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Locating Economic Concentration

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Locating economic concentration[1]

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Abstract

We analyze the distribution of economic activity across space for different types of activity and different levels of aggregation. Not only is this distribution highly uneven (independently of the type of activity and level of aggregation), it is also remarkably regular regarding its size distribution (rank-size rule or Zipf's Law) and regarding its interaction (gravity equation).

Keywords: economic activity, distribution, rank-size rule, Zipf's Law, and gravity equation

JEL codes: F0, O0, R0

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1 Introduction

We were asked by Steven Brakman and Harry Garretsen for a contribution to this volume with the primary objective "to show that economic activity is not uniformly distributed across space." Although the editors also asked us several other research questions which we will address in the sequel, the reader's first reaction to the primary objective may be: "but of course economic activity is not homogenously distributed across space, everyone knows that!" An Australian 'walkabout' in the bush will give an entirely different picture of 'economic activity' than an attempt to cross the center of Manila during rush hour. Evidently, the distribution of economic activity is uneven. Nonetheless, the reader's potential first reaction regarding the obviously uneven distribution of economic activity is unjustified for at least three reasons.

First, we have to be precise in what we mean with *economic activity*. Obviously, these are activities involving people, so a first indication of the distribution of economic activity can be given by looking at the distribution of people across the globe. As a result of differences in education, available capital, quality of infrastructure and communication, however, there are enormous differences in productivity between people, leading to huge differences in value added per capita, to be taken into consideration in analyzing the distribution of economic activity. In turn, this correction for productivity differences should not be pushed too far as it is positively correlated with the local price level, for which we then should also correct. This brings us to purchasing power corrected value added as probably the most suitable empirical measure of economic activity.

Second, we have to take the *level of aggregation* into consideration, both in terms of geography and economic activity. The geographic level of aggregation may focus on global regions as defined by the World Bank (see below), on countries, on regions within countries, on cities, and even on areas within cities. The economic level of aggregation focuses on a specific type of economic activity. This might be all produced goods and services[4], a specific category (such as agriculture or services), or an analysis of just one or only a few types of goods (such as the flower or the movie industry).

Third, we can analyze if there are *regularities* in the (un)even distribution of economic activity or in the interaction between centers of economic activity. We then go beyond the affirmation that economic activity is not evenly distributed across space, to try to find a pattern in this distribution. If there is such a pattern, we would of course like an explanation for it. This

[4] The term 'goods' also refers to services.

explanation, in turn, can be of the 'first nature' type (exogenous in character: the wood industry is usually located in areas with lots of trees; big harbors are usually at the mouth of a navigable river) or the 'second nature' type (endogenous in character: computer activity is located in Silicon Valley to benefit from local knowledge spillovers; there are many hot dog stands in New York because there are many people). Insights in these explanations can result in proper policy advice. This chapter analyzes the structure and distribution of economic activity, but not the possible explanations for this distribution or the concomitant policy recommendations. The latter two issues are addressed in the other articles in this volume, notably by de Mooij, Gorter, and Nahuis (location decisions), Lambooij and van Oort (agglomeration powers), and Oosterhaven and Rietveld (transport costs and infrastructure).

As there is a sheer endless series of possible combinations that we could analyze regarding type of economic activity, distribution, economic and geographic aggregation, and interaction, it is remarkable that a few clear and simple conclusions regarding the distribution and interaction of economic activity can be drawn nonetheless, as summarized in the following five stylized facts:

- There is an uneven distribution regardless of the *type* of economic activity.
- There is an uneven distribution regardless of the *geographic level* of aggregation.
- There is an uneven distribution regardless of the *economic level* of aggregation.
- There is a remarkable *regularity* in the *spatial distribution* of economic activity.
- There is a remarkable *regularity* in the *interaction* between economic centers.

2 Global regions[5]

There are many countries in the world. The World Bank distinguishes 207 different countries on its CD-Rom, many of which are so small that you may not know them (Palau? Kiribati?). Because China considers it a province, Taiwan is the only important country not included as a separate entity, although it is included in various groups of countries. The next section analyzes difference between countries. This section characterizes groups of countries based on the World Bank's grouping in global regions (see the appendix for details):

1. EAP: East Asia and Pacific (includes China and Indonesia)
2. ECA: (East) Europe and Central Asia (includes Turkey and Russia)
3. HIC: High Income Countries (includes Western Europe, USA, and Japan)
4. LAC: Latin America and Caribbean (includes Brazil and Mexico)
5. MNA: Middle East and North Africa (includes Egypt)

[5] Unless otherwise indicated, all data in sections 2-4 are for the year 2000 and taken from the World Development Indicators CD-ROM 2002. Rural population density data are for the year 1999.

6. SAS: South Asia (includes India)
7. SSA: Sub-Sahara Africa (includes Nigeria and South Africa)

With the exception of the high income countries (HIC), these are geographically coherent entities, although the World Bank classification is also based on social, political, economic, and historical factors.[6] Table 1 provides basic information regarding population, area, and production for these global regions.

Table 1 Basic information for global regions (2000)

	EAP	ECA	HIC	LAC	MNA	SAS	SSA	World
Population	1,855	474	903	516	295	1,355	659	6,057
Area	16,0	23,8	30,9	20,1	11,0	4,8	23,6	130,1
GNP	2,027	927	24,945	1,922	651	591	303	31,351
GNP ppp	7,609	3,140	24,793	3,624	1,545	2,984	1,044	44,459
Population density	116	20	29	26	27	283	28	47
GNP density	127	39	807	96	59	124	13	241
GNP ppp density	476	132	802	181	141	624	44	342

Area in million km^2; population in millions; GNP = Gross National Product in $ billion; ppp = purchasing power parity; GNP ppp in $ billion; population density in people per km^2; GNP and GNP ppp density in $ 1000 per km^2; data are for 2000

According to the United Nations there are more than six billion people on our planet since 12 October 1999, a doubling in about 40 years.[7] Almost a third of these six billion live in South-East Asia (EAP; 1,85 billion), more than six times as many as the 295 million people in the Middle East and North Africa (MNA). The other global regions are within these two extremes. Obviously, these absolute numbers give no indication regarding the distribution of the population as the global regions also differ in size, ranging from 30.9 million km^2 for the high income countries (HIC) to 4.8 million km^2 for South Asia (SAS). The earth's total area is about 130 million km^2, indicating that there are on average about 47 people per km^2. As there is a negative correlation at this level of aggregation between size and population, the population density (people per km^2) is more unevenly distributed than the absolute population levels. The highest density (283) is reached in South Asia (SAS), more than 14 times higher than the lowest density (20) of (East) Europe and Central Asia (ECA).

[6] Sometimes a sub-grouping of high income countries is warranted, see section 6.
[7] See http://www.popexpo.net/english.html, also for other population information.

The uneven distribution of people across the global regions provides only a limited view of the distribution of economic activity. One person may be much more productive than another, for example as a result of better schooling, the availability of powerful machinery, good (rail-, water-, or regular) roads, efficient communication, a stable and secure system of law, etc. To measure economic activity we have to take three steps. First, a well-functioning statistics office will have to gather accurate information regarding the value of millions of different goods produced by all firms in an area. This occurs, of course, in local currency, that is euro in Western Europe, dollars in America, and yen in Japan. Second, we have to determine what to compare between different areas: the production of all goods or of specific types of goods, of goods produced in an area (domestic product), or of goods produced by factors of production owned by inhabitants of an area (national product), etc. Third, we have to decide how to compare the gathered information for the various areas.

In this section we concentrate on a comparison of gross national product (GNP) as it provides the best indication of all kinds of economic activity in an area.[8] GNP is equal to the market value of all goods produced by factors of production owned by inhabitants of an area. This implies we are literally comparing apples and oranges, measured in a common domestic currency. For an international comparison, we can then for example use the average exchange rate on the currency markets in this period. Measured accordingly, the total world production of goods in 2000 was valued at $31,351 billion, a truly astronomical figure. Obviously, this value is highest for the high income countries (HIC), with a total of $24,945 billion, more than 82 times the production value of $303 billion in Sub-Sahara Africa (SSA). Usually, our attention focuses on differences in income per capita, and it is clear that these differences are substantial. To determine the distribution of economic activity, however, the interaction between population density and productivity differences is important, so it is best to focus on production density per area unit (in this case GNP $1000 per km^2). This turns out to be highest for the high income countries (HIC; $807 thousand per km^2), being more than 62 times higher than for Sub-Sahara Africa (SSA; $13 thousand per km^2).

Based on the above information, it appears that the distribution of economic activity is more uneven than the distribution of population. Although true in general, we should note that the method of comparison (using the average exchange rate in a given period) leads to an overestimation of the value of production in high income countries relative to low income countries. The distinction between tradable and non-tradable goods is important in this respect.

[8] At this level of aggregation there is virtually no difference between GNP and GDP.

Since tradable goods can in principle be shipped to other regions (perhaps at considerable costs), the suppliers of tradable goods more or less compete with each other on a global market based on the exchange rate, which is partly determined by these activities. Non-tradable goods, on the other hand, are produced and consumed locally and do not compete on a global market. Since (i) different sectors in an economy compete for the same worker, such that (ii) the wage rate in an economy reflects average productivity, and (iii) the productivity differences between countries are larger for tradable goods than for non-tradable goods, using the exchange rate as a basis for comparison for non-tradable goods leads to an underestimate of the value of production in low income countries. Using the exchange rate as a basis for comparison, it may cost for example $15 to get a simple haircut in Chicago and less than $1 to get the same haircut in Tanzania. Similarly, if you go to the latest James Bond movie in Rotterdam it will cost $8, while viewing the same movie in the Philippines will cost $1.50.

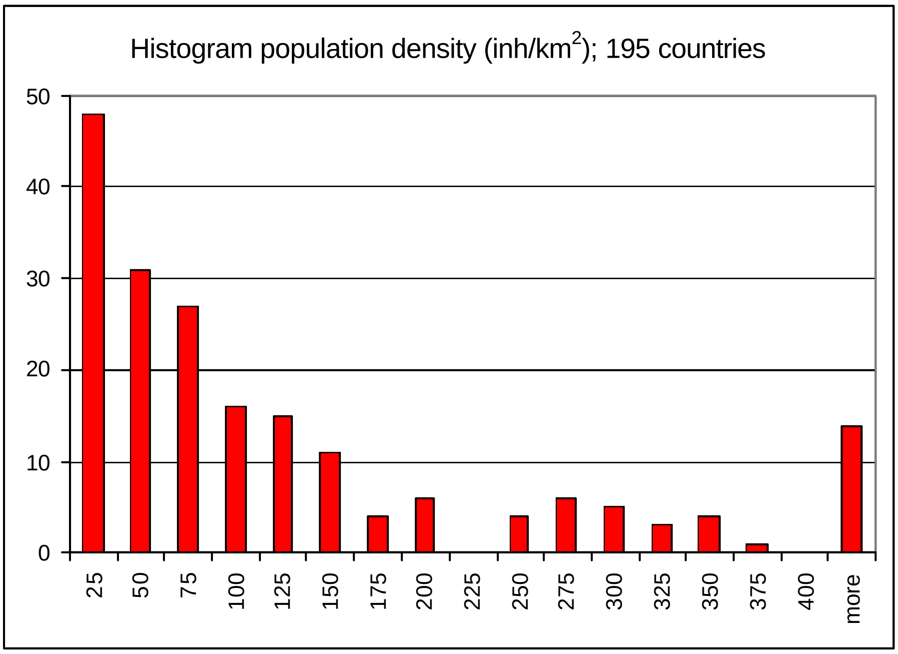
To correct for these price difference for non-tradable goods, the United Nations International Comparison Project (ICP) gathers information on the prices of goods in virtually all countries of the world. It uses the information to calculate purchasing power parity (ppp) corrected exchange rates. Table 1 also provides an overview of GNP ppp for the various global regions using the ppp exchange rates. This gives a better picture of the real economic activity in an area. The total value of world production is then $44,459 billion, ranging from $24,793 billion for the high income countries (HIC) to $1,044 billion for Sub-Sahara Africa. Using this to calculate production density in $ thousand per km^2, the high income countries are still in the lead, with a value of $802 thousand, more than 18 times higher than the $44 thousand in Sub-Sahara Africa. The differences in production density therefore become considerably smaller after correcting for purchasing power, but do not disappear. The distribution of economic activity is still very uneven across the globe.

Conclusion: There are large differences in the distribution of economic activity between the global regions analyzed in this section. The relative density differences (highest density / lowest density) are large regarding population density (more than 14), GNP density (more than 62), and GNP density corrected for purchasing power differences (more than 18).

3 Concentration at the country level

After illustrating the uneven distribution of economic activity at the level of global regions in section 2, we focus on differences at the country level in this section. We start with all countries in the world, and zoom in on the countries of Sub-Sahara Africa, one of the global regions analyzed in section 2, towards the end of this section.

Figure 1 Variation in population density; 195 countries (2000)



The World Bank provides information regarding the *population* density for 195 countries in the world. On average there are 47 persons per km^2. At the country level this varies from 6,587 for Singapore (no less than 140 times the world average) to 0.16 for Greenland (part of Denmark), or to 1.53 for Mongolia. The differences between countries are therefore enormous, see also Figure 1. We should note, however, that the city-state of Singapore is an exception, as its population density is five times as high as the second-highest density (Bermuda's 1,260 people per km^2). Table 2 gives an overview of the 15 countries with the highest population density. These are all small geographic areas, with the exception of Bangladesh (number 4), South Korea (number 10), and the Netherlands (number 11). It is therefore no surprise that only a minority of the number of countries (about 40 percent) has a population density *below* the world average. As illustrated in Figure 2, the countries with a high population density are geographically concentrated in South-East Asia and Europe, with a few exceptions in Africa and Mid America.

Figure 2 Geographic distribution of population density; 195 countries (2000)

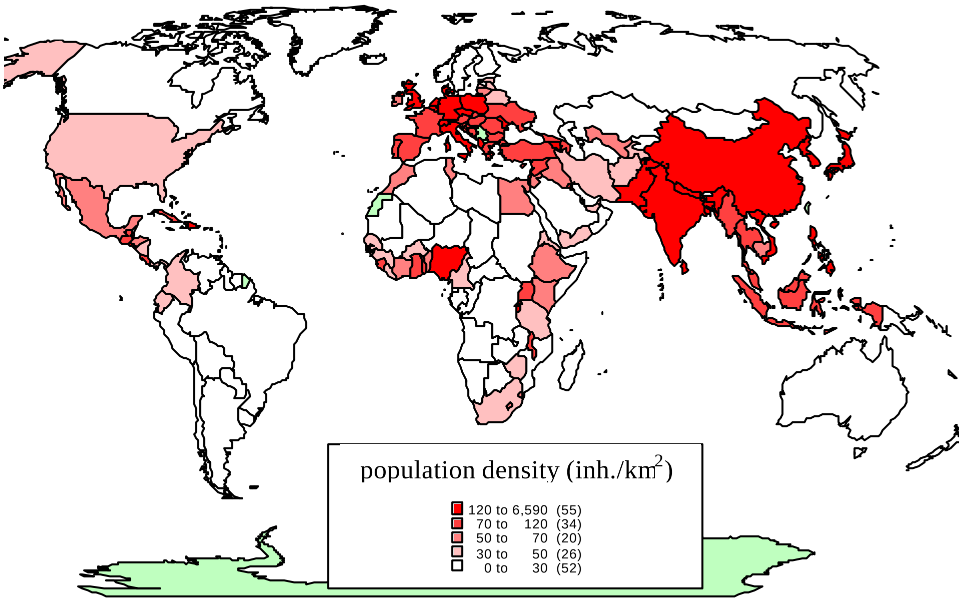


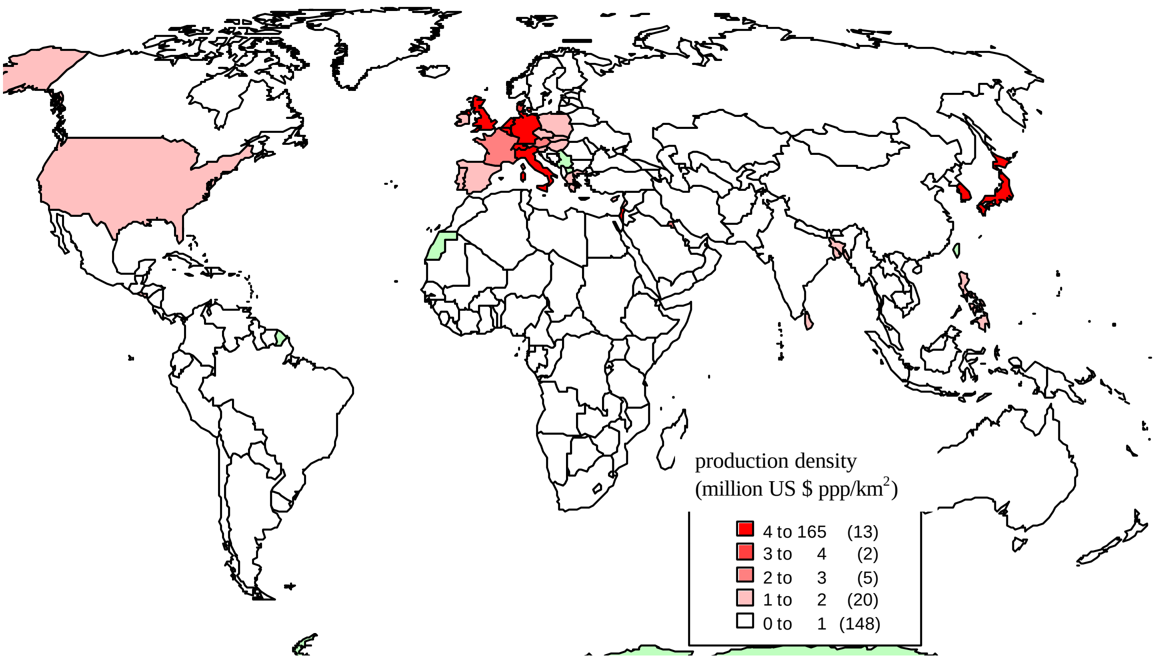
Table 2 Top 15 density of economic activity (2000)

rank	country	pop dens	country	GNP ppp dens
1	Singapore	6.587	Singapore	164,05
2	Bermuda	1.260	Malta	20,15
3	Malta	1.219	Netherlands	12,15
4	Bangladesh	1.007	Japan	9,43
5	Bahrain	1.001	Barbados	9,33
6	Maldives	920	Belgium	8,58
7	Barbados	621	South Korea	8,28
8	Mauritius	584	Israel	5,84
9	Aruba	532	United Kingdom	5,84
10	South Korea	479	Mauritius	5,81
11	Netherlands	470	Germany	5,74
12	San Marino	450	Switzerland	5,53
13	Puerto Rico	442	Italy	4,60
14	Lebanon	423	Maldives	3,90
15	Virgin islands	356	Denmark	3,43

pop dens = population density (people per km^2); GNP ppp dens in \$ million per km^2.

As explained in section 2, to get an adequate picture of the distribution of economic activity it is better to correct for differences in productivity and purchasing power between countries. The World Bank provides the relevant data for 160 countries in the world, with an average ppp corrected value of production of $342 thousand per km^2 in 2000. Table 2 also lists the 15 countries with the highest *production* density. Singapore is again in the lead, with a value of $164,05 million per km^2, which is 480 times the world average, 8 times as high as number two (Malta; $20.15 million), and almost 14 times as high as number three (the Netherlands; $12.5 million). The top 15 in production density also lists large countries, like Japan (number 4), South Korea (number 7), the United Kingdom (number 9), Germany (number 11), and Italy (number 13). Consequently, about 57 percent of all countries has a production density *below* the world average. Seven countries are both in the top 15 in terms of population density and in terms of production density. As suggested by this fact and by Singapore's solid first place on both lists, there is a positive association between population density and production density at the country level: the correlation coefficient is 0.73. There is also a geographic clustering of production density around the core of rich countries: Europe, Japan, and the United Stated, see Figure 3. Of the less developed countries the high production density of Bangladesh (number 26), the Philippines (number 39), and Sri Lanka (number 41) are remarkable. These are, indeed, all countries with a high population density, ranked 4th, 32nd, and 23rd, respectively.

Figure 3 Geographic distribution of production density; 160 countries (2000)



If we break down the global regions of section 2 into the countries composing those regions, as we did above, it is not remarkable that the uneven-ness of the distribution increases. As we saw, however, the extent of this increase is remarkable. We can also disaggregate geographically in a different way. After noting that economic activity is unevenly distributed at the level of global regions, we can 'zoom in' on one of those regions and analyze the distribution of economic activity within that region. As an example, we take Sub-Sahara Africa, a relatively coherent geographical region consisting of a fairly large (48) number of individual countries. Table 3 gives an overview of the countries in Sub-Sahara Africa with the highest and lowest population and production densities, and the averages of these variables for the region as a whole.

Table 3 Variation in density within Sub-Sahara Africa (SSA; 2000)

Average density			
area	pop dens	area	GNP ppp dens
SSA	28	SSA	44
Highest density			
country	pop dens	country	GNP ppp dens
Mauritius	584	Mauritius	5.809
Rwanda	345	Cape Verde	525
Burundi	265	Comoros	444
Comoros	250	South Africa	321
Seychelles	181	Rwanda	317
Lowest density			
country	pop dens	country	GNP ppp dens
Central African Rep.	6,0	Central African Rep.	6,9
Gabon	4,8	Niger	6,3
Botswana	2,8	Chad	5,3
Mauritania	2,6	Congo, Rep.	5,1
Namibia	2,1	Mauritania	4,2

pop dens = population density (people per km^2); GNP ppp dens in \$ million per km^2.

The average *population* density in Sub-Sahara Africa is 28 people per km^2, varying from 584 for Mauritius (more than 20 times the average) to 2.1 for Namibia (less than 10 percent of the average). The *production* density varies in a similar fashion: the average is \$44 thousand per km^2 in 2000, ranging from \$5,809 thousand in Mauritius (more than 130 times the average) to

$4.2 thousand in Mauritania (less than 10 percent of the average). For both density measures the variation within the Sub-Sahara Africa global region is enormous. Again, there is a clear positive association between population density and production density: for the 42 countries for which data are available the correlation coefficient is 0.79.

Conclusion: At a lower level of geographic aggregation, in this case at the country level, the uneven distribution of economic activity becomes more pronounced, both for population and production (measured as value added, after correcting for purchasing power).

4 Deeper still: regional periphery and urban concentration

In this section we will first apply the procedure used at the end of section 3 (where we looked at the countries comprising Sub-Sahara Africa) again at the country level (in this case by looking at the different regions of the Netherlands). Second, we will illustrate the core – periphery economic structure of Europe at the regional level using a periphery index. Third, we will illustrate the dynamic tendency of increasing economic concentration at the city level for the world as a whole.

The regional classification used within the European Union is based on three levels of detail, known as the Nomenclature of Territorial Units for Statistics (NUTS) and therefore referred to as NUTS I, NUTS II, and NUTS III. At the NUTS I level, the Netherlands is subdivided into 4 regions (North, East, West, and South). At the NUTS II level, these are subdivided in 12 sub-regions (the 12 Dutch provinces). At the NUTS III level, finally, these are subdivided again into 40 sub-sub-regions, see Table 4 (see below for the periphery indices in this table). In 1997 the average *population* density in the Netherlands was 380 people per km^2. At the NUTS III (sub-sub-region) level this varied from 86 for South-West Friesland (23 percent of the average) to 2,815 for the agglomeration of The Hague (740 percent of the average). In 1996 the average *production* density in the Netherlands was 7,620 euro per km^2, varying from 1,261 for South-West Friesland (17 percent of the average) to 63,899 for the agglomeration of The Hague (839 percent of the average). As suggested by the stable first and last place of the same region on both lists, the positive association between population density and production density is high: the correlation coefficient is equal to 0.981.

Table 4 Economic activity in the Netherlands and periphery indices

		density		periphery index			
		pop.	prod.	GDP	GDP ppp	pop	labor force
Netherlands		380	7,620				
NL1	North-Netherlands	144	2,786				
NL11	Groningen	188	4,725				
NL111	East Groningen	168	2,083	50.4	50.9	58.8	59.8
NL112	Delfzijl and surr.	147	2,497	52.7	53.2	62.2	63.2
NL113	Misc. Groningen	208	6,619	49.9	50.2	58.4	59.5
NL12	Friesland	107	1,758				
NL121	North Friesland	94	1,638	51.9	52.2	60.8	62.1
NL122	South-West Friesland	86	1,261	50.5	50.7	58.6	60.0
NL123	South-East Friesland	168	2,599	49.7	50.0	57.7	59.0
NL13	Drenthe	173	2,832				
NL131	North Drenthe	183	2,888	49.4	49.7	57.3	58.5
NL132	South-East Drenthe	191	3,388	48.9	49.3	56.4	57.7
NL133	South-West Drenthe	148	2,318	46.2	46.5	51.9	53.5
NL2	East-Netherlands	309	5,377				
NL21	Overijssel	310	5,444				
NL211	North Overijssel	214	3,857	44.2	44.5	48.5	50.2
NL212	South-West Overijssel	330	6,300	40.8	41.1	42.2	44.1
NL213	Twente	411	6,952	42.5	43.1	46.0	47.9
NL22	Gelderland	368	6,560				
NL221	Veluwe	333	5,999	39.7	40.0	40.6	42.6
NL222	Achterhoek	244	4,093	40.9	41.3	42.7	44.7
NL223	Arnhem/Nijmegen	685	12,760	38.0	38.2	37.5	39.6
NL224	South-West Gelderland	287	4,812	38.9	39.0	39.4	41.6
NL23	Flevoland	149	2,090	45.7	45.8	51.9	53.4
NL3	West-Netherlands	615	13,257				
NL31	Utrecht	756	17,013	36.7	36.6	35.7	37.6
NL32	North-Holland	614	13,883				
NL321	Top of North-Holland	163	2,395	52.4	52.6	61.9	63.3
NL322	Alkmaar and surr.	697	11,115	44.8	44.9	50.3	51.8
NL323	IJmond	983	19,482	48.8	48.9	56.9	58.5

Table 4 continued

		density		periphery index			
		pop.	prod.	GDP	GDP ppp	pop	labor force
NL324	Agglom. Haarlem	1,363	27,291	39.5	39.4	41.7	43.2
NL325	Zaanstreek	1,164	19,606	39.7	39.7	42.0	43.2
NL326	Agglom. Amsterdam	1,295	37,120	37.6	37.4	38.3	39.7
NL327	Gooi and Vechtstreek	983	19,302	37.3	37.2	36.7	38.5
NL33	South-Holland	973	20,179				
NL331	Aggl. Leiden & bollenst.	1,375	24,658	40.7	40.6	43.4	45.0
NL332	Agglom. The Hague	2,815	63,899	39.3	39.1	41.3	43.1
NL333	Delft and Westland	1,121	28,051	37.9	37.7	38.6	40.4
NL334	East South-Holland	579	9,811	39.7	39.6	41.2	43.0
NL335	Agglom. Rijnmond	823	17,537	41.2	41.1	44.2	46.1
NL336	South-Ea South-Holland	713	13,385	40.1	40.0	41.9	44.2
NL34	Zeeland	126	2,419				
NL341	Zeeuwsch-Vlaanderen	123	2,862	44.3	43.9	49.3	52.3
NL342	Misc. Zeeland	127	2,231	44.6	44.3	49.8	52.6
NL4	South-Netherlands	473	9,232				
NL41	North-Brabant	455	9,141				
NL411	West North-Brabant	426	8,622	37.6	37.4	37.5	40.2
NL412	Mid North-Brabant	410	7,351	37.1	37.0	36.3	38.9
NL413	North-Ea North-Brabant	464	9,507	37.4	37.4	36.9	39.2
NL414	South-Ea North-Brabant	509	10,729	35.1	35.2	32.8	35.4
NL42	Limburg (NL)	515	9,446				
NL421	North Limburg	316	6,230	33.3	34.0	30.3	33.3
NL422	Mid Limburg	327	6,133	34.8	35.3	32.9	35.8
NL423	South Limburg	941	16,620	35.1	35.4	32.8	36.3

Population density in people per km^2 (1997); production density in thousand euro per km^2 (1996). Density calculations based on Eurostat data; periphery indices: Copus (1999).

The above descriptive analysis has sufficiently demonstrated that economic activity, measured in various ways at different levels of aggregation, is unevenly distributed across space and that the various measures of density and production are strongly correlated. Regional economists have long ago already felt a need to measure this uneven-ness, and subsequently to identify and analyze core – periphery structures. Harris's (1954) 'market potential' approach is at the basis of this procedure, namely by calculating an indicator of market potential at the county level, taking into consideration the size of economic markets in the vicinity of this county, corrected for distance to this market. The demand by policy makers to identify core – periphery structures and analyze the economic consequences of such structures led Keeble, Owens, and Thompson (1981) to apply Harris's approach to construct a peripherality index for the regions of the European Union at the NUTS I level. Over the years, the methods used for calculating such a peripherality index have become more sophisticated, ultimately leading to Andrew Copus's (1999) study of 1,105 European regions (at the NUTS III level for the European Union plus 19 European countries). For each region Copus defines a 'center' (usually the largest city, but sometimes the geometric center) and calculates detailed travel times to other centers, taking into consideration the type of road, ferries, waiting times for ferries and crossing a border, driving speeds in mountains and urban areas, rest times for drivers, etc.[9] Copus uses this as the basis for calculating the potential for each region as follows:

(1) $P_i = \sum_j M_j / D_{ij}$, in which

P_i potential for region i

M_j economic mass of region j

D_{ij} distance between regions i and j

An adequate economic theoretical explanation for the structure of equation (1) is not simple. It is the basis for a substantial body of economic research, culminating in the 'new economic geography' or 'geographical economics' approach (Fujita, Krugman, and Venables, 1999, and Brakman, Garretsen, and Van Marrewijk, 2001). For the distances between regions Copus uses the travel times, as described above. For the economic mass of a region he uses four indicators:

- GDP Gross Domestic Product in euro's
- GDP pps Gross Domestic Product, corrected for purchasing power
- pop Population size
- labor force Size of the labor force

Finally, on the basis of this outcome, he calculates a periphery index ranging from 0 for the most central region (with the highest potential) to 100 for the peripheral region (with the lowest potential). Which measure is used exactly as an indicator of 'economic mass' for constructing the peripherality index hardly matters, see Table 5.

[9] The distance of a region to itself equals 1/3 of the axis of the smallest rectangle containing the region.

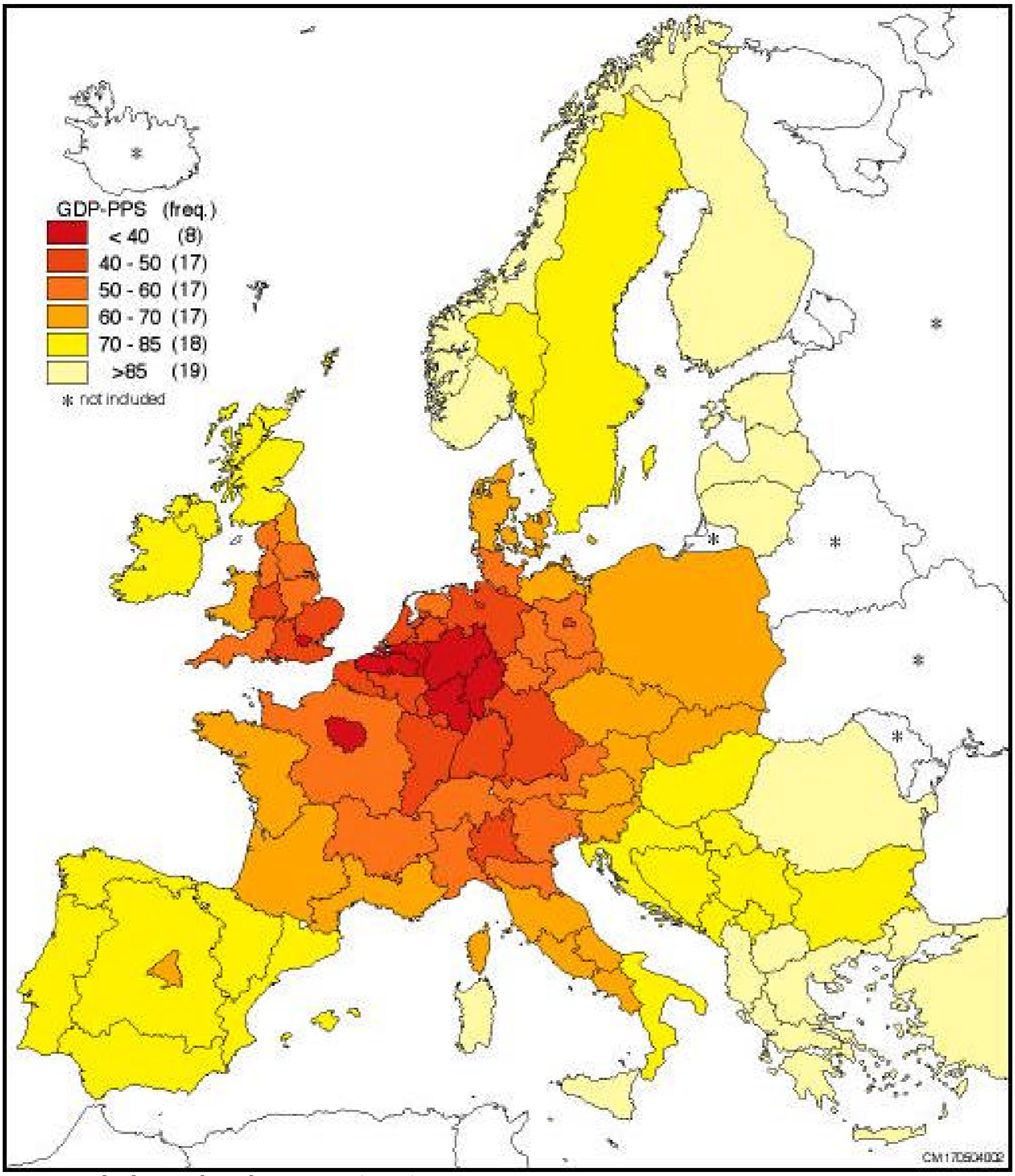
Table 5 Correlation coefficients for Copus periphery indices

	GDP	GDP ppp	pop	labor force
GDP	1	0.996	0.978	0.977
GDP ppp	0.996	1	0.980	0.975
pop	0.978	0.980	1	0.995
labor force	0.977	0.975	0.995	1

Table 4 also gives the results of the Copus (1999) periphery index calculations for the 40 NUTS III regions in the Netherlands. Again, the used indicator of economic mass is hardly relevant (the *lowest* correlation coefficient is 0.996, see Table 5). In all cases, the most central region is North Limburg. In three out of four cases Delfzijl and surroundings is the most peripheral region (only on the basis of population the Top of North Holland is classified as such). We note, of course, that the region with the highest economic density (The Hague) is not the most central region in the Netherlands (depending on the index used, it is ranked 14th or 16th). The most important reason is that the Copus periphery indices identify core – periphery structures at the European level, and thus take into consideration the location of other European regions. In view of their location close to the Dutch Randstad (Amsterdam, Rotterdam, the Hague, and Utrecht) *and* the German Ruhrgebiet *and* Brussels in Belgium, the three Limburg regions together with South-East North Brabant are always the four most central regions in the Netherlands. The first Randstad region is Utrecht (5th place). The regions in Groningen, Friesland, Drente, and the Top of North Holland constitute the Dutch periphery.

At the European level, none of the Dutch regions is located in the periphery, as even the most peripheral Dutch region is in the top half of the rankings. To illustrate this at a not too detailed level of analysis while using the detailed Copus data, Figure 4 depicts the European core – periphery structures at the NUTS I level using the average score of the NUTS III components (GDP, corrected for purchasing power). At the European level, the southern half of the Netherlands is part of a big European core, consisting also of Flanders, Brussels, Nordrhein-Westfalen, Hessen, Rheinland-Palts, and London. Almost all of the Netherlands, Belgium, and West Germany is economically centrally located. Paris is a fairly separate economic entity, although still linked to the European core. Other examples are Lombardy (Milan), Berlin, and Madrid. Clearly, some of the new European Union members entering on May 1 2004, such as Poland, the Czech Republic, and Slovakia, are economically more centrally located than some of the older EU members, such as Greece, Finland, Sweden, Portugal, Ireland, Scotland, and parts of Italy.

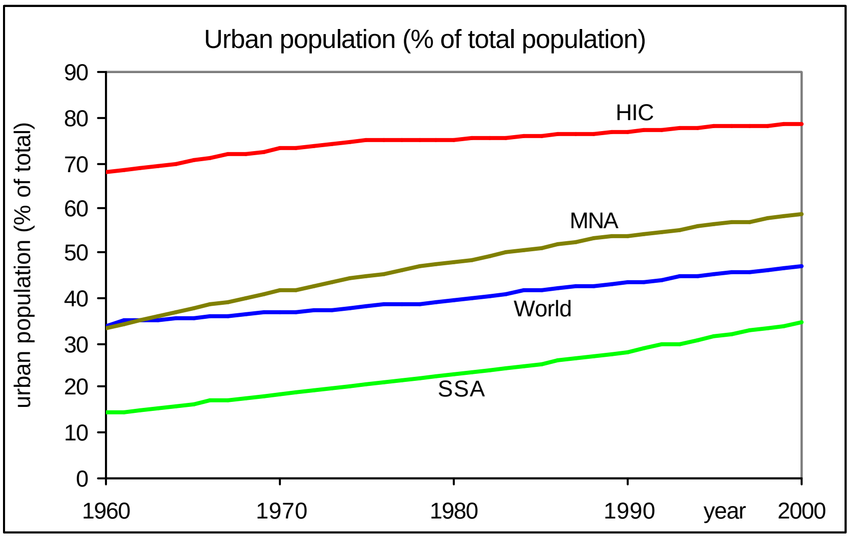
Figure 4 Core – periphery structures in Europe (based on GDP pps)



Source: calculations based on Copus (1999).

If we look in more detail at the spatial distribution of economic activity within a region of a country, we have to investigate the distribution of cities and villages. A process of urbanization has been noticeable worldwide for a considerable time. Of the 3,021 million people living on our planet in 1960, about 1,017 million (almost 34 percent) lived in the city.[10] In the next 40 years, the number of people on our planet doubled to 6,057 million in 2000. The number of people in urban areas rose relatively more rapidly, to 2,848 million (47 percent of the population). Obviously, this does not mean that the population in the rural areas falls (it rose from 2,004 million in 1960 to 3,210 million in 2000), just that the urban population rises more rapidly. At this rate, the urban population will be larger than the rural population by the year 2009. The process of urbanization has been virtually completed in many countries. In the Netherlands, for example, the urban population rose from 85.0 percent in 1960 to 89.4 percent in 2000. Of the global regions identified in section 2, urbanization in the period 1960-2000 has been highest in Latin America in percentage points (LAC; from 49.3 percent to 75.4 percent) and in Sub-Sahara Africa in relative terms (SSA; from 14.5 percent to 34.4 percent). As the urbanization process is largely completed in most high income countries, the increase has been lowest in percentage and relative terms in those countries (HIC; from 67.8 percent to 78.9 percent), see Figure 5.

Figure 5 Urbanization; global regions and world (1960-2000)



According to the World Bank (2000), the majority of the urban population (63.5 percent) lives in small- and medium-sized cities (population smaller than 1 million), whereas 21.4 percent lives in large cities (population between 1 and 5 million), and 'only' 15.1 percent lives in mega-cities (population above 5 million). The number of mega-cities has, however, rapidly increased in the 20th century; London (6.5 million inhabitants) was the only mega-city in 1900, whereas there were 16 cities with more than 10 million inhabitants in 2000.

Conclusion: A 'fractal dimension' in the distribution of economic activity becomes clear now that we have established that at the regional and city level economic activity is also unevenly

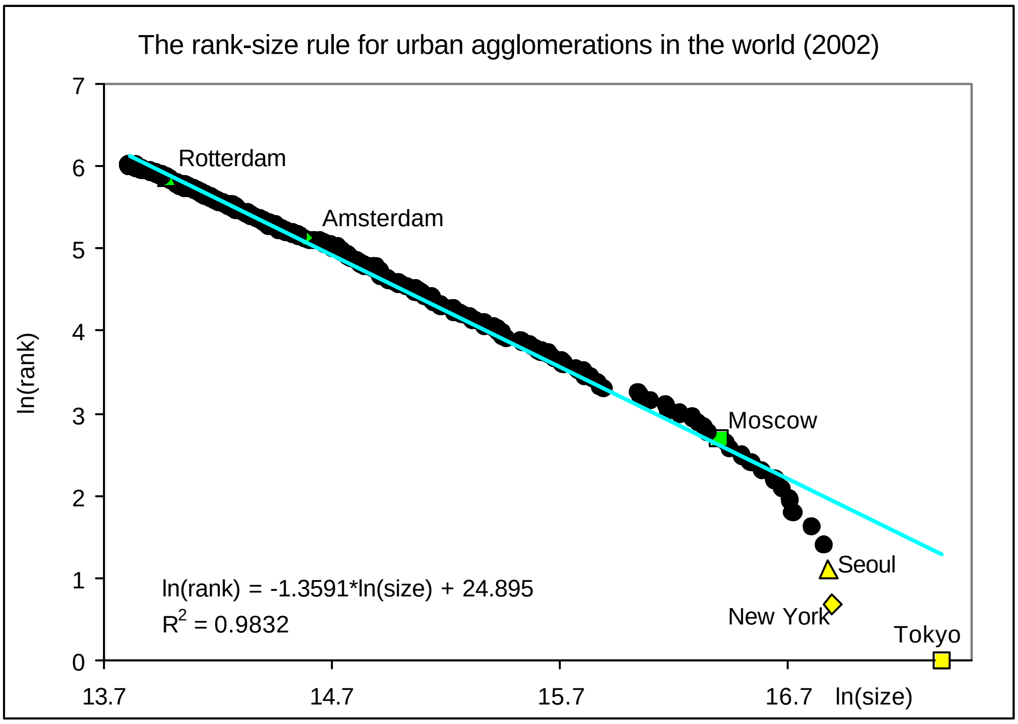
[10] This is the population identified as living in an urban area. Note that this definition may vary from country to country, which leads to an underestimate of the urban population in e.g. China and India.

distributed. This enables the identification of core – periphery patterns at the regional level. The degree of urbanization, which varies from country to country, is still increasing worldwide.

5 The fractal dimension of regularity in concentration

Now that we have sufficiently illustrated the uneven distribution of economic activity, it is time to analyze the empirical structure of that distribution. We will do this in two ways. In this section we focus on the *spatial distribution* of economic activity, known as the 'rank-size rule' (with 'Zipf's Law' as a special case). In the next section we focus on the *spatial interaction* between economic centers, known as the 'gravity equation'. Both empirical regularities have inspired theorists in geography and economics to try to construct models to improve our understanding of these facts. As noted before, we do not discuss these theoretical contributions.

Figure 6 Regularity in the distribution of economic activity: urban agglomerations in the world



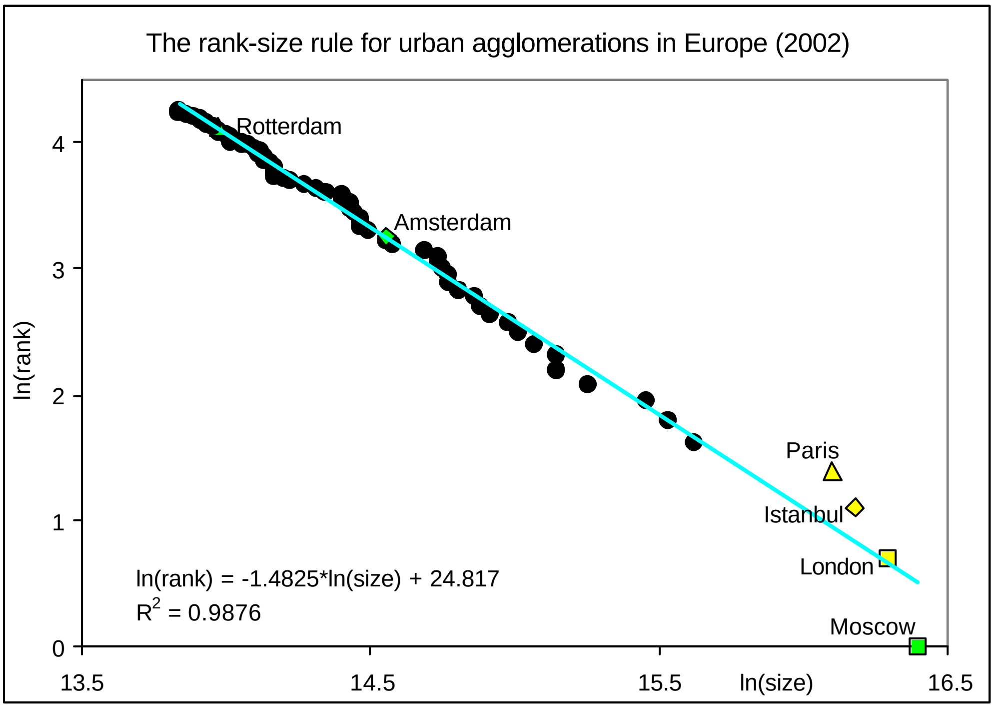
The regularity in the spatial distribution of economic activity is most easily demonstrated using the size distribution of urban agglomerations. There are cities in many sizes. Most are small or of reasonable size. A few are truly large, with millions of inhabitants. We should note that 'large' has been a relative measure in history. When Christ was born, Rome was considered to be an extremely large city with, according to the New Zealand classicist Art Pomeroy, at least 500,000 inhabitants (some estimates are up to 1 million). Nowadays, however, there are more than 400 cities with more than 1 million inhabitants (see below).

A well-known problem in comparing or measuring the size of cities, is the distinction between urban agglomeration and city proper (official boundaries). The latter usually arose in a complex historical process of evolution, annexation, and coincidence. A ranking based on city proper sizes therefore usually gives a less complete picture of economically relevant size. The city of Rotterdam, for example, had 599,463 inhabitants on 1 November 2002 according to the Dutch Central Bureau of Statistics. Other municipalities in the direct vicinity, such as Schiedam (75,901 inhabitants) and Capelle aan den IJssel (65,304 inhabitants), are effectively part of the same economic entity with the city of Rotterdam. Together with some other municipalities, they constitute the agglomeration of Rotterdam. The data we use here is taken from Thomas Brinkhoff's website[11], which tries to compare the size of city agglomerations worldwide as much as possible on calculating the central city (or sometimes the central cities, such as for the Ruhrgebiet) together with economically associated surrounding municipalities.

There were 408 agglomerations in the world with more than 1 million inhabitants in 2002, of which Tokyo (including Yokohama and Kawasaki) was the largest with 35.1 million inhabitants, followed by New York (21.65 million), and Seoul (21.35 million). The largest European agglomeration is Moscow (13.2 million, 15th place). The above mentioned agglomeration of Rotterdam is ranked 350th (1.175 million), preceded in the Netherlands by the agglomeration of Amsterdam (2.1 million, 170th place). To illustrate the regularity in the spatial distribution of economic activity, we rank the cities in size. The largest city (Tokyo) is given rank 1, the second largest city (New York) is given rank 2, etc. We then calculate the natural logarithm of the rank of each city and the natural logarithm of the size of each city. Figure 6 plots the 408 data points calculated accordingly in a graph. With the exception of the largest cities (a well-known phenomenon in the literature, see Brakman, Garretsen, and Van Marrewijk, 2001, chapter 7), all data points are almost exactly on a straight line. A simple regression explains 98.32 percent of the variance in the data, see Figure 6. Based on its size, the rank number predicted by the regression for the city of Amsterdam (166), for example, is very close to the actual rank number (170). Similarly for the city of Rotterdam (actual 350, predicted 365). The negative relationship between rank and size follows, obviously, from our way of organizing the data. The almost perfect log-linear relationship between rank and size, indicating regularity and predictability in the spreading of economic activity, is highly remarkable. It was first discovered by George Kingsley Zipf (1949). In general, this is referred to as the rank-size rule. If the slope of the estimated regression is equal to one, it is referred to as 'Zipf's Law'.

[11] All data in this section are taken from that website (dated 12 November 2002), see Th. Brinkhoff: Principal Agglomerations and Cities of the World, http://www.citypopulation.de .

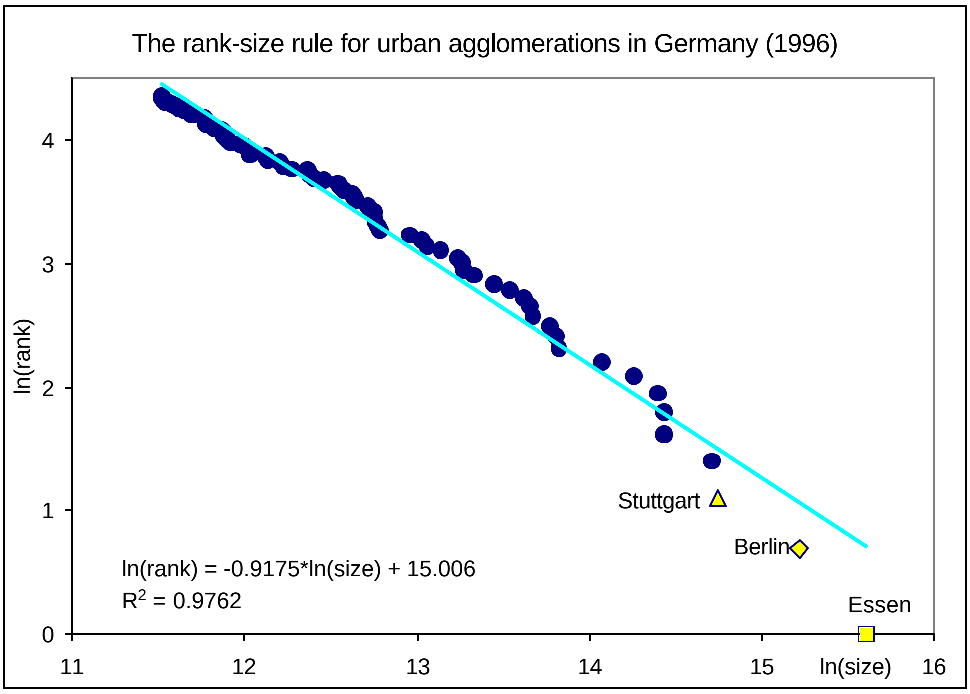
Figure 7 Regularity in the distribution of economic activity: urban agglomerations in Europe



We will illustrate the fractal dimension in the regularity of the distribution of economic activity in a similar way as we did for the uneven-ness of this distribution. First, by showing that the same regularity holds if we limit ourselves to a global region, in this case Europe. Second, by repeating this exercise for one of the countries in Europe, in this case Germany. Moscow (13.2 million inhabitants) is the largest agglomeration in Europe, followed by London (11.85 million), Istanbul (10.65 million), and Paris (9.8 million). Within Europe, Amsterdam is placed 25th and Rotterdam 61st. Similar calculations as performed before at the global level, again lead to the rank-size rule, see Figure 7 (note that the ‘problem’ with the largest cities is less pronounced than in Figure 6). A simple regression explains 98.76 percent of the variance in the data, which are again on an almost perfect log-linear line. The economic powers at work at the global level to create order in the distribution chaos, are apparently also operative at the European level.

Within Germany, Essen (5.93 million inhabitants) was the largest agglomeration in 1996, followed by Berlin (4.06 million), Stuttgart (2.52 million), Hamburg (2.46 million), and Frankfurt (1.87 million). Similar rankings and calculations as before lead to Figure 8, which again shows that the relationship between rank and size creates an almost perfect log-linear line. A simple regression explains 97.62 percent of the variance in the data. At the country level too, therefore, similar regulatory powers in the distribution of economic activity play a role. Brakman, Garretsen, and Van Marrewijk (2001, chapter 7) and Soo (2002) provide a detailed overview of the rank-size rule for all countries in the world for which data are available. In general, this rule holds no matter the size of a country, its political system, its cultural, social, or ethnical background, etc. Indeed, the rank-size rule on the empirical distribution of economic activity holds almost perfectly for such diverse countries as, for example, the United States, Brazil, France, India, Russia, and China.

Figure 8 Regularity in the distribution of economic activity: urban agglomerations in Germany

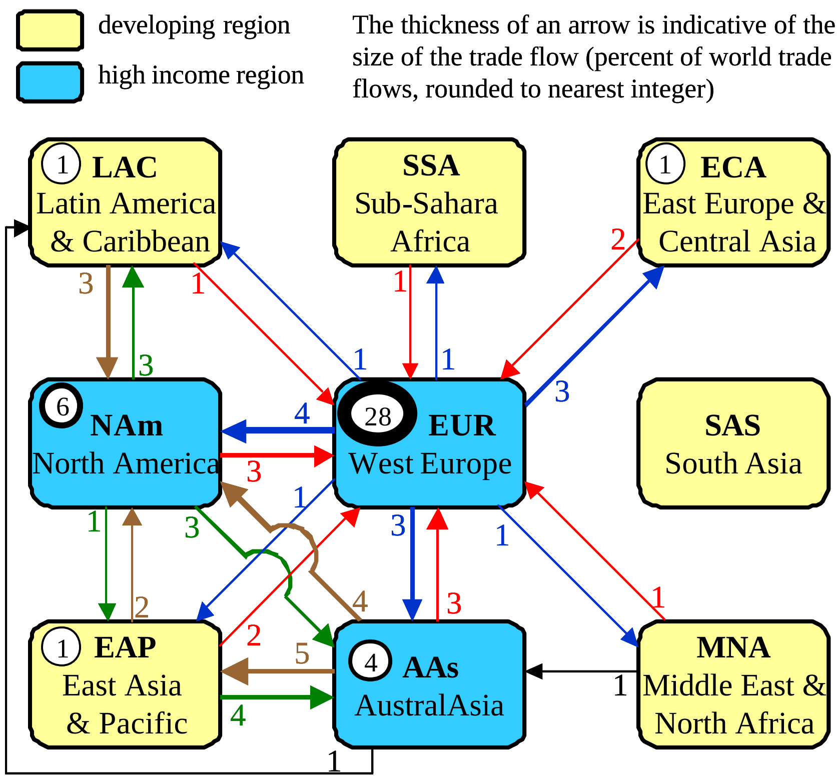


Conclusion: There is a 'fractal dimension' in the regularity of the spatial distribution of economic activity, known as the rank-size rule (with Zipf's Law as a special case). This empirical regularity holds globally, at the continent level, and at the country level.

6 Regularity in interaction

As explained in section 5, the spatial distribution of economic activity displays a remarkable regularity. In this section we will show that this also holds for the interaction between economic centers in the form of international trade flows. Before investigating the interaction at the country level, we first give an overview of this interaction at the global region level (see also section 2). In this respect it is useful to sub-divide the group of high income countries (HIC) into three sub-groups: Western Europe, North America, and AustralAsia. In combination with the six developing regions, this creates nine global regions. Our overview is based on a combination of the CID-UC-Davis/Feenstra (2000) data set, consisting of annual observations on bilateral trade flows for 4-digit sectors, 183 countries, and 28 years, with a total of slightly less than 18.4 million positive observations.[12] First, we aggregated all data to the country level. Second, we calculated the intra-regional trade flows (that is, trade flows between countries in the same global region) and the inter-regional trade flows (that is, trade flows between countries in two different global regions).

Figure 9 Inter- and intra-regional trade flows; global regions (% of world total, 1996)



• 51 of the 81 inter- and intra-regional trade flows are smaller than 0.5 per cent; these are not shown in the picture.
• intra-regional trade flows are indicated by a circle in that region.

With a combined total of more than 75 percent of world trade, the three high income regions are the three largest trade regions. This image is reinforce once we take into consideration that these three regions only contain about 16 percent of the world population. Western Europe is by far the most important trade region within this group. It is the source of about 42 percent of world exports, more than twice as much as the other two high income regions (North America and AustralAsia), which each are the source of about 17 percent of world exports. South-East Asia is the most important developing region (10 percent of world exports), followed by Latin America (5 percent of world exports). The trade shares of South Asia and Sub-Sahara Africa (both about 1 percent of world exports) are remarkably small.

[12] See the eta – center website for details: www.few.eur.nl/few/people/vanmarrewijk/eta . We focus on

Of the nine global regions identified here no less than 41.1 percent of world trade flows are *intra*-regional. There is, however, a large difference between the regions concerning the extent of intra-regional trade flows. South Asia (SAS; 2 percent), the Middle East and North Africa (NMA; 3 percent), and Sub-Sahara Africa (SSA; 4 percent) have very low intra-regional trade flows, implying that they depend mostly on (far away) other parts of the world for their export flows. North America (NAm; 35 percent) and (Eastern) Europe and Central Asia (ECA; 31 percent) have much higher levels of intra-regional trade flows. By far the highest level of intra-regional trade flows is reached, however, in Western Europe (two-thirds of its trade flows), making it the only region with above-average intra-regional trade flows at the world level.

The most important information on international trade flows at the global region level is effectively illustrated in Figure 9. Since there are nine global regions, there are in principle $9 \times 8 = 72$ inter-regional and 9 intra-regional trade flows. Expressed as a percentage of total world trade flows and rounded to the nearest integer, however, only 30 out of these possible 81 trade flows have a value of 1 or higher. These are shown in Figure 9. It is immediately evident that South Asia hardly participates in the global economy: none of its trade flows is large enough to be depicted in Figure 9. The central role of Western Europe (partially based on its past as a colonial power) is also evident. Finally, the local character of international trade flows becomes evident: the intra-regional trade flows are relatively large and the largest inter-regional trade flows are usually directed towards local global regions. This local character of international trade flows is at the center of the regularity in interaction between economic centers, known as the 'gravity equation'. Newton's second law states that the attraction between two objects is proportional to their mass and inversely related to their distance. A similar feature holds in economics if we replace attraction with trade flows and use GDP as a measure of economic mass. Not surprisingly, it was a physicist (Nobel laureate Jan Tinbergen, 1962) who first used Newton's second law to explain international trade flows. Many researchers since then have confirmed this empirical regularity in economics, which yields a solid empirical explanation of bilateral trade flows and thus illustrates the regularity of interaction between economic centers quite effectively.

the data for 1996 in view of missing observations for the year 1997.

Table 6 Estimated gravity equation, 1996

	Africa	income	t-stat	distance	t-stat	adj. R2	# obs.
1	South Africa	0.957	11.87	-2.886	-7.39	0.67	129
2	Algeria	0.194	1.35	-1.256	-3.57	0.16	53
3	Morocco	0.552	6.63	-1.860	-6.48	0.40	99
4	Tunisia	0.471	5.43	-1.698	-6.84	0.39	93
5	Egypt	0.519	6.41	-1.771	-8.02	0.51	104
6	Cameroon	0.600	4.67	-2.873	-8.34	0.41	70
7	Gabon	0.680	4.40	-2.009	-4.96	0.28	64
8	Congo (Zaire)	0.500	2.05	-1.171	-1.77	0.12	53
9	Ethiopia	0.483	2.86	-1.047	-2.12	0.17	55
10	Ghana	0.824	4.04	-1.399	-3.18	0.30	57
11	Cote D'ivoire	0.528	4.43	-2.167	-5.31	0.38	58
12	Kenya	0.497	4.78	-2.199	-7.24	0.29	94
13	Madagascar	0.529	3.51	-0.792	-1.10	0.16	73
14	Malawi	0.516	4.99	-1.490	-4.18	0.28	58
15	Mauritius	0.500	4.50	-1.448	-2.44	0.17	80
16	Nigeria	0.666	4.27	-1.325	-2.68	0.27	67
17	Senegal	0.559	4.26	-1.647	-2.64	0.23	50
18	Zimbabwe	0.820	6.41	-2.239	-6.44	0.42	90
19	Untd Rp Tanzania	0.618	3.47	-1.221	-2.08	0.22	59
	North America						
20	Canada	0.673	9.60	-0.946	-2.44	0.58	132
21	USA	0.345	6.79	-0.749	-3.42	0.39	133
	South America						
22	Argentina	0.821	11.12	-1.612	-5.90	0.51	119
23	Bolivia	0.785	3.64	-2.341	-7.01	0.45	60
24	Brazil	0.564	9.02	-2.037	-7.74	0.47	125
25	Chile	0.761	10.44	-2.394	-7.81	0.55	111
26	Colombia	0.661	7.71	-1.901	-10.43	0.51	101
27	Ecuador	0.553	4.53	-1.608	-7.04	0.37	80
28	Mexico	0.609	8.83	-1.892	-10.53	0.56	113
29	Peru	0.955	7.95	-1.935	-6.28	0.50	97
30	Uruguay	0.831	7.11	-1.560	-4.62	0.49	88

Table 6 continued

		income	t-stat	distance	t-stat	adj. R2	# obs.
31	Venezuela	0.615	4.85	-2.744	-9.81	0.46	77
32	Costa Rica	0.491	5.12	-2.155	-11.11	0.51	88
33	El Salvador	0.595	5.52	-1.992	-9.96	0.52	50
34	Guatemala	0.414	3.24	-1.828	-8.77	0.41	78
35	Honduras	0.579	6.08	-1.756	-10.58	0.47	60
36	Nicaragua	0.518	3.00	-1.732	-5.74	0.32	51
37	Bahamas	0.519	3.14	-0.340	-1.01	0.18	62
38	Barbados	-0.000	-0.00	-1.165	-3.12	0.12	51
39	Dominican Rp	0.368	2.39	-1.608	-5.28	0.27	65
40	Jamaica	-0.007	-0.04	-1.217	-2.99	0.15	58
41	Neth Antilles	0.343	1.75	-1.701	-5.97	0.28	65
42	Trinidad-Tobago	0.380	2.15	-2.146	-7.47	0.31	68
43	Panama	0.319	3.04	-1.433	-6.61	0.32	61
	Middle East						
44	Israel	0.657	10.72	-0.531	-3.10	0.53	111
45	Japan	0.398	8.40	-0.276	-1.34	0.42	133
46	Bahrain	0.522	5.88	-1.565	-7.66	0.36	68
47	Cyprus	0.667	9.28	-1.613	-8.56	0.59	103
48	Iran	0.508	3.27	-1.651	-5.24	0.41	71
49	Jordan	0.588	4.52	-1.224	-3.36	0.36	62
50	Kuwait	0.645	7.20	-1.980	-7.97	0.49	78
51	Lebanon	0.489	4.16	-1.264	-6.10	0.36	66
52	Oman	0.205	1.81	-1.498	-4.11	0.15	81
53	Saudi Arabia	0.636	4.49	-1.579	-5.40	0.43	70
54	Syrn Arab Rp	0.481	4.69	-1.734	-6.51	0.45	67
55	Untd Arab Em	0.508	3.68	-2.218	-4.36	0.33	73
56	Turkey	0.578	9.21	-1.214	-9.52	0.62	125
	Asia						
57	Afghanistan	0.366	2.77	-0.508	-1.45	0.12	53
58	Bangladesh	0.771	8.79	-0.234	-0.96	0.44	102
59	Myanmar (Burma)	0.599	2.86	-1.824	-3.48	0.32	52
60	Sri Lanka	0.597	6.08	-1.843	-5.18	0.50	79

Table 6 continued

		income	t-stat	distance	t-stat	adj. R2	# obs.
61	Hong Kong	0.199	5.01	-0.078	-0.44	0.17	131
62	India	0.381	7.22	-0.756	-4.24	0.34	132
63	Indonesia	0.439	8.61	-1.119	-4.75	0.44	114
64	Malaysia	0.406	7.27	-1.083	-6.80	0.39	129
65	Pakistan	0.444	6.83	-1.079	-4.24	0.38	128
66	Philippines	0.723	8.05	-1.568	-6.49	0.52	109
67	Singapore	0.306	4.86	-1.118	-3.91	0.38	107
68	Taiwan	0.308	3.55	0.041	0.22	0.17	83
69	China	0.402	7.49	-0.413	-1.31	0.39	133
70	Vietnam	0.829	5.25	-1.062	-2.40	0.46	72
	Western Europe						
71	Belgium-Lux.	0.383	7.05	-0.371	-2.83	0.41	133
72	Denmark	0.447	7.74	-0.723	-5.40	0.56	133
73	France	0.263	5.22	-0.228	-2.19	0.27	133
74	Germany	0.274	6.99	-0.367	-3.76	0.47	133
75	Greece	0.706	10.14	-1.278	-6.35	0.53	127
76	Ireland	0.539	10.03	-0.495	-3.13	0.58	131
77	Italy	0.280	7.29	-0.305	-3.70	0.44	133
78	Netherlands	0.406	6.97	-0.373	-2.48	0.46	133
79	Portugal	0.599	9.03	-0.960	-4.76	0.51	128
80	Spain	0.419	7.99	-0.269	-2.24	0.40	129
81	United Kingdom	0.227	5.90	-0.175	-2.18	0.24	133
82	Austria	0.705	10.63	-0.806	-6.53	0.68	129
83	Finland	0.609	10.24	-0.933	-5.28	0.61	126
84	Iceland	0.547	4.10	-1.708	-3.82	0.40	63
85	Norway	0.655	8.73	-0.615	-3.34	0.54	131
86	Sweden	0.477	7.43	-0.402	-3.31	0.47	133
87	Switzerland	0.541	8.15	-0.239	-1.49	0.48	133
88	Malta	0.499	5.83	-1.019	-4.34	0.33	88
	Eastern Europe						
89	Bulgaria	0.639	5.95	-1.366	-8.17	0.60	74
90	Czechoslovakia	0.592	8.43	-0.938	-5.73	0.54	128

Table 6 continued

		income	t-stat	distance	t-stat	adj. R2	# obs.
91	Hungary	0.686	9.25	-1.164	-6.98	0.60	119
92	Poland	0.782	9.20	-0.932	-4.61	0.66	115
93	Romania	0.606	7.82	-1.584	-8.62	0.51	120
94	Fm USSR	0.598	6.35	-1.563	-7.50	0.52	109
	Oceania						
95	Australia	0.727	10.07	-2.802	-7.20	0.56	132
96	New Zealand	0.631	6.54	-2.696	-5.66	0.40	109

As an illustration of the regularity of the interaction between countries, Table 6 reports estimation results of a basic gravity equation for 96 countries in the world with at least 50 observations in 1996. The income data are from the World Development Indicators CD-ROM (2002; GNI, current dollars). The distances were determined using longitude and latitude data from the Britannica Atlas of the most important economic center in a country (usually the capital city) by calculating the distance to other economic centers using the assumption that the earth is a perfect sphere.[13] The estimated equation is:

(2) $\ln(\text{export}) = \text{constant} + \text{coefficient}_1 \times \ln(\text{GDP}) + \text{coefficient}_2 \times \ln(\text{distance})$

Except for Barbados and Jamaica, the estimated income coefficient has the right sign and is highly significant.[14] The estimated significant coefficients are fairly close together, ranging from 0.194 for Algeria to 0.957 for South Africa, with an average of 0.545, a median of 0.544, and a variance of only 0.027. For all countries except Taiwan, the distance variable has the correct sign. The estimated coefficient is usually statistically (highly) significant, ranging from –2.886 for South Africa to –0.078 for Hong Kong. De average distance estimate is –1.354, the median is –1.399, and the variance is 0.486.

Conclusion: There is a remarkable regularity in the interaction between economic centers. As it is proportional to the (economic) mass of a country and inversely related to the distance between countries, this is known as the 'gravity equation'.

[13] For the USA the shortest distance to either New York or Los Angeles was taken.
[14] The calculated t-values are consistent under heteroscedasticity (White, 1980).

7 Summary and conclusions

There is an enormous array of possibilities to analyze regarding economic concentration in terms of what (population, value added, specific sectors), where (global regions, countries, regions, districts, cities), and how (structure in spreading and interaction). At the global regional level as identified by the World Bank, economic activity is unevenly distributed. The relative density differences (highest density / lowest density) are large regarding population density (more than 14 times), GNP density (more than 62 times), and GNP density corrected for purchasing power differences (more than 18 times). At a lower level of geographic aggregation (the country level) the uneven distribution of economic activity becomes more pronounced, both for population and production (measured as value added, after correcting for purchasing power). A 'fractal dimension' in the distribution of economic activity becomes evident after establishing that at the regional and city level economic activity is also unevenly distributed. This enables the identification of core – periphery patterns at the regional level.

There are remarkable regularities in the distribution of economic activity, both with respect to the spatial distribution itself and regarding the interaction between economic centers. The degree of urbanization, which varies from country to country, is still increasing worldwide. There is a fractal dimension in the regularity of the spatial distribution of economic activity, known as the rank-size rule (with Zipf's Law as a special case), since this empirical regularity holds globally, at the continent level, and at the country level. The regularity in the interaction between economic centers, which is proportional to the (economic) mass of a country and inversely related to the distance between countries, is known as the gravity equation.

In short, we can summarize the distribution of economic activity in five stylized facts:

- There is an uneven distribution regardless of the *type* of economic activity.
- There is an uneven distribution regardless of the *geographic* level of aggregation.
- There is an uneven distribution regardless of the *economic* level of aggregation.
- There is a remarkable *regularity* in the *spatial distribution* of economic activity.
- There is a remarkable *regularity* in the *interaction* between economic centers.

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Appendix World Bank global regions, 2002

East Asia & Pacific (*EAP*), excluding high-income economies

American Samoa	Cambodia	China
Fiji	Indonesia	Kiribati
Korea, Dem. Rep.	Korea, Rep.	Lao PDR
Malaysia	Marshall Islands	Micronesia, Fed. Sts.
Mongolia	Myanmar	Palau
Papua New Guinea	Philippines	Samoa
Solomon Islands	Thailand	Tonga
Vanuatu	Vietnam	

Europe & Central Asia (*ECA*), excluding high-income economies

Albania	Armenia	Azerbaijan
Belarus	Bosnia & Herzegovina	Bulgaria
Croatia	Czech Republic	Estonia
Georgia	Hungary	Isle of Man
Kazakhstan	Kyrgyz Republic	Latvia
Lithuania	Macedonia, FYR	Moldova
Poland	Romania	Russian Federation
Slovak Republic	Tajikistan	Turkey
Turkmenistan	Ukraine	Uzbekistan
Yugoslavia, Fed. Rep.		

High income (*HIC*) group aggregate (2000 GNI per capita of $9,266 or more)

Andorra	Aruba	Australia
Austria	Bahamas, The	Barbados
Belgium	Bermuda	Brunei
Canada	Cayman Islands	Channel Islands
Cyprus	Denmark	Faeroe Islands
Finland	France	French Polynesia
Germany	Greece	Greenland
Guam	Hong Kong, China	Iceland
Ireland	Israel	Italy
Japan	Kuwait	Liechtenstein

Luxembourg	Macao, China	Malta
Monaco	Netherlands	Netherlands Antilles
New Caledonia	New Zealand	N. Mariana Islands
Norway	Portugal	Qatar
San Marino	Singapore	Slovenia
Spain	Sweden	Switzerland
United Arab Emirates	United Kingdom	United States
Virgin Islands (U.S.)		

<u>Latin America & Caribbean</u> (*LAC*), excluding high-income economies

Antigua and Barbuda	Argentina	Belize
Bolivia	Brazil	Chile
Colombia	Costa Rica	Cuba
Dominica	Dominican Republic	Ecuador
El Salvador	Grenada	Guadeloupe
Guatemala	Guyana	Haiti
Honduras	Jamaica	Mexico
Nicaragua	Panama	Paraguay
Peru	Puerto Rico	St. Kitts and Nevis
St. Lucia	St. Vincent & Grenad.	Suriname
Trinidad and Tobago	Uruguay	Venezuela, RB

<u>Middle East & North Africa</u> (*MNA*), excluding high-income economies

Algeria	Bahrain	Djibouti
Egypt, Arab Rep.	Iran, Islamic Rep.	Iraq
Jordan	Lebanon	Libya
Morocco	Oman	Saudi Arabia
Syrian Arab Republic	Tunisia	West Bank and Gaza
Yemen, Rep.		

<u>South Asia</u> (*SAS*)

Afghanistan	Bangladesh	Bhutan
India	Maldives	Nepal
Pakistan	Sri Lanka	

<u>Sub-Saharan Africa</u> (*SSA*)

Angola	Benin	Botswana
Burkina Faso	Burundi	Cameroon
Cape Verde	Central African Rep.	Chad
Comoros	Congo, Dem. Rep.	Congo, Rep.
Côte d'Ivoire	Equatorial Guinea	Eritrea
Ethiopia	Gabon	Gambia, The
Ghana	Guinea	Guinea-Bissau
Kenya	Lesotho	Liberia
Madagascar	Malawi	Mali
Mauritania	Mauritius	Mayotte
Mozambique	Namibia	Niger
Nigeria	Rwanda	São Tomé & Principe
Senegal	Seychelles	Sierra Leone
Somalia	South Africa	Sudan
Swaziland	Tanzania	Togo
Uganda	Zambia	Zimbabwe