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# Global Metropolis: Assessing Economic Activity in Urban Centers Based on Nighttime Satellite Images\*

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This research provides new data and insight on metropolitan areas worldwide. It summarizes new data, derived from satellite images of the world at night, to provide systematic estimates of the economic activity generated by cities and metropolitan areas worldwide. It identifies 681 global metropolitan areas each with more than 500,000 people. Taken as a whole, these large global metropolitan regions house 24 percent of the world's population but produce 60 percent of global output, measured as light emissions. Asia leads the way in global economic urbanization according to our findings, followed by North America, the emerging economies, and Europe. **Key Words:** globalization, metro regions, nighttime lights, urbanization.

这项研究对全世界都市区提供了新的数据和洞察。它总结了从晚上世界卫星图像提取出的新数据，提供由世界各地的城市和大都市区的经济活动所产生的系统估计。它确定了全球 681 个超过 50 万人的都市区。作为一个整体，这些大的全球大都市地区居住着 24% 的世界人口，但产生 60% 的以光发射来度量的全球产量。根据我们的调查结果，亚洲引领全球经济城市化的方式，其次是北美，新兴经济体和欧洲。关键词：全球化，大都市地区，夜间灯光，城市化。

Esta investigación genera nuevos datos y comprensión de las áreas metropolitanas a escala mundial. Se resumen nuevos datos derivados de imágenes satelitales nocturnas del mundo, para proveer cálculos sistemáticos de la actividad económica propia de ciudades y áreas metropolitanas a través del planeta. Se identifican 681 áreas metropolitanas globales, cada una de ellas con más de 500.000 habitantes. Tomadas en conjunto global, estas regiones metropolitanas mayores albergan el 24 por ciento de la población del mundo, pero son responsables del 60 por ciento del producto global, medido como emisiones de luz. De acuerdo con nuestros hallazgos, Asia va a la cabeza de la urbanización económica global, seguida de América del Norte, las economías emergentes y Europa. **Palabras clave:** globalización, regiones metropolitanas, luces nocturnas, urbanización.

The year 2007 marked a turning point in world history: It was the year the world became urban. The share of the world's population living in urban areas increased from just 3 percent in 1800 to 14 percent in 1900. By 1950, it had reached 30 percent. In 2007, this number crossed the 50 percent mark. In the advanced countries, three quarters of people

live in urban areas (United Nations Population Fund 2007). Noting this momentous shift, *The Economist* ("The World Goes to Town" 2007) put it this way: "Whether you think the human story begins in a garden in Mesopotamia known as Eden, or more prosaically on the savannahs of present-day east Africa, it is clear that Homo sapiens did not start life as an urban

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creature. Man's habitat at the outset was dominated by the need to find food, and hunting and foraging were rural pursuits." But today, the story concludes, "Wisely or not, *Homo sapiens* has become *Homo urbanus*." According to United Nations projections, more than two thirds of the world's population (4.4 billion people) will be urbanites by the year 2030 (United Nations Population Fund 2007).

Professional geographers and urbanists of all sorts have long been interested in the cities around the world and the extent of global urbanism. The past several years have seen numerous, very useful, and important attempts to develop data and to better understand the economic role of cities and metropolitan areas in the global economy. Researchers like Sassen (1991, 2006, 2008), Taylor (2003, 2005), Lang and Dhavale (2005), and others have developed new and innovative ways to track and benchmark global cities and their surrounding metropolitan areas. Meijers (2005) showed that large urban regions extend far beyond single cities but are rather made up of polycentric structures. Hall and Pain (2006) illustrated the role of networked polycentric regions in Europe and discuss the impact of such structures on various political, economic, and social factors. Ni and Kresl (2008) compiled data from a wide range of sources to produce detailed rankings of urban competitiveness for 500 cities worldwide. Mercer Consulting (2008) publishes annual reports on the cost and quality of life in a sample of global cities. Mastercard (2008) produced a Worldwide Centers of Commerce Index, drawing from the work of leading global scholars on economic activity in global cities. Henderson, Storeygard, and Wiel (2009) used light emissions to estimate regional economic growth in Africa, where reliable data are hard to find.

Despite this important and successful line of research, one limiting factor in the field has been the lack of a systematic and consistent data set for cities, urban areas, and metropolitan regions on a global basis. There is no one group or agency that collects the necessary data. Regional units and definitions also vary considerably across countries (see Brunn, Williams, and Zeigler 2003).

There is an extensive body of research on urbanization, the characteristics and role of large urban and metropolitan regions, and their relationship to economic growth and

development. The literature offers several explanations for urbanization in the presence of technological change. The first stream of literature focuses on the way that geographic clustering and collocation makes firms more productive, efficient, and innovative. Long ago Marshall (1890) stressed the effects of collocation or agglomeration on firm efficiency. Christaller (1933) showed the importance of economies of spatial concentration and reduced transport costs. Fujita, Krugman, and Venables (1999) showed that the trade-off between scale economies and transportation costs leads to the emergence of multiple central places serving surrounding markets. A second stream focuses on the way locations improve the productivity of human capital, knowledge accumulation, and creativity (Jacobs 1969, 1984; Lucas 1988; Romer 1990; Florida 2002; Berry and Glaeser 2005). Lucas (1988) credited Jacobs (1969, 1984) for the fundamental insight that human capital externalities provide the basic underlying mechanism for economic development, and a wide range of empirical studies substantiate that claim (Glaeser, Kolko, and Saiz 2001; Florida, Mellander, and Stolarick 2008).

Our research helps fill this gap by developing a new data set on metropolitan regions across the entire world. It builds on earlier research by Florida, Gulden, and Mellander (2008), who used satellite images to identify megaregions globally. We use the same light-based estimates but for a different regional unit: metropolitan regions worldwide. By using light-based data from satellite images of the earth at night, our method enables us to generate metropolitan-level boundaries that are consistent across countries and thus overcomes the problem of different regional definitions. Our research uses these data to provide more systematic estimates of the economic activity generated by metropolitan areas across the globe.

We begin with a short summary of our methodology for using the satellite images to develop economic estimates. We then summarize our key findings on the role of metropolitan areas in the global economy overall, before turning to a more detailed look at their role in the world's major economic areas—North America, Europe, Asia, the newly industrializing countries, and the developing world. The last section summarizes the overall, very significant, contribution of metropolitan areas to the global economy.

## Data and Methods

We use a novel but straightforward and simple method to develop systematic data for metropolitan areas globally. We calculate economic activity for these locations based on satellite images of the entire globe. We define a metropolitan area as a core city and its surrounding hinterland. These are completely contiguously lighted areas as seen from space at night. The strength of our method is its consistency and simplicity. National government statistical bodies typically use commuting ranges to identify metropolitan areas. Other studies suggest that metropolitan areas composed of a central city and its surrounding suburbs and hinterland share common social, cultural, and political characteristics and benefit from close interconnections and network connectivity that inform and shape metropolitan regions. These are all important aspects of metropolitan areas, but data for them are not available on a global basis. The use of light emission data enables us to fill in an important gap in research and provide a simple, straightforward, and consistent method to identify metropolitan areas across the world.

We utilize light emission data for the year 2000 (Doll, Muller, and Elvidge 2000). The base data are from the Earth Observation Program of the National Oceanic and Atmospheric Administration's National Geophysical Data Center (NGDC). These data provide a measure of light intensity for each 30 arc second cell between  $-65^\circ$  and  $65^\circ$  latitude. These cells cover approximately  $1 \text{ km}^2$  at the equator and become somewhat smaller at higher and lower latitudes. Although the data capture low light levels that are consistent with low-density suburban and electrified semirural areas, the measured emission level saturates far from the most economically intense center of a major city due to the design of the sensors and the processing algorithms used by NGDC. The fall-off in brightness gradient as this threshold is quite steep and occurs in the inner suburbs of large U.S. urban areas (see Weier 2000). Although this presents a challenge in producing estimates, 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.

We then set a light threshold that captures the essence of the U.S. metropolitan areas. After we determine the threshold that gives the best approximation of the established U.S. metro areas, we apply this same threshold to the nighttime lights data set for the rest of the world. We thus calibrate the model by using detailed published data for gross regional product (GRP) for 363 U.S. metropolitan areas (Global Insight 2006). This calibration also yields an objective measure of the precision of this process. We are able to reproduce the GRP estimates with a standard error of 34 percent. In evaluating this number, it should be borne in mind that the GRP estimate also contains measurement error. We also review satellite data for the entire decade 1993 to 2003, and that shows some regional instability and difference in the brightness of the light emissions. This introduces some impreciseness in our estimates for regions, but given the calibration technique we minimize this error, which is a by-product of the light emission itself.

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 gross domestic product (GDP) in 2000 U.S. 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. In cases where we have high-quality metropolitan region estimates for areas with well-defined borders, we renormalize those areas in line with the published estimates for GRP as per earlier. When such subregional adjustments are made, we again renormalize the national total to coincide with World Development Indicators national estimates (GDP).

The result of this process is an estimate of economic activity for every 30 arc second grid

cell (less than one square kilometer) in the world. We refer to this indicator as *light-based regional product* (LRP). Although it is expressed in the same nominal dollars as GDP and GRP and is designed to aggregate up to published estimates of GDP, it is different enough in terms of both its derivation and its conceptual design that it is best identified with its own name.

## Key Findings

We now turn to key findings of the research. Table 1 shows the top twenty regions worldwide in economic activity (or LRP). The Appendix provides a more detailed listing of the top 100 economic regions worldwide.

The world's largest metropolitan area in terms of economic activity is Greater Tokyo, which produces nearly \$2 trillion in economic output (see Table 1). It is followed by Greater New York, Osaka-Kyoto-Kobe, Los Angeles, Nagoya, Chicago, London, Greater Brussels, Greater Koln, and Washington, DC.

The economic activity produced by these regions is substantially greater than their population size. The top ten regions, which house just 2.6 percent of the world's population, account for 21.2 percent of global economic activity. The twenty largest regions, in economic terms, are home to 4.4 percent of the world's

**Table 1** World's largest metropolitan regions by light-based regional product (LRP; in billions)

|    | Region                               | LRP (billions) |
|----|--------------------------------------|----------------|
| 1  | Tokyo-Kawasaki-Yokohama              | \$1,997.5      |
| 2  | New York-Philadelphia-Newark         | 1,181.9        |
| 3  | Kyoto-Osaka-Kobe                     | 617.9          |
| 4  | Los Angeles                          | 561.7          |
| 5  | Nagoya                               | 558.4          |
| 6  | Chicago-Milwaukee                    | 405.7          |
| 7  | London                               | 378.1          |
| 8  | Antwerpen-Gent-Bruxelles-Lille-Liege | 336.2          |
| 9  | Bonn-Dortmund-Duisburg-Koln          | 315.2          |
| 10 | Washington, DC-Baltimore             | 297.3          |
| 11 | Paris                                | 280.9          |
| 12 | Boston                               | 275.2          |
| 13 | Seoul-Inch'on                        | 238.9          |
| 14 | San Jose                             | 235.1          |
| 15 | Leeds-Sheffield-Birmingham           | 222.2          |
| 16 | Dallas                               | 212.7          |
| 17 | Guangzhou-Hong Kong-Kowloon          | 200.5          |
| 18 | Amsterdam-Rotterdam-The Hague        | 187.5          |
| 19 | Milano                               | 181.9          |
| 20 | Houston                              | 170.3          |

**Table 2** North America's largest economic regions

|    | Region                       | LRP (billions) |
|----|------------------------------|----------------|
| 1  | New York-Philadelphia-Newark | \$1,181.9      |
| 2  | Los Angeles                  | 561.7          |
| 3  | Chicago-Milwaukee            | 405.7          |
| 4  | Washington, DC-Baltimore     | 297.3          |
| 5  | Boston                       | 275.2          |
| 6  | San Jose                     | 235.1          |
| 7  | Dallas                       | 212.7          |
| 8  | Houston                      | 170.3          |
| 9  | Detroit                      | 168.3          |
| 10 | Atlanta                      | 164.5          |

Note: LRP = light-based regional product.

people and produce 28 percent of global economic activity. And, the world's fifth largest economic regions, home to 7 percent of global population, account for 38.5 percent of global economic activity. We now turn to the leading economic regions by major continent—North America, Europe, and Asia.

### North America

Table 2 lists the ten largest economic regions in North America. New York tops the list, followed by Los Angeles; Chicago; Washington, DC; Boston; San Jose; Dallas; Houston; Detroit; and Atlanta—all U.S. regions. These regions generate 11.7 percent of global economic activity while housing 1.3 percent of world population. Toronto-Buffalo ranks eleventh in North America, with \$161.8 billion in LRP, and Mexico City ranks fourteenth in North America, with nearly \$140 billion in economic activity. It is interesting to note that Mexico City generates nearly a quarter (24 percent) of Mexico's total economic activity.

### Europe

Table 3 lists the ten largest economic regions in Europe. London is the largest economic region, followed by Greater Brussels, Greater Koln, Paris, Leeds-Sheffield-Birmingham, Amsterdam-Rotterdam, Milan, Manchester-Liverpool, Berlin, and Frankfurt. These regions, which host 1.3 percent of world population, produce approximately 7.1 percent of world economic activity.

### Asia

Table 4 lists Asia's ten largest economic regions. Greater Tokyo is Asia's—and the

**Table 3** *Europe's largest economic regions*

|    | Region                            | LRP<br>(billions) |
|----|-----------------------------------|-------------------|
| 1  | London                            | \$378.1           |
| 2  | Antwerp-Gent-Brussels-Lille-Liege | 336.2             |
| 3  | Bonn-Dortmund-Duisburg-Koln       | 315.2             |
| 4  | Paris                             | 280.9             |
| 5  | Leeds-Sheffield-Birmingham        | 222.2             |
| 6  | Amsterdam-Rotterdam-The Hague     | 187.5             |
| 7  | Milan                             | 181.9             |
| 8  | Manchester-Liverpool              | 134.3             |
| 9  | Berlin                            | 96.0              |
| 10 | Frankfurt                         | 93.0              |

Note: LRP = light-based regional product.

world's—largest, with nearly \$2 trillion in LRP. Kyoto-Osaka-Kobe, Nagoya, Seoul, Fukuoka-Kita Kyushu, Singapore, Sapporo, Bangkok, and Okayama complete the top ten. The regions account for 12.8 percent of world economic activity, while housing 2.3 percent of world population.

#### *The BRICs*

A Goldman Sachs report (O'Neill et al. 2005) identified the so-called BRIC nations—that is, Brazil, Russia, India, and China—as large, rapidly growing, and increasingly significant global economic actors. Table 5 shows the top ten metro areas in the BRIC nations. The largest is Hong Kong, followed by Sao Paolo, Beijing, Shanghai, Rio de Janeiro, New Delhi, Tianjin, Belo Horizonte, Calcutta, and Porto Alegre.

#### *Other Emerging Economies*

Table 6 lists the ten largest metros for the emerging economies—Argentina, Egypt, Malaysia, Mexico, Poland, South Africa,

**Table 4** *Asia's ten largest economic regions*

|    | Region                      | LRP<br>(billions) |
|----|-----------------------------|-------------------|
| 1  | Tokyo-Kawasaki-Yokohama     | \$1,997.5         |
| 2  | Kyoto-Osaka-Kobe            | 617.9             |
| 3  | Nagoya                      | 558.4             |
| 4  | Seoul                       | 238.9             |
| 5  | Guangzhou-Hong Kong-Kowloon | 200.5             |
| 6  | Fukuoka-Kita Kyushu         | 105.8             |
| 7  | Singapore                   | 91.9              |
| 8  | Sapporo                     | 79.4              |
| 9  | Bangkok                     | 75.4              |
| 10 | Okayama                     | 53.1              |

Note: LRP = light-based regional product.

**Table 5** *BRIC's ten largest economic regions*

|    | Region                      | LRP<br>(billions) |
|----|-----------------------------|-------------------|
| 1  | Guangzhou-Hong Kong-Kowloon | \$200.5           |
| 2  | Sao Paolo                   | 114.3             |
| 3  | Beijing                     | 46.9              |
| 4  | Shanghai                    | 45.8              |
| 5  | Rio de Janeiro              | 42.1              |
| 6  | New Delhi-Delhi             | 31.6              |
| 7  | Tianjin                     | 17.3              |
| 8  | Belo Horizonte              | 16.5              |
| 9  | Calcutta                    | 14.9              |
| 10 | Porto Alegre                | 14.5              |

Note: BRIC = Brazil, Russia, India, and China; LRP = light-based regional product.

Thailand, and Turkey. The largest is Buenos Aires, followed by Mexico City, San Diego, Jerusalem-Tel Aviv, Bangkok, Pretoria-Johannesburg, Jakarta, Cairo, Kuala Lumpur, and El Paso.

### **Global Economic Role of Metropolitan Regions**

We now summarize the global impact of the world's largest metropolitan areas. Table 7 shows the share of global economic activity generated by metropolitan areas of various sizes.

From our full global sample of approximately 14,000 estimated metropolitan regions, 681 regions house more than 500,000 people. Together, these 681 regions account for roughly a quarter (24 percent) of world population and account for nearly 60 percent of total worldwide economic activity. Such metros account for more than 80 percent of economic activity

**Table 6** *Ten largest economic regions in the emerging economies*

|    | Region                  | LRP<br>(billions) |
|----|-------------------------|-------------------|
| 1  | Buenos Aires            | \$143.2           |
| 2  | Mexico City             | 139.4             |
| 3  | San Diego               | 110.3             |
| 4  | Jerusalem-Tel Aviv-Yafa | 104.6             |
| 5  | Bangkok                 | 75.4              |
| 6  | Pretoria-Johannesburg   | 62.9              |
| 7  | Jakarta                 | 45.9              |
| 8  | Cairo-El-Giza           | 44.3              |
| 9  | Kuala Lumpur            | 39.5              |
| 10 | El Paso                 | 27.5              |

Note: LRP = light-based regional product.

**Table 7** Economic activity by major region

| Region                          | Population cutoff (millions) |                        |                        |                       |
|---------------------------------|------------------------------|------------------------|------------------------|-----------------------|
|                                 | 10.0                         | 5.0                    | 1.0                    | 0.5                   |
| North America                   | \$2,288.7<br>(20.69%)        | \$3,451.5<br>(31.21%)  | \$5,972.0<br>(54.00%)  | \$6,704.9<br>(60.62%) |
| Europe                          | \$1,310.4<br>(15.01%)        | \$2,118.1<br>(24.26%)  | \$3,609.3<br>(41.49%)  | \$4,183.8<br>(47.93%) |
| BRIC                            | \$322.3<br>(13.43%)          | \$369.1<br>(15.38%)    | \$785.4<br>(32.73%)    | \$954.9<br>(39.80%)   |
| Asia <sup>a</sup>               | \$3,613.1<br>(65.44%)        | \$3,658.0<br>(66.26%)  | \$4,154.5<br>(75.25%)  | \$4,421.0<br>(80.07%) |
| Emerging economies <sup>b</sup> | \$417.0<br>24.94%            | \$609.8<br>(36.47%)    | \$1,023.2<br>(61.20%)  | \$1,602.9<br>(95.87%) |
| All nations                     | \$7,962.8<br>(25.49%)        | \$10,615.1<br>(34.13%) | \$16,259.1<br>(52.27%) | \$18,205.1<br>(58.5%) |

Note: BRIC = Brazil, Russia, India, and China.

<sup>a</sup>Hong Kong, Japan, Macao, South Korea, and Singapore.

<sup>b</sup>Argentina, Egypt, Malaysia, Mexico, Poland, South Africa, Thailand, and Turkey.

in Asia, roughly 60 percent of economic activity in North America, approximately 95 percent in the emerging economies, 40 percent in the BRICs, and nearly 50 percent of economic activity in Europe.

The 347 metropolitan areas worldwide with more than 1 million people, which house 20.38 percent of the world's population, account for more than half (52.27 percent) of worldwide economic activity. These metros account for roughly three quarters (75.25 percent) of economic activity in Asia, half (54 percent) in North America, roughly 60 percent in the emerging economies, just over 40 percent in Europe, and one third (32.73 percent) in the BRICs.

The sixty-one metros with more than 5 million people, which house roughly 10 percent of the world's population, account for a third of all global economic activity. These metros account for two thirds of economic activity in Asia, roughly a third (31.21 percent) in North America, a quarter (24.26 percent) in Eu-

rope, approximately 36 percent in the emerging economies, and 15 percent in the BRICs.

The twenty-nine metros with more than 10 million people, which house roughly 8 percent of global population, account for a quarter of global economic activity. These metros account for two thirds of economic activity in Asia, a fifth (20.69 percent) in North America, 15 percent in Europe, a quarter (24.94 percent) in the emerging economies, and 13 percent in the BRICs.

Overall, some 60 percent of worldwide activity is generated by metro areas with more than 500,000 people. Asia leads the way in global economic urbanization, followed by North America, the emerging economies, and Europe.

Finally, just the ten largest economic regions produce more than a fifth of total economic output. The top twenty produce nearly 30 percent, and the top 100 economic regions produce almost half (46 percent) of global economic activity (Table 8).

**Table 8** Share of global economic activity produced by the largest economic regions

| Top metro regions | Total LRP (billions) | Economic share (%) |
|-------------------|----------------------|--------------------|
| 10                | \$6,649.75           | 21.18              |
| 20                | \$8,854.81           | 28.02              |
| 100               | \$14,458.68          | 46.05              |

Note: LRP = light-based regional product.

## Conclusion

Global urbanization is a critical dimension of world development. Geographers and urbanists have charted the progress of global urbanization, and the past decade or so has seen significant research on the role and nature of world cities. But we lack comparable and systematic data on the world's metropolitan areas. Although international statistical agencies collect data on nations, there is no repository

of economic data on the world's cities and metropolitan areas. The absence of these data has made it impossible to identify and compare the world's cities and metropolitan areas. To overcome this data limitation, we use satellite images of the world at night to derive systematic and comparable estimates of economic activity across the world's cities and metropolitan areas.

Our research identifies 681 global metropolitan areas with more than 500,000 people. These global metropolitan regions house 24 percent of the world's population but produce 60 percent of global output. We further find that Asia leads the way in global economic urbanization, followed by North America, the emerging economies, and Europe.

Our research that identifies global metropolitan areas is just a start. We want to encourage more research using these and other data sources to further probe the scope, nature, and effects of the world's cities and metropolitan areas. ■

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**Table A1** Top 100 metros by LRP (billions)  
(Continued)

| Rank | Region                        | LRP (\$billions) |
|------|-------------------------------|------------------|
| 17   | Guangzhou-Hong Kong-Kowloon   | 200.5            |
| 18   | Amsterdam-Rotterdam-The Hague | 187.5            |
| 19   | Milan                         | 181.9            |
| 20   | Houston                       | 170.3            |
| 21   | Detroit                       | 168.3            |
| 22   | Atlanta                       | 164.5            |
| 23   | Toronto-Buffalo               | 161.8            |
| 24   | Tampa                         | 146.3            |
| 25   | Buenos Aires                  | 143.2            |
| 26   | Miami                         | 142.7            |
| 27   | Mexico City                   | 139.4            |
| 28   | Manchester-Liverpool          | 134.6            |
| 29   | Seattle                       | 123.1            |
| 30   | Sao Paulo                     | 114.4            |
| 31   | San Diego                     | 110.3            |
| 32   | Minneapolis                   | 107.4            |
| 33   | Phoenix                       | 106.7            |
| 34   | Fukuoka-Kita Kyushu           | 105.8            |
| 35   | Jerusalem-Tel Aviv-Yafo       | 104.6            |
| 36   | Denver                        | 99.7             |
| 37   | Cleveland                     | 99.1             |
| 38   | Berlin                        | 96.1             |
| 39   | Frankfurt                     | 93.0             |
| 40   | Singapore                     | 91.9             |
| 41   | Sydney                        | 83.4             |
| 42   | Cincinnati                    | 82.8             |
| 43   | Madrid                        | 81.8             |
| 44   | Sapporo                       | 79.4             |
| 45   | Venice                        | 79.3             |
| 46   | St. Louis                     | 77.7             |
| 47   | Glasgow                       | 76.2             |
| 48   | Bangkok                       | 75.4             |
| 49   | Melbourne                     | 72.7             |
| 50   | Barcelona                     | 69.2             |
| 51   | Naples                        | 68.9             |
| 52   | Rome                          | 67.1             |
| 53   | Montreal                      | 66.9             |
| 54   | Pittsburgh                    | 64.4             |
| 55   | Pretoria-Johannesburg         | 62.9             |
| 56   | Newcastle                     | 62.7             |
| 57   | Hamburg                       | 60.1             |
| 58   | Zurich                        | 59.8             |
| 59   | Portland                      | 58.7             |
| 60   | Charlotte                     | 56.1             |
| 61   | Kansas City                   | 55.2             |
| 62   | Stuttgart                     | 55.1             |
| 63   | Sacramento                    | 53.4             |
| 64   | Okayama                       | 53.1             |
| 65   | Lyon                          | 52.1             |
| 66   | Athens                        | 50.8             |
| 67   | Vienna                        | 49.6             |
| 68   | San Antonio                   | 49.6             |
| 69   | Indianapolis                  | 48.5             |
| 70   | Salt Lake City                | 47.9             |
| 71   | Manila-Quezon City            | 47.1             |
| 72   | Marseille                     | 47.0             |
| 73   | Beijing                       | 46.9             |
| 74   | Abu Zaby                      | 46.4             |
| 75   | Jakarta                       | 45.9             |
| 76   | Shanghai                      | 45.8             |
| 77   | Pusan                         | 45.0             |
| 78   | Las Vegas                     | 44.8             |
| 79   | Cairo-El-Giza                 | 44.3             |

**Table A1** Top 100 metros by LRP (billions)

| Rank | Region                            | LRP (\$billions) |
|------|-----------------------------------|------------------|
| 1    | Tokyo-Kawasaki-Yokohama           | 1,997.5          |
| 2    | New York-Philadelphia-Newark      | 1,181.9          |
| 3    | Kyoto-Osaka-Kobe                  | 617.9            |
| 4    | Los Angeles                       | 561.7            |
| 5    | Nagoya                            | 558.4            |
| 6    | Chicago-Milwaukee                 | 405.7            |
| 7    | London                            | 378.1            |
| 8    | Antwerp-Gent-Brussels-Lille-Liege | 336.2            |
| 9    | Bonn-Dortmund-Duisburg-Koln       | 315.2            |
| 10   | Washington, DC-Baltimore          | 297.3            |
| 11   | Paris                             | 280.9            |
| 12   | Boston                            | 275.2            |
| 13   | Seoul-Inch'on                     | 238.6            |
| 14   | San Jose                          | 235.1            |
| 15   | Leeds-Sheffield-Birmingham        | 222.2            |
| 16   | Dallas                            | 212.7            |



**Table A1** *Top 100 metros by LRP (billions)*  
(Continued)

| Rank | Region                   | LRP<br>(\$billions) |
|------|--------------------------|---------------------|
| 80   | Columbus                 | 44.2                |
| 81   | Mannheim-Heidelberg      | 43.5                |
| 82   | Rio de Janeiro           | 42.1                |
| 83   | Munchen                  | 40.8                |
| 84   | T'ai-chung               | 40.8                |
| 85   | Brisbane                 | 40.6                |
| 86   | Perth-Fremantle          | 40.5                |
| 87   | Austin                   | 40.0                |
| 88   | Kuala Lumpur             | 39.5                |
| 89   | San Juan                 | 38.9                |
| 90   | Richmond                 | 38.9                |
| 91   | Kobenhavn                | 38.8                |
| 92   | Taipei-Chingmei          | 38.2                |
| 93   | Raleigh-Durham           | 37.0                |
| 94   | Santiago                 | 37.0                |
| 95   | Greensboro-Winston-Salem | 36.8                |
| 96   | Norfolk                  | 36.5                |
| 97   | Nashville                | 36.3                |
| 98   | Oslo                     | 36.3                |
| 99   | Kao-Hsiung-T'ai-nan      | 36.0                |
| 100  | Memphis                  | 35.1                |

Note: LRP = light-based regional product.

**Table A2** *Top 100 metros by population*  
(millions)

| Rank | Region                            | Population<br>(millions) |
|------|-----------------------------------|--------------------------|
| 1    | Guangzhou-Hong Kong-Kowloon       | 37.19                    |
| 2    | Cairo-El-Giza                     | 37.15                    |
| 3    | Tokyo-Kawasaki-Yokohama           | 36.52                    |
| 4    | New York-Philadelphia-Newark      | 29.63                    |
| 5    | Seoul-Inch'on                     | 22.01                    |
| 6    | Sao Paulo                         | 21.74                    |
| 7    | Mexico City                       | 19.60                    |
| 8    | New Delhi-Delhi                   | 17.59                    |
| 9    | Kyoto-Osaka-Kobe                  | 17.48                    |
| 10   | Bombay                            | 17.33                    |
| 11   | Jakarta                           | 16.27                    |
| 12   | Manila-Quezon City                | 16.01                    |
| 13   | Los Angeles                       | 15.86                    |
| 14   | Shanghai                          | 13.97                    |
| 15   | Antwerp-Gent-Brussels-Lille-Liege | 13.76                    |
| 16   | Buenos Aires                      | 13.58                    |
| 17   | Druzba-Moskva                     | 13.46                    |
| 18   | Calcutta                          | 13.10                    |
| 19   | London                            | 12.58                    |
| 20   | Karachi                           | 11.70                    |
| 21   | Tehran                            | 11.19                    |
| 22   | Upper Nile                        | 11.02                    |
| 23   | Nagoya                            | 10.78                    |
| 24   | Chicago-Milwaukee                 | 10.67                    |
| 25   | Paris                             | 10.57                    |
| 26   | Bonn-Dortm und-Duisburg-Koln      | 10.44                    |
| 27   | Beijing                           | 10.33                    |
| 28   | Rio de Janeiro                    | 10.08                    |
| 29   | Bangkok                           | 10.02                    |
| 30   | Taipei-Chingmei                   | 9.54                     |

**Table A2** *Top 100 metros by population*  
(millions) (Continued)

| Rank | Region                        | Population<br>(millions) |
|------|-------------------------------|--------------------------|
| 31   | Istanbul                      | 9.44                     |
| 32   | Leeds-Sheffield-Birmingham    | 9.39                     |
| 33   | Dhaka                         | 8.63                     |
| 34   | Pretoria-Johannesburg         | 8.51                     |
| 35   | Lima                          | 8.00                     |
| 36   | Milan                         | 7.71                     |
| 37   | Jerusalem-Tel Aviv-Yafo       | 7.63                     |
| 38   | Amsterdam-Rotterdam-The Hague | 7.62                     |
| 39   | Toronto-Buffalo               | 7.25                     |
| 40   | Bogota                        | 7.10                     |
| 41   | Madras                        | 7.04                     |
| 42   | Lahore                        | 7.01                     |
| 43   | Brazzaville                   | 6.99                     |
| 44   | Washington, DC-Baltimore      | 6.84                     |
| 45   | Boston                        | 6.59                     |
| 46   | Lagos                         | 6.54                     |
| 47   | Hyderabad                     | 6.35                     |
| 48   | Baghdad                       | 6.26                     |
| 49   | Manchester-Liverpool          | 5.96                     |
| 50   | Bangalore                     | 5.84                     |
| 51   | Santiago                      | 5.80                     |
| 52   | San Jose                      | 5.59                     |
| 53   | Pusan                         | 5.32                     |
| 54   | Ho Chi Minh City              | 5.30                     |
| 55   | Madrid                        | 5.29                     |
| 56   | Ar Riyad                      | 5.25                     |
| 57   | Dallas                        | 5.24                     |
| 58   | Miami                         | 5.23                     |
| 59   | Tianjin                       | 5.13                     |
| 60   | T'ai-chung                    | 5.09                     |
| 61   | Kao-Hsiung-T'ai-nan           | 5.07                     |
| 62   | Tampa                         | 4.93                     |
| 63   | Ahmadabad                     | 4.86                     |
| 64   | Kuala Lumpur                  | 4.78                     |
| 65   | Napoli                        | 4.74                     |
| 66   | Surabaja                      | 4.74                     |
| 67   | Barcelona                     | 4.73                     |
| 68   | Houston                       | 4.66                     |
| 69   | Fukuoka-Kita Kyushu           | 4.64                     |
| 70   | Saint Petersburg              | 4.60                     |
| 71   | Khartoum-Omdurman             | 4.55                     |
| 72   | Wuhan                         | 4.50                     |
| 73   | Detroit                       | 4.46                     |
| 74   | Pune                          | 4.46                     |
| 75   | Chengdu                       | 4.39                     |
| 76   | Shenyang                      | 4.31                     |
| 77   | Atlanta                       | 4.23                     |
| 78   | Singapore                     | 4.23                     |
| 79   | Belo Horizonte                | 4.16                     |
| 80   | Montreal                      | 4.13                     |
| 81   | Xian                          | 4.03                     |
| 82   | San Diego                     | 3.99                     |
| 83   | Alexandria                    | 3.95                     |
| 84   | Guadalajara                   | 3.92                     |
| 85   | Bandung                       | 3.80                     |
| 86   | Berlin                        | 3.71                     |
| 87   | Nanjing                       | 3.63                     |
| 88   | Algiers                       | 3.59                     |
| 89   | Phoenix                       | 3.58                     |
| 90   | Sydney                        | 3.54                     |

**Table A2** Top 100 metros by population (millions) (Continued)

| Rank | Region     | Population (millions) |
|------|------------|-----------------------|
| 91   | Casablanca | 3.54                  |
| 92   | Monterrey  | 3.49                  |
| 93   | Rome       | 3.46                  |
| 94   | Athens     | 3.42                  |
| 95   | Caracas    | 3.36                  |

**Table A2** Top 100 metros by population (millions) (Continued)

| Rank | Region        | Population (millions) |
|------|---------------|-----------------------|
| 96   | Recife        | 3.34                  |
| 97   | Ankara        | 3.30                  |
| 98   | Porto Alegre  | 3.25                  |
| 99   | Santo Domingo | 3.16                  |
| 100  | Rangoon       | 3.15                  |

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