters economic development thanks to agglomeration economies. However, all the sources of such economies - especially knowledge spillovers, labor market pooling and input sharing - crucially depend on high levels of urban density. Current projections for the next decades suggest that rising urbanisation will map into a staggering expansion of built up areas across the world (Figure 3). The projections are particularly impressive for

developing countries, where the doubling of urban population by 2030 will result in a tripling of their built up areas, thus leading to lower urban density ('urban sprawl').

Figure 3 – Build up area projections by region



Source: Angel, S., S.C. Sheppard, and D.L. Civco, *The Dynamics of Global Urban Expansion* (Washington, D.C.: World Bank, 2005).

Source: World Bank (2008).

41. Though still partly debated, the problems deriving from 'urban sprawl' are well known. Sparse urban communities are associated with more frequent and longer driving spells generating higher pollution, more time lost in traffic and more traffic-related fatalities. In sparse communities limited social interactions undermine social capital and hamper knowledge spillovers.

42. In addition, low density due to urban sprawl puts an extra strain on the development of the infrastructures needed to serve ongoing urbanisation. The reason is that several types of urban infrastructure typically entail large indivisible investments that may end up being economically unviable in sparse communities as these do not allow reaping the corresponding economies of scale. Examples of such investments are mass transit, communication networks, water supplies, power facilities, social services, shelters and services in the case of extreme events. Moreover, in the presence of such large indivisible investments coordination failures may arise whenever the private return is much lower than the social return. When this is the case, high urban density may act as a coordination device by revealing common interests as well as identifying shared objectives and strategies.

Taking stock

43. To summarise, the adverse impacts of climate change on economic activities are particularly disruptive in cities where world population increasingly lives.

44. The creation of climate-proof urban infrastructure often involves large indivisible investments for which the private return is much lower than the social return. Urban sprawl not only reduces the economic viability of those large investments but it also creates coordination failures even when they are economically viable.

CONCLUSION

45. Cities promote economic development by allowing agglomeration economies to materialise. These benefits can be seized provided that effective urban infrastructure fosters knowledge spillovers, labour market pooling, input sharing, demand and cost linkages.

46. Recently urban economies are increasingly under strain. On the cost side, climate change is raising the costs of the clustering of economic activities in cities. On the benefit side, urban sprawl is weakening the social and economic interactions through which agglomeration economies work. Urban sprawl is also weakening the economic and social viability of the large infrastructural investments that are needed to tackle the twin challenges of climate change and urbanisation.

47. In this respect, a crucial prerequisite for the creation of climate-proof urban infrastructure is the implementation of "integrated land use and transport policies that allow for compact cities to develop with clusters of high density nodes that can support mass transit options and efficient grouping of residential developments, commercial services, and centers of employment. This would create lower transit emissions, less energy-intensive development, and proximity to shelters and services in the case of emergencies".[45]

BIBLIOGRAPHY

Anas A., R. Arnott and K. Small (1998), "Urban spatial structure", *Journal of Economic Literature* 36, pp. 1426-1464.

Aschauer D. (1989), "Is Public Expenditure Productive?", *Journal of Monetary Economics* 23, 177-200.

Baldwin R. (1999), "Agglomeration and endogenous capital", *European Economic Review*, n. 43, pp. 253-280.

Baldwin R., P. Martin and G. Ottaviano (2001), "Global income divergence, trade and industrialization: The geography of growth take-off", *Journal of Economic Growth*, n. 6, pp. 5-37.

Baldwin, R., R. Forslid, P. Martin, G. Ottaviano and F. Robert-Nicoud (2003), *Economic Geography and Public Policy*, Princeton University Press, Princeton.

Behrens K., C. Gaigné, G. Ottaviano and J.-F. Thisse (2006), "Is remoteness a locational disadvantage?", *Journal of Economic Geography* 6, pp. 347-368.

Behrens K., A. Lamorgese, G. Ottaviano and T. Tabuchi (2007a), "Changes in transport and non-transport costs: Local vs. global impacts in a spatial network", *Regional Science and Urban Economics*, forthcoming.

Behrens K., A. Lamorgese, G. Ottaviano and T. Tabuchi (2007b), "Testing the 'home market effect' in a multi-country world", CORE-UCLouvain, mimeo.

Borck R., M. Pflüger and M. Wrede (2007), "A simple theory of industry location and residence choice", University of Munich, mimeo.

Brenneman A. and M. Kerf (2002), "Infrastructure and Poverty Linkages: A Literature Review", The World Bank, mimeo.

Calderon C.A. and L. Serven (2003), "The output cost of Latin America's infrastructure gap", in Easterly W. and L. Serven, eds., The Limits of Stabilization: Infrastructure, Public Deficits, and Growth in Latin America. Stanford: Stanford University Press and the World Bank.

Calderon C.A. and L. Serven (2004), "The effects of infrastructure development on growth and income distribution", World Bank Policy Research Working Paper No. 3400.

Cronon W. (1991), *Nature's Megalopolis: Chicago and the Great West*, Norton, New York.

Devarajan S., V. Swaroop and H. Zhou (1996), "The composition of public expenditure and economic growth", *Journal of Monetary Economics* 37, 313-44.

Duranton G. and D. Puga (2004), "Micro-foundations of urban agglomeration economies", in Henderson V. and J.-F. Thisse, *Handbook of Regional and Urban Economics*, vol. 4, Elsevier, Amsterdam.

Easterly W. (2001), “The lost decade: Developing countries' stagnation in spite of policy reform, The World Bank, Mimeo.

Easterly W. and S. Rebelo (1993), “Fiscal policy and economic growth: An empirical investigation”, *Journal of Monetary Economics* 32, 417-58.

Esfahani H. and M.T. Ramirez (2002), “Institutions, infrastructure and economic growth”, *Journal of Development Economics* 70, 443--77.

Estache A. (2003), “On Latin America's infrastructure privatization and its distributional effects”, The World Bank, mimeo.

Feldman M. (1994), *The Geography of Innovation*, Dordrecht, Kluwer Academic Publishers.

Fujita M. and J-F. Thisse (1996), “Economics of agglomeration”, *Journal of the Japanese and International Economies*, n. 10, pp. 339-378.

Fujita M. and J.-F. Thisse (2002), *Economics of Agglomeration: Cities, Industrial Location and Regional Growth* , Cambridge University Press, Cambridge.

Gannon C. and Z. Liu (1997) “Poverty and transport”, The World Bank, mimeo.

Gramlich E. (1994), “Infrastructure investment: A review essay”, *Journal of Economic Literature* 32, pp. 1176-1196.

Harris, C. (1954), “The market as a factor in the localization of industry in the United States”, *Annals of the Association of American Geographers* 64, pp. 315-348.

Head K. and T. Mayer (2004), “The empirics of agglomeration and trade”, in Henderson V. and J.-F. Thisse, *Handbook of Regional and Urban Economics*, vol. 4, Elsevier, Amsterdam.

Helsley, R. and W. Strange (1990), "Agglomeration Economies and Matching in a System of Cities." Regional Science and Urban Economics, 20: 189-212.

Henderson V. (1988), *Economic Theory and the Cities*, Academic Press, London.

Hohenberg P. and L. Lees (1985), *The Making of Urban Europe (1000-1950)*, Harvard University Press, Cambridge MA.

Hulten C. (1996), “Infrastructure capital and economic growth: How well you use it may be more important than how much you have”, NBER Working Paper 5847.

Krugman P. (1991), “Increasing returns and economic geography”, *Journal of Political Economy*, n. 99, pp. 483-499.

Krugman P. (1993), “The hub effect: or, threeness in international trade”, in Ethier W., E. Helpman, and P. Neary, *Theory, Policy and Dynamics in International Trade*, Cambridge University Press, Cambridge.

Krugman P. and A. Venables (1995), “Globalization and the inequality of nations”, *Quarterly Journal of Economics*, n. 110, pp. 857-880.

Kuznets S. (1966) *Modern Economic Growth: Rate, Structure and Spread*, Yale University Press, New Haven.

Loayza N., P. Fajnzylber and C. Calderon (2003), "Economic growth in Latin America and the Caribbean: Stylized facts, explanations and forecasts", The World Bank, mimeo.

Lucas R. (1988) "On the mechanics of economic development", *Journal of Monetary Economics* 22, pp. 3-42.

Marshall A. (1890), *Principles of Economics*, Macmillan, London.

National Research Council (1987) *Infrastructure for the 21st Century: Framework for a research agenda*, National Academy Press, Washington DC.

Ottaviano G. (2008) "Infrastructure and economic geography: An overview of theory and evidence", *European Investment Bank Papers* 13, pp. 8-35.

Ottaviano G. and J.-F. Thisse (2001), "On economic geography in economic theory: increasing returns and pecuniary externalities", *Journal of Economic Geography* 1, pp. 153-179.

Ottaviano G., T. Tabuchi and J.-F. Thisse (2002), "Agglomeration and trade revisited", *International Economic Review* 43, pp. 409-435.

Pirenne H. (1925) Medieval Cities, Princeton University Press, Princeton

Puga D. (1999), "The rise and fall of regional inequalities", *European Economic Review* 43, pp. 303-34.

Puga D. and A. Venables (1997), "Preferential trading arrangements and industrial location", *Journal of International Economics* 43, pp. 347-368.

Pyke F., B. Becattini and W. Sengenberger (1990) *Industrial Districts and Inter-firm Cooperation in Italy*. Geneva, International Institute for Labour Studies.

Röller L-H. and L. Waverman (2001) "Telecommunications Infrastructure and Economic Development: A Simultaneous Approach", *American Economic Review* 91, 909--23.

Rosenthal S. and W. Strange (2004), "Evidence on the nature and sources of agglomeration economies", in Henderson V. and J.-F. Thisse (eds.), *Handbook of Regional and Urban Economics*, vol. 4, Elsevier, Amsterdam.

Sanchez-Robles B. (1998), "Infrastructure investment and growth: Some empirical evidence", *Contemporary Economic Policy* 16, 98-108.

Smith T. (1975), "A choice theory of spatial interaction", *Regional Science and Urban Economics* 5, pp. 137-176.

Venables A. (1996), "Equilibrium locations of vertically linked industries", *International Economic Review* 37, pp. 341-359.

Williamson J. (1988) "Migration and Urbanization", in H. Chenery and T.N. Srinivasan (eds.), *Handbook of Development Economics*, vol. 1, North Holland, Amsterdam.

World Bank (1994) *World Development Report*. Washington DC: The World Bank.

World Bank (2003) *Inequality in Latin America and the Caribbean*. Washington DC: World Bank Latin American and Caribbean Studies.

World Bank (2008) *Climate Resilient Cities*. Washington DC: The World Bank.

11

* Expert presentation prepared for the *2nd Annual Meeting of the OECD Roundtable Strategy for Urban Development "Competitive Cities and Climate Change"*, 9-10 October 2008, Milan, Italy. Sections 2 and 3 are based on Ottaviano (2008). Email: gianmarco.ottaviano@unibo.it.

[2] National Research Council (1987).
[3] Kuznets (1966).

[4] Hohenberg and Lees (1985).

[5]The role of cities in economic growth and technological progress has been emphasized by urban economists (Henderson, 1988, Fujita and Thisse, 1996), development economists (Williamson, 1988) as well as by economists of growth (Lucas, 1988).

[6] Pirenne (1925).

[7] The distinction between 'first nature' and 'second nature' is due to Cronon (1991).

[8] See Fujita and Thisse (2002) for a thorough assessment of the relative merits of the different approaches.

[9] Fujita and Thisse (1996).

[10] The taxonomy adopted here is the one proposed by Rosenthal and Strange (2004).

[11] See Duranton and Puga (2004) for a theoretical survey of the microfoundations of agglomeration economies.

[12] Marshall (1890).

[13] Feldman (1994).

[14] For example, in Helsley and Strange (1990) an increase in the number of agents trying to match improves the expected quality of each match.

[15] Krugman (1991); Ottaviano, Tabuchi and Thisse (2002).

[16] When agglomeration fosters capital accumulation, the outcome is similar to the one with migration. The reason is that both expand the local market through the additional income they generate. See, e.g., Baldwin (1999) as well as Baldwin et al (2001).

[17] Krugman and Venables (1995); Venables (1996).

[18] World Bank (1994).

[19] Calderon and Serven (2004).

[20] This is highlighted in a seminal contribution by Aschauer (1989), who finds that the stock of public infrastructure capital is a significant driver of aggregate TFP. Even though subsequent efforts question Aschauer's quantitative assessment, overall his qualitative insight survives more sophisticated econometric scrutiny (see, e.g., Gramlich, 1994; Röller and Waverman, 2001).

[21] Calderon and Serven (2003).

[22] Easterly and Rebelo (1993).

[23] Sanchez-Robles (1998) on physical infrastructure; Easterly (2001) as well as Loayza, Fajnzylber and Calderon (2003) on telecommunications.

[24] Devarajan et al (1996); Hulten (1996); Esfahani and Ramirez (2002).

[25] World Bank (2003).

[26] See Brenneman and Kerf (2002) for a survey.

[27] Estache (2003).

[28] Gannon and Liu (1997).

[29] See, e.g., Baldwin et al (2003).

[30] Ottaviano and Thisse (2001).

[31] Anas, Arnott and Small (1998).

[32] Pyke, Becattini and Sengenberger (1990).

[33] Smith (1975).

[34] Behrens, Lamorgese et al (2007a,b).

[35] Attraction and accessibility are also the main ingredients of gravitational models of international trade (see, e.g., Head and Mayer, 2004).

[36] Martin and Rogers (1995).

[37] Behrens, Lamorgese et al (2007a,b).

[38] Behrens, Gaigné et al (2006).

[39] Krugman (1993), Behrens, Gaigné et al (2006).

[40] Puga (1999).

[41] Borck, Pflüger and Wrede (2007).

[42] Baldwin, Martin and Ottaviano (2001).

[43] See, e.g., Behrens, Gaigné et al (2006). Similar results hold true in the absence of interregional migration whenever firms are linked by strong input-output ties (Puga and Venables, 1997).

[44] Behrens, Gaigné et al (2006).

[45] World Bank (2008).