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The rise of the mega-region

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This paper develops new data on mega-regions. It takes issue with theories of globalization which argue that global economic activity is being more widely decentralized—'the world is flat'. We use a global dataset of night-time light emissions to produce an objectively consistent set of mega-regions for the globe. We draw on high-resolution population data to estimate the population of each of these regions. We then process the light data in combination with national gross domestic product (GDP) to produce rough but useful regional estimates of economic activity. We also present estimates of technological and scientific innovation.

Keywords: mega-region, globalization, urbanization, night-time lights
JEL Classifications: O18, R10

Introduction

When we think about economic growth and development, we usually think in terms of nation states. But the past two or three decades have seen the rise of a new economic unit—the mega-region. At the time when the great classical economists were framing economic theory, nations truly were the space over which labour and capital were reallocated by the economic process. International investment and travel existed, but they were burdensome and not nearly as common as they have become. Nations were thus natural units of macroeconomic analysis and these nations were productively conceived as being composed of cities and hinterlands. In the 21st Century, however, the emergence of globalization makes national boundaries mean a lot less. Capital can now be allocated freely around the globe—seeking maximum return wherever that may be. Even labour, particularly highly creative and productive labour, can be reallocated globally in a way that would once have been impractical.

This has meant that other units of spatial analysis are increasing in importance and relevance vis-a-vis the nation state. One that appears increasingly important is the mega-region. Mega-regions are integrated sets of cities and their surrounding suburban hinterlands across which labour and capital can be reallocated at very low cost. The 40 that we identify

here all have economies on the scale of $100 billion or more. Similarly, the 40th largest nation in terms of gross domestic product (GDP) also has an economy of about $100 billion.

The mega-regions of today perform functions that are somewhat similar to those of the great cities of the past—massing together talent, productive capability, innovation and markets. But they do this on a far larger scale. Furthermore, while cities in the past were part of national systems, globalization has exposed them to worldwide competition. As the distribution of economic activity has gone global, the city system has also become global—meaning that cities now compete on a global terrain. Urban mega-regions are coming to relate to the global economy in much the same way that metropolitan regions relate to national economies.

Friedman (2005) argues that technology and globalization combine to flatten the world economy and that this geographic location is becoming less relevant. Friedman focuses almost exclusively on the global forces that act to pull economic activity apart. There is, however, a strong set of counterforces that lead to geographic clustering and the pushing together, so to speak, of economic activity. The mega-region, as this paper will show, is a consequence and a reflection of this clustering force. While it may be technologically possible to do high-tech work in obscure, remote locations, we seldom observe this in practice—innovative industries still tend to cluster. There are many reasons for this including local spillovers and synergistic labour markets. The immense pools of productive labour and innovative industries that come together in modern mega-regions allow them to compete in the global market in a way that is very difficult for smaller places to match. The economic transformation of China, for example, is by no means evenly spread across its vast territory or among its huge population. It is, rather, focused in a handful of tremendously dynamic coastal mega-regions. This phenomenon has produced the most massive urban migration in history as people scramble to get in on the action. While it may no longer be necessary to emigrate in order to innovate, it remains critically important to be in the right kind of place. An ambitious Chinese entrepreneur need not leave China, but still must move to one of these global hot spots. China, in other words, is far from 'flat'—and the same is true across the globe.

The gradients between the nation states that are the subject of international macroeconomic analysis may be dissolving (though the degree of this dissolution is often overstated, see Leamer, 2007), but that does not mean that location is becoming irrelevant. Instead, it means that the relevant unit of analysis is shifting from the politically dictated units of the nation state towards the economically emergent units of the global mega-region. Subglobal markets still matter and location still has a lot to do with the making of markets. The world remains extremely lumpy, spiky, hilly, etc., but the shapes of the lumps are changing. Though the economic dissolution of the nation state is not (and probably never will be) complete, the mega-region is emerging as a critical organizational level in this new global terrain.

While others have used different methods to define mega-regions in various parts of the world (see e.g. Gottman, 1961; Lang and Dhavale, 2005; PricewaterhouseCoopers, 2007; Regional Plan Association, 2006; Scott, 2001; Yusuf, 2007) or contributed to the understanding of their evolution and significance (Axtell and Florida, 2001; Glaeser, 2007; Ohmae, 1993), there has not, to date, been a method for systematically defining the global set of mega-regions and consistently estimating their attributes. This paper seeks to do this, based on a global dataset of nighttime lights. We use these data to produce an objectively consistent set of mega-regions for the globe. We draw on high-resolution population data to estimate the population of each of these regions. We then process the light data in combination with published estimates of national GDP to produce rough but useful estimates of the economic activity of each region. Finally, we draw on other sources to estimate both technological and scientific innovation for each.

Concepts and theory

The classical economists Smith (1776) and Ricardo (1817) both argued that nation states were the geographic engines behind economic growth. Most students of economic history see a progression from

rural villages to cities to nation states. The reality is that economic activity—such as trade, commerce and innovation—has always originated in cities. Jacobs (1961, 1969, 1984) long ago argued that cities are key mechanisms in economic development (see also Lucas, 1988). A dynamic city, according to Jacobs, integrates its hinterland and becomes a 'city region'. As nearby farmland is revolutionized by city-created technology and innovation, rural dwellers move closer to town to assume jobs in urban industry. As the city generates more output, more money becomes available for civic and infrastructure improvement as well as new technology and innovation to aid the city's outlying areas. Jacobs refutes the long-standing theory that cities emerged only after agriculture had become sufficiently productive to produce a surplus beyond what was needed to survive. In fact the earliest cities, according to Jacobs, formed around rudimentary trade in wild animals and grains, which led them to discover agriculture and the fiscal benefits of product exportation. Even activities typically considered 'rural' originated in cities before proliferating in outlying regions. Productivity improvements in agriculture, Jacobs points out, always originated in cities before they were adopted in farming areas: the mechanical reaper, for instance, was originally invented, perfected and used in cities before the technology reached and revolutionized rural agricultural areas.

The importance of trade identified by Ricardo and given mathematical form by Ohlin (1933) still matters today, but national borders no longer define economies. Instead, the mega-region has emerged as the new 'natural' economic unit. The mega-region is not an artefact of artificial political boundaries, like the nation state or even its provinces, but the product of concentrations of centres of innovation, production and consumer markets. Today's mega-regions extend far beyond individual cities and their hinterlands (e.g. Meijers, 2005).

Mega-regions are more than just a bigger version of a city or a metropolitan region. As a city is composed of separate neighbourhoods, and as a metropolitan region is made up of a central city and its suburbs, a mega-region is a polycentric agglomeration of cites and their lower density hinterlands. It represents the new, natural economic unit that emerges as metropolitan regions not only grow upward and become denser but also grow outward and into one another. Just as a city is not simply a large neighbourhood, a mega-region is not simply a large city—it is an 'emergent' entity with characteristics that are qualitatively different from those of its constituent cities.

The construct of the mega-region has a long history. Gottman (1957) originally coined the term 'megalopolis' to describe the emerging economic hub that was the Boston-to-Washington corridor. Derived from the Greek and meaning 'very large city', the term was later applied to a number of other regions: the great swath of California stretching from San Francisco to San Diego, the vast Midwestern megalopolis running from Chicago through Detroit and Cleveland and down to Pittsburgh and the bustling Tokyo–Osaka region of Japan.

Ohmae (1993) later argued that 'region states' had replaced nation states as the organizing economic units the global economy.

> Region states may lie entirely within or across the borders of a nation state. This does not matter. It is the irrelevant result of historical accident. What defines them is not the location of their political borders but the fact that they are the right size and scale to be the true, natural business units in today's global economy. Theirs are the borders—and connections—that matter in a borderless world.

In a similar vein, Scott observes two concurrent reorganizations of modern capitalism. National economic systems are folding into a world capitalist order in a process widely defined as 'globalization', while certain regional centres serve as entry points for, and 'motors of' this global system (Scott, 1996, and Sassen, 2006).

There is a considerable, related literature on 'world cities'. Sassen (1991) originally introduced the concept of world cities and has identified the critical role and function of large world cities like New York, London and Tokyo in the global

economy. Taylor (2003, 2005) identified a hierarchical system of 'global cities' according to their functions and connectivity. Sassen (2008) finds specialized differentiation between world cities to be an important driver of the world economy, while also identifying a critical need for standards in both production techniques and built environments. Numerous attempts have been made to sketch a world city hierarchy according to airline patterns (see Derudder and Witlox, 2005) commercial services (Taylor, 2005), labour migration (Beaverstock and Smith, 1996) and immigration (Benton-Short et al., 2005).

Sassen (2008) argues for a heterogeneous conception of global cities. She observes that 'the global network' is composed of numerous sector-based circuits each dominated by different cities. For instance, Chicago may exert a controlling influence in some financial sectors, while it is more marginal in others. She defines global cities loosely as infrastructures for advanced capitalist operations and not necessarily members of a 'roster' of global cities, each of whom conforms with pre-set criteria (also see Beaverstock et al., 1999).

Not all large metropolitan areas meet the criteria of mega-regions. Large but poor 'mega-cities' like Calcutta or Delhi are 'immense human aggregations', Ohmae (1993) writes that 'either do not or cannot look to the global economy for solutions to their problems or for the resources to make those solutions work. They look instead to the central governments of the nation states in which they reside.' Scott (1996) considers these large cities to be at the frontier of global capitalism, without the economic organization that gives them limited access to global networks and/or productive agglomeration economies. He foresees the convergence of some regions such as Bangkok or Kuala Lampur with global city powerhouses, but cautions that such a transition is not free of instability.

It is important to differentiate between size (measured as population) and levels of economic activity. There are many large 'mega-cities' so to speak, which do not meet the criteria for being a mega-region. Mega-regions by definition have large populations, but they also possess large markets, significant economic capacity, substantial innovative activity and highly skilled talent.

Examining mega-regions in terms of population can be highly misleading. Mega-cities are generally conceived in terms of population (often as metropolitan areas of 10 million or more). In many cases, these mega-cities seem to have arisen with a price, especially in the underdeveloped parts of the world. Retsinas (2007) describes the problems stemming from developing world mega-cities in terms of poverty, disease and despair in many of the fastest growing regions in the world, comparing those with the problems related to the urbanization process during the industrial revolution as experienced by Dickens and Marx.

There have been numerous attempts to quantify and to describe the evolution of the mega-regions. Glaeser (2007) examines the factors behind the growth of American metropolitan regions into mega-regions. He comes to the conclusion that it is the initially less dense areas that have experienced the fastest growth and speculates that this reflects the importance of accessibility by car. He also finds that climate seems to play a part in the development of the fastest growing regions. In contrast to a number of results concerning metropolitan areas (Ciccone and Hall, 1996; Glaeser and Mare, 2001; Overman and Venables, 2005), Glaeser finds no evidence that initial income impacts population growth in the mega-regions; finding instead that population growth is an effect of successful housing supply.

Looking at economic growth and the creation of wealth solely through nation state data is also misleading. Globalization renders national political borders less relevant in economic terms. Firms locate where skill, capabilities and markets cluster; capital flows to where the returns are greatest and highly skilled people move where opportunity lies. To be sure, this results in a more fully integrated global economy. But it also means that both capital and talent concentrate where opportunities for productivity and returns are highest—hence every nation experiences massive concentrations of population and productivity in its largest urban regions. This is true in the advanced economies of the USA,

Europe and Japan, and even more so for the emerging economies like China and India (Wilson and Purushothaman, 2003).

National borders also have increasingly less to do with defining cultural identity. We all know how different two cities can be within the same state, much less the same country. Cities that have not become a part of the global economy are experiencing more than just lagging economies: they are becoming culturally distinct from their mega-region neighbours as well. These growing pains, on top of glaring economic disparities, are exacerbating the divide between the haves and the have-nots—the urban sophisticates and rural people—of the world.

At the same time, that cities within national borders are diverging, mega-regions whose geographic locations could not be farther apart are growing closer. The more two mega-regions—regardless of their physical distance or historical relationship—have in common in terms of their economic output, the more likely they are to develop similar social mores, cultural tastes, political leanings and even built environments (Sassen, 2008). This is not true just for New York and London; even New York and Shanghai arguably have more in common than, say, New York and Louisville.

Data and methods

Since comprehensive subnational data on global economic activity do not exist, we developed a straightforward strategy and method to identify the world's mega-regions. We define mega-regions in terms of contiguously (or very nearly contiguously) lighted areas as seen from space at night. We begin with data from the Earth Observation Program of NOAA's National Geophysical Data Center. These data provide a measure of light intensity for each 30 arcsec cell between $-65°$ and $65°$ latitude. These cells cover approximately 1 km^2 at the equator and become somewhat smaller at higher and lower latitudes.

We then set a light threshold that captures the essence of the US mega-regions described by Lang and Dhavale (2005) and the Regional Plan Association (2006). These authors and others have used much more complex methods, including measures of commuting patterns, etc. We find that while these factors are critically important for understanding the functioning of a mega-region, contiguous development is a good enough proxy for economic integration that it can meaningfully be used in this context. Intuitively, then, we are defining a mega-region as a very large area across which one could walk, carrying only money, without getting hungry.

After we determine the threshold that gives the best approximation of the established US mega-regions, we apply this same threshold to the night-time lights dataset for the rest of the world. This produces tens of thousands of lighted patches representing the full range of settlement sizes—from the largest mega-regions covering thousands of square kilometres to small villages and other light sources that are on the order of a single square kilometre. We then proceed to close small gaps, merging lighted areas that are separated by less than 2 km. In some cases, in the heavily industrialized regions of Northeastern North America, Europe and Japan, this approach generates mega-regions that tenuously connect to one another. In these cases, we split the conjoined regions at their narrowest connections. Finally, we estimate economic activity for each of the areas using the method described below and establish a threshold of economic activity that defines an area as a global mega-region.

Our method possesses both strengths and weaknesses. It enables us to identify a consistent and systematic set of mega-regions worldwide. It is novel in this regard. Using light emissions to define mega-regions provides results that are consistent if somewhat speculative. The idea here is not that contiguous development is required for the functioning of a mega-region, but rather that contiguous development results from that functioning. If multiple urban centres become deeply integrated to the point where their labour markets (i.e. commuter sheds) and local supply chains overlap, the interstitial spaces between them will tend to fill with lower density development. This method leads us to identify mega-region borders which are at times different than those others have identified. The

Figure 1. *Global distribution of economic activity (LRP). Used by permission of Dr Richard Florida. Copyright © 2008 Richard Florida. All rights reserved.*

relationship between Las Vegas and the Southern California mega-region anchored by Los Angeles provides an interesting example. The Regional Plan Association (2006) includes Las Vegas in the So-Cal mega, while we do not. Our omission of Las Vegas may be an artefact of the physical geography of the area as the Sierra Nevada is not developable for a host of reasons—no matter how closely the two metros may be integrated. On the other hand, one might also argue that the inclusion of Los Vegas is an artefact of the sprawling nature of the counties in the American Southwest—San Bernardino county, is contiguous with Clark county, even though the urban fringes of these metros are separated by nearly 90 miles.

Others argue that our definition, based on light emissions, does not account for many of the cultural and political factors, as well as network connectivity, that inform and shape regions and mega-regions. That, we note, is an important and useful criticism. No method can do everything. And our method, dependent as it is on light emission patterns, does not account for such historical, cultural, political or social context. Its strength, however, lies in the application of a systematic criterion for identifying global mega-regions, something that to our knowledge has not been done. We encourage other research, some of which we will be pursing, to add to our dataset of mega-regions by capturing systematic and comparable information, particularly on network connectivity and related factors.

The use of light footprints to define mega-regions produces a precise and complex boundary for each region. While this boundary bears a meaningful resemblance to the pattern of urbanization it describes, it often does not bear much resemblance to the political and administrative boundaries for which statistics are generally calculated—making it difficult to develop indicators for these regions. We begin to address this by estimating values for four variables that are important in understanding the relative size and global importance of each region. These variables are economic activity, population, patent activity as a proxy for technological innovation and highly cited scientific authors as a measure of basic scientific innovation.

Economic activity: light-based regional product

We use the light that is visible from space at night as a basis for estimating economic activity. The relationship between light emission and GDP is complex and their correlation is imperfect. We take a pragmatic and empirical approach that we are still refining. We will present a detailed account of this procedure elsewhere. Here, we will simply outline the method.

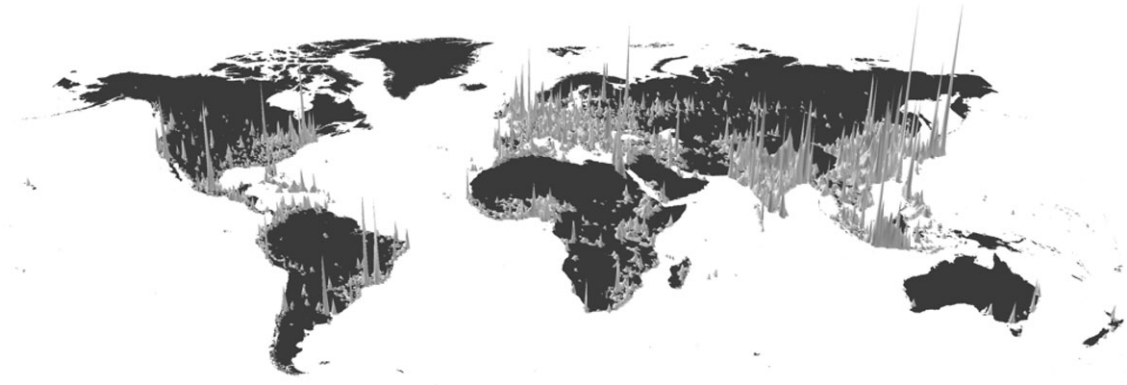

Figure 2. *Global Distribution of Population. Used by permission of Dr Richard Florida. Copyright © 2008 Richard Florida. All rights reserved.*

Figure 3. *Global distribution of patent activity. Used by permission of Dr Richard Florida. Copyright © 2008 Richard Florida. All rights reserved.*

We begin with light emission data for the year 2000 (Doll et al., 2000). These data have limited range. While they capture low light levels that are consistent with low-density suburban and electrified semi-rural areas, the measured emission level saturates far from the most economically intense centre of a major city due to the design of the sensors and the processing algorithms used by the National Geophysical Data Center. This saturation begins in the inner suburbs of large American cities. While this presents a challenge in producing estimates, we find that it is not insurmountable. This data limitation is in some ways liberating because we suspect that the relationship between light emissions and economic activity breaks down as higher levels of urbanization expand vertically rather than horizontally. We would thus be forced to estimate central cities differently from their surroundings in any case.

To deal with the problem of saturation of urban cores, we break the process of estimating economic activity from light emissions into two stages: we estimate activity levels for low light areas, including urban peripheries, as a direct function of light level. We separately estimate urban cores as a function of both area and shape.

Figure 4. *Global distribution of star scientists (highly cited science authors). Used by permission of Dr Richard Florida. Copyright © 2008 Richard Florida. All rights reserved.*

We calibrate our model using estimates of 2001 GDP for the 356 metropolitan areas in the lower 48 US states prepared by the US Conference of Mayors (USCoM) (Global Insight, 2006). This calibration also yields an objective measure of the precision of this process—we are able to reproduce the USCoM GDP estimates with a standard error of 34%. In evaluating this number, it should be borne in mind that the USCoM estimate also contains measurement error. It is worth noting that the larger the area in question, the more accurate the estimate (because local errors tend to cancel) and that the current application is to areas larger than all but the largest US metropolitan regions. For these reasons, we believe the mega-regional GDP estimates to be more precise than the estimates for US metropolitan areas. Still, while the method yields reasonable—and objective—estimates of GDP for each mega-region, their precision should not be over interpreted. This method can be compared to that of Doll et al (2006) which used satellite light emission data to identify geographic clusters of economic activity in the US and Europe. They also found that when these data are appropriately processed they could produce estimates of regional economic activity that correlate reasonably well with published estimates. The primary difference between the two approaches is that we improve this correlation by treating the saturated core areas separately from the periphery as described above.

We deal with the problem of translating physical economic activity into standard units by renormalizing the total for each nation to agree with that nation's 2000 GDP in 2000 US dollars at current market exchange rates (World Bank, 2006). We thus use the light-derived estimates to establish the relative importance of pixels within nations while maintaining consistency with published estimates at the national level.

Finally, in cases where we have high quality metropolitan region estimates for areas with well-defined borders, we renormalize those areas to agree with the published estimates. At this point, we use such data only for the 365 US metropolitan areas estimated by the USCoM, but this could be expanded to cover other metro areas for which reliable numbers can be obtained. In this case, the light-based estimates represent the relative level of activity within the metropolitan region. When such subregional adjustments are made, we again renormalize the national total to coincide with World Development Indicators national estimates.

The result of this process is an estimate of economic activity for every 30-arcsec grid cell (less than 1 km^2) in the world. We refer to this indicator as light-based regional product or LRP. While it is expressed in the same nominal dollars as GDP and designed to aggregate up to published estimates of GDP, we believe that it is different enough in terms

of both its derivation and its conceptual design that is best identified with its own name.

LRP can be summed for any arbitrarily defined area including our newly defined mega-regions. While it is less reliable inside the urban core areas, where economic activity is estimated as a function of area and shape rather than directly inferred from light levels, this does not present a problem for mega-region estimation because mega-region boundaries cannot, by definition, pass through urban cores.

Population

Population is estimated by summing population estimates for 30-arcsec grid cells from the 2005 LandScan dataset (Oak Ridge National Laboratory, 2006) within each light-based mega-region polygon. Because light data are used as one of several inputs for producing these estimates, we find that they produce more plausible estimates for light-based urban regions than does the similar Gridded Population of the World dataset (CIESIN, 2006) which is based on local census and administrative records.

Patents

We estimate patents for world mega-regions by conflating city-specific data from the US Patent and Trademark Office (USPTO) with nationally aggregated data from the World Intellectual Property Office (WIPO).

Because inventors from around the world file for patent protection in the USA, and the USPTO tracks the city of residence of the inventor, we can count the number of US patents for each city in the world. While this file provides a fine portrait of inventions in US cities, it undercounts (sometimes radically) inventions in other countries due to the fact that not every inventor files for a US patent. We compensate for this by using the USPTO data to estimate the relative importance of the cities within each country. We then take the number of patents reported to WIPO by each national patent office as granted to domestic inventors and reallocate them to cities using the weights derived from the USPTO data. We thus assume that inventors who patent in the USA have the same spatial distribution as inventors who patent domestically. This may overstate the importance of major cities (where access to the world patent system might be easier), but we believe that this is not a large source of bias.

When the city estimates are complete, we sum the estimated patents for all the cities that fall within a given mega-region.

Star scientists

We use the location of highly cited scientific authors as a proxy for basic scientific innovation. We derive this from data compiled by Batty (2002), aggregating upward from the city level to the mega-region. It is important to note that the scope of these data is limited, excluding mathematics, the social sciences and the humanities and are thus skewed heavily towards medicine (Batty 2002).

Findings

Tables 1 and 2 summarize key statistics on the economic size and scale of the world's largest

Table 1. *Distributions based on population rankings*

	LRP		Population		Patents		Scientific citations	
	Absolute number (billion dollars)	Share (%)	Absolute number (millions)	Share (%)	Absolute number	Share (%)	Absolute number	Share (%)
Top 10	7891	25.1	666	10.5	123,932	41.1	423	35.0
Top 20	13,433	42.8	1081	17.0	184,240	61.1	520	43.1
Top 40	18,489	58.9	1478	23.2	231,797	76.8	785	64.9

Table 2. *Distributions based on LRP rankings*

	LRP		Population		Patents		Author citation	
	Absolute number (billion dollars)	Share (%)	Absolute number (millions)	Share (%)	Absolute number	Share (%)	Absolute number	Share (%)
Top 10	13,433	42.8	416	6.5	170,885	56.6	672	55.6
Top 20	17,777	56.6	636	10.0	229,212	76.0	925	76.5
Top 40	20,711	66.0	1125	17.7	258,181	85.6	912	88.3

mega-regions. Table 3 provides a list of the top 40 mega-regions worldwide. As our findings make clear; out of roughly 200 nations in the world and their thousands upon thousands of cities, only a small number of economic mega-regions power and structure the world economy. There are two mega-regions—Greater Tokyo and Bos-Wash—which generate more than $2 trillion in LRP, while another five produce in excess of $1 trillion in LRP.

As Table 1 shows, if we take the largest mega-regions in terms of population, the world's 10 biggest are home to roughly 666 million people or 10.5% of world population; the top 20 comprise close to 1.1 billion people, 17% of the world total; while the top 40 are home to 1.5 billion people, 23% of global population.

As Table 2 shows, the economic role of mega-regions becomes even clearer when we look at economic output measured as LRP. The world's 10 largest mega-regions in terms of LRP house only about 416 million people, or 6.5% of the world's population, but account for 42.8% of economic activity ($13.4 trillion), 56.6% of patented innovations and 55.6% of the most-cited scientists. The top 20 mega-regions in terms of economic activity account for 10% of population, 56.6% of economic activity, 76% of patented innovations and 76.5% of the most-cited scientists. And the top 40 mega-regions in economic activity, which make up about 17.7% of the world's population, produce 66% of economic activity, 85.6% of patented innovations and 83.3% of the most-cited scientists.

We find that there is a marked concentration of economic activity in the mega-regions of the USA and the European Union. In the USA, LRP per capita is nearly 30% higher in the mega-regions than it is in the rest of the country. In the European Union, this figure is over 40%.

Having identified a consistently defined set of global mega-regions, we can set about the task of examining them to better understand the role each one plays in both its regional and its global context. The following sections provide maps and discussion of the major mega-regions in North America, Europe, Asia and the emerging economies.

North America

Figure 5 is a map of the mega-regions in North America. The Boston–New York–Washington corridor is the second largest mega-region in the world. When originally identified by Gottman in 1961, it was home to about 32 million people; today it is home to some 54.3 million, more than 18% of all Americans. Generating $2.2 trillion in LRP it is larger than all but two national economies—those being the USA and Japan. Its economic output is greater than that of France or the UK, and more than double the size of India's or Canada's.

The Chicago–Pittsburgh mega-region, originally dubbed 'Chi-Pitts' by Gottman, covers more than 100,000 square miles and is home to 46 million people and $1.6 trillion in LRP. The So-Cal or Southern California mega-region, which runs from Los Angeles to San Diego and Tijuana, is home to 21.4 million people and the source of $710 billion in LRP. A second mega-region in California is NorCal surrounding the San Francisco Bay area (rank 14). Claiming 12.8 million people and more than $470 billion in LRP, it is a leading centre of technology industry and venture capital and is home to a cluster of world-class universities. The Char-lanta

Table 3. *Top 40 mega-regions based on LRP*

Name	Population (millions)	Population rank	LRP 2000 (billion dollars)	LRP rank	Patents (2001)	Patent rank	Authors (2001)	Author rank
Greater Tokyo	55.1	4	2500	1	91,280	1	11	16
Bos-Wash	54.3	5	2200	2	21,307	3	293	1
Chi-Pitts	46.0	9	1600	3	17,686	4	67	5
Am-Brus-Twerp	59.3	3	1500	4	6985	9	29	11
Osaka-Nagoya	36.0	14	1400	5	15,897	5	9	20
Lon-Leed-Chester	50.1	6	1200	6	3315	14	89	3
Rom-Mil-Tur	48.3	7	1000	7	4000	33	12	14
Char-lanta	22.4	18	730	8	4188	11	49	7
So-Cal	21.4	22	710	9	6902	10	74	4
Frank-Gart	23.1	17	630	10	3199	15	39	8
Barce-Lyon	25.0	16	610	11	1896	23	10	17
Tor-Buff-Chester	22.1	19	530	12	3402	12	56	6
Seoul-San	46.1	8	500	13	21,833	2	0	40
Nor-Cal	12.8	28	470	14	11,567	6	108	2
So-Flo	15.1	25	430	15	2693	19	8	22
Fuku-kyushu	18.5	24	430	16	1965	21	9	20
Paris	14.7	26	380	17	9007	8	16	13
Dal-Austin	10.4	30	370	18	3149	17	16	13
Hou-Orleans	9.7	32	330	19	2724	18	30	10
Mexico City	45.5	10	290	20	91	35	0	40
Cascadia	8.9	33	260	21	3179	16	33	9
Rio-Paulo	43.4	12	230	22	457	30	0	40
Hong-Zen	44.9	11	220	23	2231	20	1	31
Sapporo	4.3	37	200	24	232	32	0	40
Vienna-pest	21.8	21	180	25	1365	26	1	31
Tel Aviv-Amman-Beirut	30.9	15	160	26	377	31	8	22
Prague	10.4	29	150	27	3400	13	2	25
Buenos Aires	14.0	27	150	28	95	34	0	40
Denver-Boulder	3.7	40	140	29	1921	22	11	16
Phoenix-Tucson	4.7	36	140	30	1652	24	6	24
Shanghai	66.4	2	130	31	988	27	0	40
Taipei	21.8	20	130	32	5000	37	1	31
Lisbon	9.9	31	110	33	44	39	1	31
Beijing	43.1	13	110	34	1582	25	0	40
Delhi–Lahore	121.6	1	110	35	160	36	0	40
Glasburgh	3.8	39	110	36	643	29	9	20
Berlin	4.1	38	110	37	9998	7	7	23
Singapore	6.1	34	100	38	170	40	1	31
Madrid	5.9	35	100	39	849	28	1	31
Bangkok	19.2	23	100	40	58	38	0	40

mega-region that runs from Charlotte through Atlanta is home to 22 million people and produces $730 billion in LRP, making it bigger than India's GDP and about the same size as Canada's. In Texas, there is the substantial economic triangle that encompasses Dallas, San Antonio and Austin, housing 10 million people and producing $370 billion in LRP. Also in Texas, running from Houston to New Orleans is a mega-region of 10 million people and the source of $330 billion in LRP. The Cascadia corridor stretches up from Portland, OR, through Seattle and into Vancouver, Canada. It

Figure 5. *North America mega-regions. Used by permission of Dr Richard Florida. Copyright © 2008 Richard Florida. All rights reserved.*

is also strong in technology-based industry, particularly with regard to software publishing and aerospace manufacturing, but the region also specializes in lifestyle industries. Microsoft, Amazon, Real Networks, Starbucks, REI and Costco all have their roots in this mega-region. Denver–Boulder and Phoenix–Tucson each generates about $140 billion in LRP.

Europe

Figure 6 is a map of the mega-regions of Europe. Like America's 50 states, the countries of Europe nation are also historical artefacts defined by political, linguistic and geographic boundaries. The major economies of Europe are a small number of world-class mega-regions that compose the bulk of the continent's innovation and production. European mega-regions are comparable in size to their North American and Asian counterparts, even though most of the metropolitan areas of which they are composed are smaller (with the notable exceptions of London and Paris). We believe that this makes a mega-regional perspective particularly important in the European context.

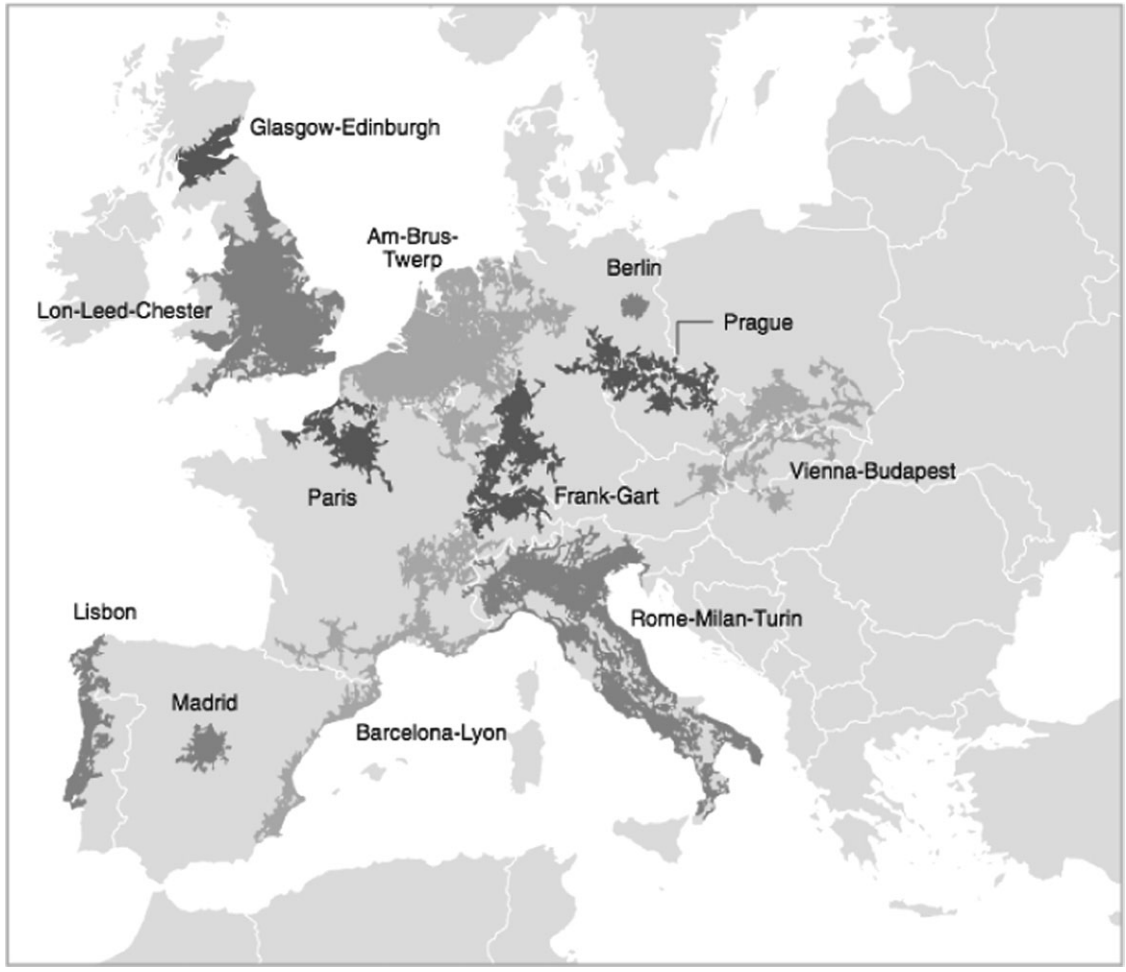

Figure 6. *Europe mega-regions. Used by permission of Dr Richard Florida. Copyright © 2008 Richard Florida. All rights reserved.*

Europe's largest mega-region is the enormous economic composite spanning Amsterdam–Rotterdam, Ruhr–Cologne, Brussels–Antwerp and Lille. Housing 59.2 million people and producing nearly $1.5 trillion in economic output, this mega-region's production exceeds Canada's and as well as China's or Italy's. Next in size is the British mega-region stretching from London through Leeds, Manchester, Liverpool and into Birmingham. This mega-region is home to 50 million people and responsible for $1.2 trillion in economic output. The Italian mega-region stretching from Milan through Rome to Turin is a leading centre for fashion and industrial design. In total, 48 million people produce some $1 trillion in output, making it the third largest economic conglomerate in Europe and the seventh largest in the world. In Germany, the mega-region encompassing Stuttgart, Frankfurt and Mannheim is home to 23 million people. To the west is Greater Paris, a mega-region of 14.7 million people accountable for $380 billion in LRP. The binational Euro-Sunbelt mega-region (rank 11), which stretches from Barcelona into Marseille and then Lyon, claims some 25 million people who produce $610

billion in LRP. Vienna-pest ($180 billion in LRP), Prague ($150 billion LRP), Lisbon ($110 LRP), Scotland's Glasburgh ($110 LRP), Madrid ($100 billion LRP) and Berlin ($100 billion LRP) round out the list of Europe's mega-regions.

Asia

Figure 7 is a map of the mega-regions of Asia. Japan is home to four significant mega-regions. Greater Tokyo (rank 1), home to more than 55 million people and responsible for nearly $2.5 trillion in economic output, is the world's largest mega-region, with world-class strengths in finance, design and high technology. The mega-region stretching from Osaka to Nagasaki is home to 36 more million people who generate $1.4 trillion in output. Fuku-kyushu houses 18.5 million people and produces 430 billion in LRP. Greater Sapporo is home to 4.3 million people, producing $200 billion in

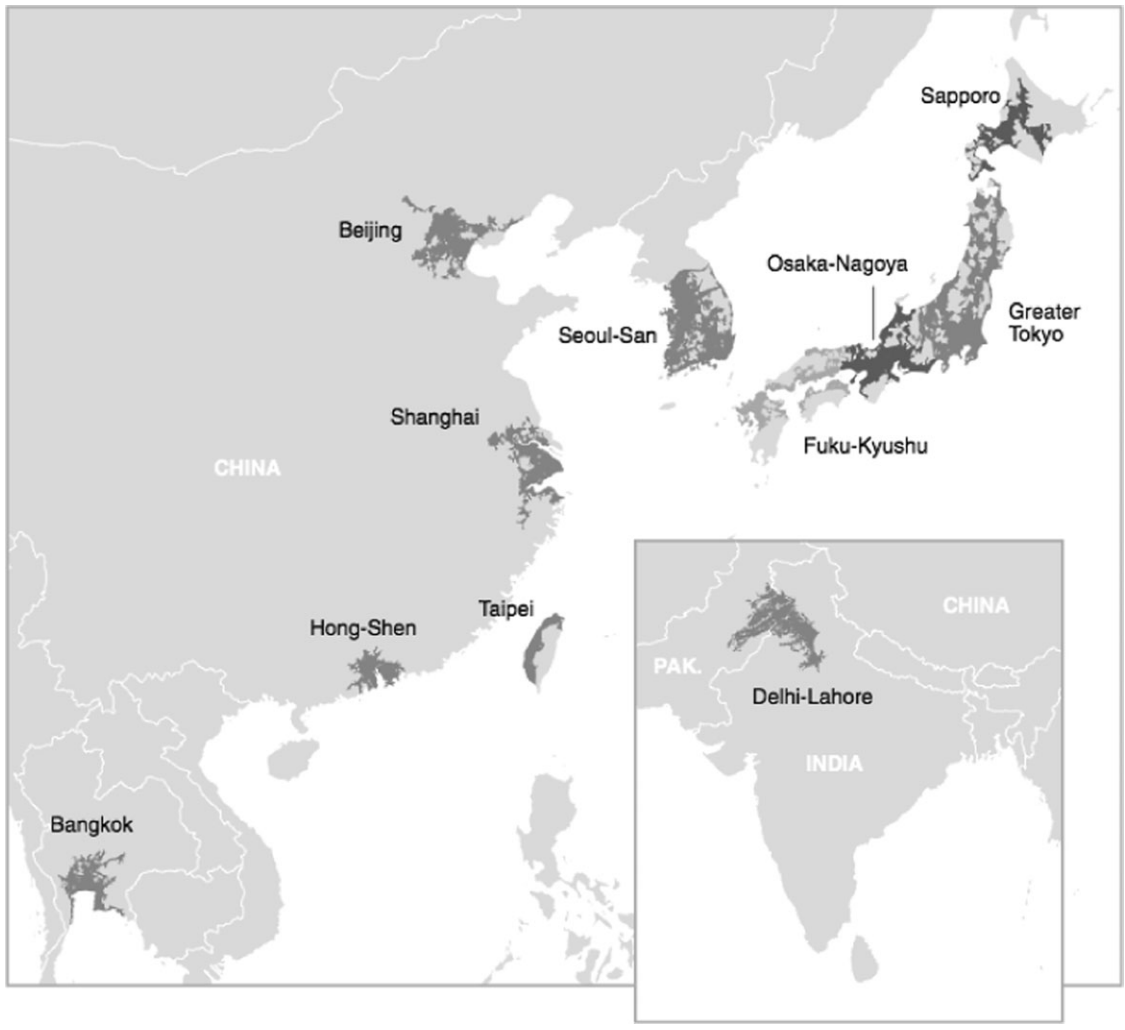

Figure 7. *Asia mega-regions. Used by permission of Dr Richard Florida. Copyright © 2008 Richard Florida. All rights reserved.*

LRP. Our light mapping procedures indicate that the boundaries between these megas are indeed blurring and that much of Japan may be becoming an integrated super-mega-region. This merging is illustrated by the fact that three of Japans four mega-regions are served by the same high-speed rail system (with extensions planned for service to Sapporo).

The mega-region that runs from Seoul to Busan (rank 13) houses 46 million people and produces 500 billion in LRP. Greater Singapore is a classic city state, whose population of 6 million (nearly 2 million of whom are actually across the border in Malaysia) generates a GDP of more than $100 billion. It has 'willingly and explicitly given up the trappings of nation states', Kenichi Ohmae writes about the country, 'in return for the relatively unfettered ability to tap into … the global economy' (Ohmae, 1993). The Bangkok mega-region is home to 19 million people, producing $100 billion in economic output.

Mega-regions in the emerging economies

There are also mega-regions in the emerging economies. Recall that we identify mega-regions as significant economic centres producing at least $100 billion in LRP. Mega-regions, as per our definition, thus differ from the mega-cities of the emerging economies and developing world, which though they house large populations, do not meet our threshold for economic activity.

China is home to three significant mega-regions. The Hong Kong—Shenzhen (or Hong-zhen) mega-region is anchored by the established manufacturing powerhouse of Hong Kong, but also includes the fast-growing centres of Shenzhen and Guangdong. It includes 44.9 million people and produces $220 billion in LRP. The Shanghai mega-region is home to 66 million people, producing $130 billion in LRP in 2000, making it the 31st largest mega-region in the world. With its considerable rate of growth, we can assume it has grown substantially bigger since that time. The Beijing mega-region is home to 43 million people, producing $110 billion in economic output. China's three leading mega-regions account for 38% of its LRP. Furthermore, in China, LRP per capita is a whopping 360% higher among the 12% (154 million) of the population living in the Bejing, Shanghai and Hong-Sen mega-regions than it is among the 88% of the populace living elsewhere in the country. This wealth disparity is driving the most massive urbanization trend in history.

India is home to one mega-region meeting our criteria for contiguity and economic output (Delhi–Lahore). We also identify two rapidly expanding regions that are destined to join the ranks of mega-regions soon, if they have not already. One of these, anchored by Bangalore and Madras, is home to 72 million people and produces 49 billion in LRP. The other is the Mumbai–Poona region with 62 million people and 57 billion in LRP. Recall again that these figures are for 2000. We can expect that both are substantially bigger now. The Indian mega-regions have an LRP per capita that may be as much as 10% lower than the rest of the country. It seems that the continuing crowding and poverty associated with the third world mega-city status of these cities is offsetting the remarkable wealth creation associated with their emerging status as global mega-regions.

Mega-regions play an increasingly significant role in other emerging economies around the world. In Latin America, Greater Mexico City (rank 20) is home to 45.5 million people while generating $290 billion in LRP. In Brazil, the mega-region which goes from Sao Paolo to Rio de Janeiro (rank 22) generates $230 billion in LRP and is home to 43 million people. In the Middle East, the mega-region that runs from Tel Aviv to Amman and Beirut is home to 31 million people and $160 billion in LRP.

Conclusions

We have examined the rise of global mega-regions. Initially identified by Gottman (1957), mega-regions are natural economic units, arising as metropolitan regions become increasingly integrated with one another. Previous research has documented the existence of mega-regions in specific countries like

the USA or continents like Europe. Research of this sort has, until now, been regionally specific and cross-regional comparisons were limited by the absence of systematic definitions and comparable global data. We have begun to address this by identifying a consistent set of global mega-regions using satellite imagery of night-time light emissions for the globe. We have then used these light footprints, combined with other data, to estimate population, innovation and scientific discoveries, along with economic activity, for each of them.

As noted above, our approach, being novel, has both strengths and weaknesses. A major strength of the approach is that it establishes a consistently defined set of global mega-regions. Our direct use of night-time light emissions allows us to produce a globally consistent set of regions that are derived quite independently of administrative units of any sort. Unlike many relevant economic and cultural variables, light emissions are a physical quantity that can be measured without interpretation. A weakness of the method is that it does not capture complex contextual information on commuting patterns, material flows, cultural norms, etc. It should be remembered that we are not directly measuring integration, but rather inferring integration based on contiguity of development. This inference works reasonably well in North America, but the extent to which it holds elsewhere (particularly in places undergoing rapid development) has yet to be fully tested. A further assumption that needs further testing is that different cultures produced similar amounts of night-time light at the same level of economic activity. The plausible levels of GDP per capita produced by our current set of estimates support this assumption, but we are not yet able to quantify the quality of our predictions in this regard.

A further weakness (which stems directly from its strength) is that the resulting area definitions are not based on standard administrative units. This makes it difficult to compile statistics for these areas. That said, the task of compiling consistent statistics for an international set of urban agglomerations is inherently challenging and basing mega-region definitions on subnational administrative units would risk introducing serious biases related to the size and composition of these units across nations. We have demonstrated how several important variables can be estimated for these regions and plan, in future work, to use Geographic Information system techniques to infer additional economic, technological, demographic and cultural variables to this dataset.

Our findings indicate that mega-regions are a considerable economic force globally. The world's 40 largest mega-regions, those which produce in excess of $100 billion in LRP, cover only a tiny fraction of the habitable surface of the earth and are home to less than 18% of the world's population; yet, they are responsible for 66% of global economic activity and about 85% of technological and scientific innovation. Mega-regions not only define the economies of the advanced nations but play a central role in emerging economies as well. Our findings suggest that it makes little sense to think of the growth of India and China as a national phenomenon but rather as mega-regional one.

Furthermore, our research suggests that geography and location matter a great deal to economic development. While it has become a commonplace to argue that advances in transport and communication technology have allowed the world to become 'flat' (Friedman, 2005), the reality is that both economic activity and innovation remain greatly concentrated. Thus, the great paradox of our time: at the same moment that technology enables the geographic spread of economic activity, economic activity continues to cluster and concentrate around this mega-regional unit. The reasons for this are beyond the scope of this paper but revolve around the human capital externalities initially identified by Jacobs (1969) and codified into economic theory by Lucas (1988). Developing deeper understanding of the role of these human capital externalities in the formation, growth and function of mega-regions is an important task of future research.

References

Axtell, R. and Florida, R. (2001) Emergent cities—micro-foundations of Zipf's law. Available online at: http://www.creativeclass.com/rfcgdb/articles/Emergent_Cities.pdf [Accessed 20 October 2007].

Batty, M. (2003) The geography of scientific citation. *Environment and Planning A*, **35**: 761–770.

Beaverstock, J. V. and Smith, R. G. (1996) Lending jobs to global cities: skilled international labour migration, investment banking and the city of London. *Urban Studies*, **33**: 1377–1394.

Beaverstock, J. V., Smith, R. G. and Taylor, P. J. (1999) A Roster of world cities. *Global and world city Research Bulletin 5*. Available online at: http://www.lboro.ac.uk/gawc/rb/rb5.html [Accessed 12 August 2006].

Benton-Short, L., Price, M. and Friedman, S. (2005) Globalization from below: the ranking of global immigrant cities. *International Journal of Urban and Regional Research*, **29**: 945–959.

Ciccone, A. and Hall, R. E. (1996) Productivity and the density of economic activity. *American Economic Review*, **86**: 54–70.

CIESIN. (2006) *Gridded Population of the World v.3*. Center for International Earth Science Information Network, Available online at: http://sedac.ciesin.org/gpw/ [Accessed 15 October 2006].

Derudder, D. and Witlox, F. (2005) An appraisal of the use of airline data in assessing the world city network: a research note on data. *Urban Studies*, **42**: 2371–2388.

Doll, C., Muller, J. P. and Elvidge, C. D. (2000) Night-time imagery as a tool for global mapping of socioeconomic parameters and greenhouse gas emissions. *AMBIO: A Journal of the Human Environment*, **29**: 157–162.

Doll, C. N. H., Muller, J-P. and Morley, J. G. (2006) Mapping regional economic activity from night-time light satellite imagery. *Ecological Economics*, **57**: pp. 75–92.

Friedman, T. (2005) *The World Is Flat*. New York: Farar, Straus and Giroux.

Glaeser, E. (2007) *Do Regional Economies Need Regional Coordination?* HIER Discussion Paper Number 2131. Available online at http://econweb.fas.harvard.edu/hier/2007papers/HIER2131.pdf [Accessed 20 October 2006]

Glaeser, E. and Mare, D. (2001) Cities and Skills. *Journal of Labor Economics*, **19**: 316–342.

Global Insight. (2006) The Role of Metro Areas in the U.S. Economy, prepared for US Conference of Mayors. Available online at: http://www.usmayors.org/74thWinterMeeting/metroeconreport_January2006.pdf. Accessed 20 October 2007.

Gottman, J. (1957) Megalopolis, or the urbanization of the northeastern seaboard. *Economic Geography*, **33**: 189–200.

Gottman, J. (1961) *Megalopolis: the urbanized northeastern seaboard of the United States*. New York: Twentieth Century Fund.

Jacobs, J. (1961) *The Death and Life of Great American Cities*. New York: Random House.

Jacobs, J. (1969) *The Economies of Cities*. New York: Random House.

Jacobs, J. (1984) *Cities and the Wealth of Nations*. New York: Random House.

Lang, R. E. and Dhavale, D. (2005) *Beyond Megalopolis: Exploring America's New ''Megapolitan'' Geography*, Census Report 05:01. VA: Metropolitan Institute at Virginia Tech.

Leamer, E. E. (2007) A flat world, a level playing field, a small world after all, or none of the above? A review of Thomas L. Friedman's the world is flat. *Journal of Economic Literature*, **XLV**: 83–126.

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

Meijers, E. (2005) Polycentric urban regions and the quest for synergy: is a network of cities more than the sum of the parts? *Urban Studies*, **42**: 765–781.

Oak Ridge National Laboratory. (2006) *2005 LandScan Global Population Database*. Oak Ridge, TNAvailable online at: http://www.ornl.gov/landscan/.

Ohlin, B. (1933) *Interregional and International Trade*. Cambridge, MA: Harvard University Press.

Ohmae, K. (1993) *The End of the Nation State: The Rise of Regional Economies*. New York: Free Press. Simon and Schuster, 1995. Also his, ''The Rise of the Region State,'' Foreign Affairs, pp. 78–87.

Overman, H. G. and Venables, A. J. (2005) Cities in the Developing World, CEPR Discussion Paper, London: Centre for Economic Policy Research.

PricewaterhouseCoopers. (2007) *Largest City Economies in the World in 2005 and 2020*. Available online at: http://www.pwc.com/uk/eng/ins-sol/publ/ukoutlook/pwc_ukeo-section3-march07.pdf.

Regional Plan Association. (2006) *America 2050: A Prospectus*. New York.

Retsinas, N. P. (2007) Mega-cities, mega-problems. *LA Times*, 28 February 2007.

Ricardo, D. (2006) *Principles of Political Economy and Taxation*. Cosimo Classics, (original 1817).

Sassen, S. (1991) *The Global City: New York, London, Tokyo*. Princeton NJ: Princeton University Press.

Sassen, S. (2006) *Cities in a World Economy*. London: Pine Forge Press.

Sassen, S. (2008) Re-assembling the urban. *Urban Geography*, **29**: 113–126.

Scott, A. J. (1996) Regional motors of the global economy. *Futures*, pp. 391–411. 28.

Scott AJ. (ed). (2001). *Global City Regions*. Oxford, UK: Oxford University Press.

Smith, A. (1979) *An Inquiry into the Nature and Causes of the Wealth of Nations*. Oxford: Clarendon Press, (original 1776).

Taylor, P. J. (2003) *World City Network: A Global Urban Analysis*. London: Routledge.

Taylor, P. J. (2005) Leading world cities: empirical evaluations of urban nodes in multiple networks. *Urban Studies*, **42**: 1593–1608.

Wilson, D. and Purushothaman, R. (2003) *Dreaming with BRICs: The Path to 2050*. Global Economics Paper No. 99, NY: Goldman Sachs.

World Bank. (2006) *World Development Indicators*. Washington DC: The World Bank.

Yusuf, S. (2007) *About Urban Mega-regions: Knowns and Unknowns*. World Bank Policy Research Working Paper 4252. Development Research Group.

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