How concentrated are global infrastructure markets?

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Abstract

The purpose of this paper is to provide a quantitative assessment of the degree of concentration in infrastructure industries at the regional and global levels. We calculate regional and global concentration indexes for electricity generation and distribution, water and sanitation, and fixed and mobile telecommunications. Concentration issues are identified in only about 20% of the cases studied, while a presumption of concentration is found in another 30% of the cases. In more general terms, we find no scope for simple encompassing regional or sectoral statements because concentration is region- and sector-specific.

1 Introduction

The promotion of competition in the delivery of electricity, telecommunication, water and other infrastructure services was to be one of the main expected contributions of the microeconomic reforms of the 1990s throughout the world. Depending on the sector, roughly 40% (water) to 70% (telecoms) of developing and transition countries introduced some major institutional reform to promote competition in or for the market (Estache and Goicoechea, 2004). This search for competition resulted in major structural changes in infrastructure in many countries. Unbundling of the various segments of each sub-sector was the norm of many reforms. For instance, in electricity, generation, transmission and distribution operations became separate business units in many countries. In telecoms, fixed and mobile started to be handled as distinct commercial activities. These changes were intended to increase the number of players in infrastructure service delivery.¹

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¹ For a more detailed discussion of the economic characteristics of these industries and the scope for and limits of competition in each industry, see Newberry (2000) or Kessides (2004). In short, water and

Due primarily to economies of scale and scope, limits to the achievable degree of *competition in the market* continued to prevail in some cases. In small countries, monopolies were indeed hard to avoid in water and energy distribution, and in bigger countries, national monopolies were replaced by local or regional monopolies, but monopolies nonetheless. This is why *competition for the market* became so popular during the 1990s. Residual monopolies were auctioned – rather than awarded through beauty contests or negotiations – because auction theory promised to deliver many of the gains that competition in the market would have delivered.

One of the assumptions implicit in this promise was that the number of potential providers in the sector would be large enough to allow competition for the market to be effective. This did not happen for all sectors. In Latin America, during the 1990s, 92% of the water and sanitation auctions, 76% of the transport auctions and 57% of the energy auctions awarded had three or fewer bidders (Estache, 2003). The only sector with many bidders was the telecoms sector. For some sectors, the anecdotal evidence suggests that competition was limited simply because the number of players was limited. The most extreme is the water sector. Estache and Trujillo (2004) report that between 1990 and 1997 out of the 58 large water and sewerage projects signed in developing countries, over 50% were awarded to the same firm and 40% to two others. In most infrastructure sectors, the limitation of the competition also reflects the fact that many of the players tend to hedge by investing as members of consortia rather than as individual providers. This is quite relevant, not only to the assessment of the degree of competition but also from the viewpoint of the assessment of the sectors' concentration. It also means that the estimation of the extent of concentration does indeed require knowledge of the composition of the ownership of each large operator – and ideally, its change overtime.

With this background in mind, the main purpose of this paper is twofold. First, we provide quantitative indicators on the residual degree of concentration in each sub-sector after a decade of reforms across sectors and across regions. We cover electricity generation and distribution, fixed and mobile telephony, water and sanitation. We measure concentration at both the regional and global level. Second, we discuss the extent to which there may be a case for more coordination between country specific agencies or even a case for a supra-national agency to address any concern for excessive concentration in a sector.

To conduct the assessment, we build a database from the partial information available on the Internet, mostly from international agencies specialized in some sectors (that is, International Energy Agency, Water and Sanitation Program of the World Bank or the International Telecommunication Union) and from specialized consulting and credit rating firms. Because the database does not cover the full spectrum of firms, we also had to approximate the concentration indices typically used by competition agencies. The approximation provides a range for the measure of concentration rather than the point estimate typically relied on by competition authorities to take decisions. Accordingly, we propose an adjusted associated rule to assess the degree of market concentration.

sanitation, electricity distribution and fixed telecoms services are all natural monopolies for which *competition for the market* is the most common form of competition. Regulation is required once the markets have been awarded. Electricity generation and mobile services can generally be competitive if there are no administratively driven restrictions to entry; the role of regulation in these sectors emerges more in the context of access or issues of investment incentives.

A reason our concentration measures may be of interest is that in the face of natural monopoly properties, although there may be only limited competition within each individual country market, strong regional or global competition could still provide sufficient *competition for the market* so that desirable outcomes are obtained. On the other hand, if a handful of firms dominate a given sector across a whole region (or even worldwide), this suggests that there will be little competition for the market in any given country. Regional or global concentration may also make collusion more likely.² Our paper provides a first look at whether such concerns are worthy of further investigation.

The rest of the paper is organized as follows. Section 2 presents the methodology used to approximate the degree of concentration in each market and each region of the world. Section 3 presents the results. Section 4 discusses some of the policy implications. Section 5 concludes.

2 The methodology

What happens when a single operator or a small set of operators controls *de facto* regional or global markets – that is, a set of national or local markets? This is not an issue expected to be addressed by the local or national regulators. However, it does raise a public policy concern since users have much less choice when an auction cannot guarantee an efficient outcome. This is the case when a collusive behavior reduces competition at the regional level, even if it is unnoticed at the local level. In this case, it could be argued that the relevant market for infrastructure services with at least some degree of restriction to competition across countries is a supranational regional market (for example, Latin America, Africa or Asia). In some instances, when the sector is controlled by a limited number of specialized firms and there is a concern for world wide collusion, the relevant market may actually be the global market.

To assess the extent to which global infrastructure markets are concentrated at the regional or global level, information is needed on the number of firms active in the market, their relative size in that market and their ownership structure. This section discusses the practical challenges associated with the quantification of market concentration and the solutions adopted in this paper.

2.1 Towards a specific measure of regional and global concentration

From the perspective of competition policy, the first issue to address is the characterization of the firms, in particular in terms of their size. This should ideally be measured by the annual flow of sales in the relevant market or, if the products are homogeneous, by the quantities sold (since the price is the same for all firms) or also by the physical capacity of the operators. In practice, the appropriate data is not always available and it is sometime easier to approximate the size by the populations covered by the providers.

This section describes the approach followed in this paper to assess regional and global concentration levels. If q_i is either the MWs of installed generation capacity, the number of connections to the electricity grid, the population covered by water and sanitation or the number of telecommunication lines of firm i , and n is the number of firms active in the relevant market – national or supranational –, the market share of firm i is measured by:

² See, for instance, pp.349-405 of Pepall, Richards and Norman (2002).

$$s_i = \frac{q_i}{\sum_{j=1}^n q_j}$$

where by construction $0 < s_i \leq 1$. In the context of this paper, the shares are defined in terms of the share of ownership in the production of q_i . In other words, if q_i is owned in equal proportions by two operators, each operator i only gets credited with 50% of ownership in the calculation of its s_i .

This approach means that we control for ownership, independently of whether the firm in the sample has control over a given subsidiary or not. Assuming full ownership (100%) may lead to an overestimation of market concentration when more than one firm in the sample holds shares in the same provider (for example, in Argentina, Ondeo and Veolia both have shares in Aguas Argentinas). The appendix provides a more detailed explanation of this issue, and how we construct market concentration in this paper.

Knowing the shares $s_1, s_2 \dots s_n$ of firms, the challenge is to construct an index that can provide information about regional or global market concentration with limited amounts of information. There are essentially two groups of indices to consider: composite (or global) indices and partial indices.

The global index most commonly used is the Herfindahl-Hirschman Index (HHI), defined by

$$HHI = 10000 \sum_{i=1}^n s_i^2$$

For each exogenous value of the number of active firms n , this index varies between a minimum of $\frac{10000}{n}$ when all firms are equal ($s_i = \frac{1}{n}$) and a maximum of 10000 when there is one very large firm (nearly monopolistic) with $n-1$ very small competitors.

The index is discussed in the United State's Merger Guidelines as a possible filtering system to determine whether a planned merger should be cause for concern (Department of Justice and Federal Trade Commission Horizontal Merger Guidelines §1.51, 1992) and an equivalent suggestion is available in European Law in Regulation EEC 139/2004. Markets with an HHI under 1000 are considered "not concentrated" and generally do not require further analysis. Market in which $1000 < HHI < 1800$ are "moderately concentrated" and competition is thought threatened if the merger causes the HHI to increase by more than 100 points. Finally, if the HHI exceeds 1800, the market is highly concentrated and any transaction that causes an increase of $\Delta HHI > 50$ calls for further inquiry.

While these thresholds seem arbitrary they can be explained by considering that since $HHI = \frac{10000}{n}$ when the n firms are of the same size, the reciprocal value $\frac{10000}{HHI}$ is a good indicator of the number of firms that play a central role in the market. This means that $\frac{10000}{1000} = 10$ firms present in a market define a relatively unconcentrated market, while $\frac{10000}{1800} < 6$ firms define a highly concentrated market.

Although this indicator is relatively easy to deal with in national markets, it is somewhat more complex to generate for supranational markets. None of the infrastructure sectors has an exhaustive database on operators or their activities around the world, including their share of ownership in various contracts. The big players are generally well known but they only represent a sub-set of the total number of players in the market. In this case, an alternative is to rely on a partial index. A common such index is the sum of the market shares held by the m largest firms (with $m < n$ where n is the total number of firms offering services in the sector). This is the *m seller concentration ratio*:

$$CR_m = \sum_{i=1}^m s_i \text{ with } s_1 > s_2 > \dots > s_m > s_{m+1} > \dots > s_n.$$

For example, CR_4 measures the market share of the four largest firms. Such partial indices have a number of drawbacks. They provide very little information about differences between markets with a small number of firms.³

The main advantage of this partial index is its simplicity and its ease of interpretation. In addition, it can be used in an approximation of the relevant HHI. Indeed, Sleuwaegen and Dehandschutter (1986) have shown the existence of a non-linear relation between HHI and CR_m . In spite of a number of limitations, this result makes it easier to come up with a decision criterion in industries for which information is not available on all operators.

The approximation basically gives an upper and lower band for the HHI corresponding to a given CR :

$$HH_{\min} = \frac{CR_m^2}{m}$$

$$HH_{\max} = \begin{cases} CR_m^2 & \text{if } CR_m \geq 1/m \\ CR_m / m & \text{otherwise} \end{cases}$$

This approximation has two problems.⁴ The first is that the relationship between HHI and CR is weaker the more concentrated the market is. Indeed, the spread between $HH_{\min}$ and $HH_{\max}$ increases with the concentration ratio. This problem can thus only be assessed ex-post once the concentration rate has been assessed. If it turns out that a few companies have a fairly high market share, the approximation is likely to be weak. The second is that it does not lead to the simple decision rule equivalent to the rule adopted by the US Department of Justice.

We suggest the following adaptation which could serve to any analyst interested in assessing supranational concentration rates:

- (1) if both $HH_{\min}$ and $HH_{\max}$ are below 1000, there is no concentration problem;
- (2) if both $HH_{\min}$ and $HH_{\max}$ are over 1800, there is a clear case of concentration;

³ A second drawback is that, if mergers or acquisitions occur among firms not included among the four largest, and if those operations do not change the ranking of the top four firms, the C_4 index does not signal any change. This is more relevant when assessing the evolution of concentration than when taking a single snapshot.

⁴ Note that we have to multiply the lower and upper bound in the HH by 10000 to get to the usual range for HHI .

- (3) if $HH_{\max}$ is above 1800 and $HH_{\min}$ between 1000 and 1800, the test is inconclusive but there are good reasons to be concerned with market power from concentration so the rule should read as inclusive but presumption that “there is concentration”
- (4) if $HH_{\max}$ is between 1000 and 1800 and $HH_{\min}$ below 1000, then the test is inconclusive but the presumption is that “there is no concentration”.
- (5) if $HH_{\max}$ is above 1800 and $HH_{\min}$ below 1000, then the test is inconclusive.⁵

The first two cases are consistent with the existing use of HHI. As mentioned above, the actual HHI belongs to the interval defined by $HH_{\min}$ and $HH_{\max}$, so that the first two cases are consistent with the US legislation. The difficulty arises when the estimated $HH_{\min}$ and $HH_{\max}$ do not imply HHI is below 1000, in between 1000 and 1800 or above 1800. For instance, the test is inconclusive when $HH_{\min} < 1000$ and $HH_{\max} > 1800$ since the actual HHI can be lower than 1000 or larger than 1800. However, in case (3) the implied HHI cannot be below 1000 (so we cannot presume a lack of concentration) and in case (4) the implied HHI cannot be above 1800 (so we cannot presume concentration).

2.2 How data availability drives the definition of the appropriate market

In this setting, finding an appropriate measure of market size and concentration is constrained by the nature of the industries and the availability of information. We are covering many countries in which the relevant ideal information is not published and the best that can be done is to collect information from the website of each regulated firm. No price or demand information is available to apply the standard market definition criterion. Taking into account these limitations, we adopted the following ways of measuring market size and concentration in each industry:

- *Electricity generation*: MWs of installed capacity per country.
- *Electricity distribution*: number of connections in the sample.
- *Water and sanitation*: country and urban population.
- *Telecommunication*: number of lines in use.

These definitions deserve some further remarks. For instance in generation, the most likely candidate for measuring the size of the market is the MWs of energy produced per country. However, it is not the ideal one. Market restrictions are indeed not necessarily associated with market shares. For instance, congestion in transmission may be a bigger problem. Indeed, a small generator can exert market power on its local consumers when it is isolated from competition due to transmission constraints. Bilateral trades in which the price of the energy can be secret is another source of risk to efficient markets.

In the distribution of electricity (with a few exemptions), there is no competition in the market.⁶ We use the number of connections to the electricity grid for residential and

⁵ Note that a large discrepancy between the lower and upper bound is not necessarily a signal of concentration. See Sleuwaegen and Dehandschutter (1986).

⁶ In the UK consumers can switch retailers and it is expected that this form of competition will be implemented in France. Joskow and Tirole (2004) show that when demand is not price sensitive and there is an absence of real-time metering, there is little potential advantage of such competition.

industrial users. However, as discussed later, we could only track a certain number of providers and the number of connections cover users connected to the sample of firms analyzed. As an alternative hypothesis, we could use population as a measure of the potential market. In general there is no comparable information to determine the share population covered by the electricity network for each country. Only information on connections is provided by the sample of firms covered.

For water and sanitation, we use population as a measure of the size of the market. Note that in the case of country population we are implicitly assuming full coverage and this assumption does not hold in general. In that case we use two definitions of market size by also considering urban population.

Finally, in telecommunication, we rely on the total number of lines in use. The main issues are that fixed and the mobile technologies are close substitutes but also access to telecoms is not available to some consumers (that is penetration rates in rural areas which is where the largest share of population live in poor countries tend to be quite low). Any measure of market size and concentration has to take into account these problems.

3 The sector specific results

This section briefly discusses the basic data and presents the results of the computation of the various maximum and minimum HHI indices. Most of the data is from 2003, unless otherwise specified.⁷ Unfortunately, there is not enough information on previous years to improve the coverage of the database.

For each sector, we summarize the information. We report the market indicator selected, the minimum and maximum HHI computed, the number of operators covered by the indicator and their aggregate market share, the number of countries as well as the total number of contracts or “cases” included in the database. Each case represents an operator in the sample supplying a certain good or service per country. At regional and global levels, we only consider as a part of the market, the countries in which the firms in the sample are active. In the rest of the countries, either some firms are unidentified due to a lack of information or the reform of the infrastructure sector has not been yet implemented. In general, the main players include those most representative for each sector (for these, enough public information on their activities is usually available – most of this information was in fact collected from the website of these operators). The concentration index is computed for the main regional markets of the world as well as for the global market. Table 1 summarizes the information collected.

⁷ The database is available from the authors upon request.

Sector	Electricity		Water & Sanitation		Telecommunication	
	Generation	Distribution	Water	Sanitation	Fixed	Mobile
<i>Product Definition</i>	Installed capacity (MWs)	Number of customers (connections)	1. Urban population covered (†) 2. Country population (††)		Number of working lines	
<i>Number of Players*</i>	16 firms	12 firms	7 firms	7 firms	11 firms	11 firms
<i>Number of Countries in sample</i>						
OECD	19	12	23	20	18	25
No OECD	38	19	33	18	17	40
Total	57	31	56	38	35	65
<i>Market Shares:*</i>						
World	18%	31%	23%(††) - 34%(†)	23%(††) - 31%(†)	39%	37%

* The market share represents the market share of the firms we consider relative to the global market but only including countries in which the selected firms are active.

Table 1: Overview of the data available

First, table 1 shows that we tried to report data on the sectors as unbundled as possible. Second, for the electricity and telecommunications, we managed to get market data close enough to what a competition agency would consider appropriate. For water and sanitation, we relied on two proxies: urban population and total population. The first probably gives a lower bound and the second an upper bound of the populations affected by the large operators covered by the database. We should thus get respectively a further level of upper and lower bound for the concentration index from these two measures. Third, the country coverage is relatively evenly distributed between OECD and non-OECD countries that ensures a reasonable sense of robustness when comparing the two country groups. Finally, the combination of the market shares and of the number of players suggests that there is no outrageous domination of any sector by a very limited number of players and hence that the approximation method used here is unlikely to be much distorted at the global level.

3.1 Electricity

For electricity, we differentiate between the two main activities: generation and distribution – (that is, local transmission and retailing); we did not find enough information on transmission. Generation tends to be competitive at the national level while distribution is not. We select a set of the main international players according to the numbers of countries where these firms have activity but also with respect to the numbers of own MW installed for generation and customers covered for distribution. This choice is partially based on the information available from the Annual reports of the International Energy Agency and on information provided by credit rating agencies in their regular reports and information most commonly available on the website of the main firms in the sector. In most of the cases, the database source for each firm is its own website.

Note that in generation we rely on installed capacity instead of production to compute the HHI for two reasons. First, it captures the potential effect of concentration since a firm can produce up to its capacity. Second, many firms do not publish production in their public reports and so the sample size would have been much smaller if we measured production instead.

3.1.1 Electricity generation

For generation, we consider a set of 16 firms across 57 countries (19 OECD and 38 non OECD) and credited with 18% of the global market of the installed capacity of generation. The set of firms is composed of: American Electric Power (AEP), AES Corporation, CLP Group, Duke Energy, E.ON, Electricité de France (EDF), Electricidade de Portugal (EDP), ENDESA, ENTERGY, Union Fenosa (UF), Hong Kong Electric Group (HEG), Intergen, Public Service Enterprise Group (PSEG), Reliant Energy Inc., Southern Energy Company and Tractebel Power.⁸

	GLOBAL	Africa	Asia & Oceania	Latin America	North America	Eastern Europe	Western Europe
Market indicator	Installed Capacity per country (MW)						
HH _{min}	734	592	594	1762	20	48	1386
HH _{max}	1630	1527	1261	3467	206	416	2893
Aggregate market share	18%	16%	15%	47%	10%	8%	40%
Number of firms	16	5	10	10	9	7	12
Number of countries	57	6	14	15	2	8	12
Cases	157	7	29	60	12	13	36
Main players	AEP, AES, CLP, Duke, E.ON, EDF, EDP, ENDESA, ENTERGY, UF, HEG, Intergen, PSEG, Reliant, Southern, Tractebel	AES, EDF, UF, Intergen, PSEG	AES, CLP, Duke, E.ON, EDF, HEG, UF, Intergen, PSEG, Tractebel	AEP, AES, Duke, EDF, EDP, ENDESA, UF, Intergen, PSEG, Tractebel	AEP, AES, Duke, E.ON, ENTERGY, PSEG, Reliant, Southest, Tractebel	AES, EDF, Entergy, E.ON, PSEG, Tractebel, UF	AEP, AES, Duke, E.ON, EDF, EDP, ENDESA, UF, Intergen, PSEG, Reliant, Tractebel

Table 2: Regional HHI for electricity generation (2003)

⁸ E.on has subsidiaries LG&E and Powergen. Intergen is a group formed from equal participation of Shell and Bechtel. Tractebel Power belongs to the Suez Group.

At the global level, Table 2 generally confirms expectations, although not in all respects. Indeed, Table 2 shows that, as expected, this is not an overly concentrated market at least globally. In other words, generation is a competitive sector in general – although EDF and E.ON have a significantly larger market share than the others, their lead is not strong enough to distort competition in this market at the global level.

At the regional level, a strict adherence to the rule suggested above would however only clear firms in North America and Eastern Europe of any concern over high market concentration. Both Latin America and Western Europe should be sources of concern for a hypothetical supranational competition agency as indicated by the HHIs and hinted at by the large market shares of the operators present in the regions. For Western Europe, this is not a surprise since the liberalization of the sector has not yet fully been implemented. However, for Latin America, this comes as a surprise. Indeed, Latin America is the region in which the largest number of countries has some significant reform levels in the sector. In over half of the countries of the region, the private sector now has a significant role in generation. Yet Table 2 suggests that even the lower bound of the HHI is close to what would justify a pro-active role for a supranational competition agency concerned with the degree of concentration in the sector.

It could be argued that using the installed generation capacity rather than the effective energy produced can bias the result. Consider the case of a hydro plant in a dry year or some thermal peak generation unit in years of abundant rains. In both cases these firms produce less than the installed capacity. However in that case, we cannot determine whether the concentration is due to some manipulation of the energy produced or it is due to some non-controllable variables in the market. Surprisingly, information on the energy produced was not available in general. We expect that using the installed capacity avoids this problem.

3.1.2 Electricity distribution

For distribution, we have data on 12 firms across 31 countries (12 OECD and 19 non OECD). They account for 31% of the global electricity distribution market. We only have data on one of the two countries for North America and hence we do not deal with it at the regional level since the methodology would produce a country specific indicator. The sample size for some of the regions (Africa and Asia) is also rather small – to a large extent because of the few deals with private operators in this activity in both regions – and hence the results are likely to be biased and of lesser interest. The companies included are: American Electric Power, AES Corporation, CLP Group, E.ON, Electricité de France (EDF), Electricidade de Portugal (EDP), ENDESA, ENTERGY, Union Fenosa, Hong Kong Electric Group (HEG), Public Service Enterprise Group (PSEG) and Southern Energy Company.

The decision rule proposed suggests that globally this sector is probably subject to market concentration problems. EDF, Endesa and E.ON seem to be strong leaders at the global level with respectively 38.1%, 15.2% and 14.8% served by the 12 top operators of the business. Even if $HH_{\min}$ does not reach the 1800 threshold, it is high enough to raise concern. This impression is strongly enhanced by the $HH_{\max}$ that is well above the threshold and this for a fairly large sample size. All of Europe is clearly a concern since in both Eastern and Western Europe, all of the HH levels are above the 1800 threshold. As mentioned earlier, the liberalization of the sector has not yet gone very far. In Eastern Europe, the issue is that only a few countries have actually privatized their distribution,

and E.ON enjoys a significant share of the market by itself. Latin America and Asia and Oceania are both inconclusive but are in the range in which it may make sense to take a closer look at the situation. For Latin America, this is once more somewhat surprising. For all of its reforms, the dominating presence of Endesa, EDF and AES in several of the national markets of the region explain the high $HH_{\max}$.

	GLOBAL	Africa	Asia & Oceania	Latin America	North America	Eastern Europe	Western Europe
Market indicator	Number of customers per country						
$HH_{\min}$	1498	663	1075	1433	-	2316	2000
$HH_{\max}$	2933	1618	2654	3169	-	3769	3455
Aggregate market share	31%	16%	33%	41%	12%	38%	43%
Number of firms	12	2	3	6	5	3	5
Number of countries	31	3	3	11	1	6	7
Cases	51	3	4	20	5	6	13
Main players	AEP, AES, CLP, E.ON, EDF, EDP, ENDESA, ENTERGY, UF, HEG, PSEG, Southeast	AES, EDF, EDP	CLP, UF, HEG	AES, EDF, EDP, ENDESA, UF, PSEG	AEP, AES, E.ON, ENTERGY, Southeast	AES, E.ON, UF	E.ON, EDF, EDP, ENDESA, UF

Table 3: Regional HHI for electricity distribution

3.2 Telecoms

The market indicator is the number of lines in working conditions controlled by an operator and the information is collected from the 2003 annual report of each firm. We consider fixed and mobile technologies separately. For each sub-sector, we consider the 11 top firms identified in a 1999 ITU report in a ranking of the main 20 providers according to their turnover. It turns out that 10 of these firms are present in both the fixed and the mobile lines business. For fixed lines, the 11 top firms were then: Bell South Corporation, BT Group, China Telecom, Deutsche Telekom, France Telecom, NTT, SBC, Telecom

Italia, Telefonica de España, Telstra, and Verizon. For mobile, the firms covered are: Bell South Corporation, China Telecom, Deutsche Telekom, France Telecom, NTT DoCoMo, SBC, Telecom Italia, Telefonica de España, Telstra, Verizon and Vodafone.⁹ BT is dropped from the mobile list while Vodafone is not present in the fixed line list. For fixed lines we consider 35 countries (18 OECD and 17 non OECD) while for mobile, we cover 65 countries (20 OECD and 45 non OECD).

A few words of caution on this list may be appropriate. First, there is a fair amount of turnover in ownership in this sector. Some of the firms in the 1999 list have now changed owners (and names). Our choice of operators is thus arbitrarily frozen in 1999 even if the information is collected for these companies in their form as of 2003. Second, there is a clear regional specialization of firms. There are only 4 firms with a strong presence in LDCs: France Telecom, SBC, Telecom Italia, Telefonica de España. This last one is particularly dominant in Latin America, Telstra in Asia and Oceania, and France Telecom in Eastern Europe. Third, the list does not do justice to the growing presence of regional players in the various regional markets with strong South African firms present in Africa and strong Mexican and Brazilian operators present in Latin America for instance. However, most of these firms and many of those included in the ITU list do not publish the necessary information on their websites and hence we cannot make a fair assessment of their effective role in diluting or reinforcing market power in this sector. However, many of these firms are often at least partially owned and controlled by one of the top 11 through cross-ownership arrangements. Together, the firms covered here are present in 67 countries through 127 operators.

3.2.1 Telecoms fixed

With the market performance indicator adopted here and based on the 35 countries in which the top 11 operators have some presence, Table 4 shows that the global concentration level is quite high. These operators controlled 41% of the market in 2003 and have both the $HH_{\min}$ and $HH_{\max}$ above the 1800 threshold level. This high level of concentration is not that surprising. In many countries, fixed telephony is still a monopoly. What is more surprising is to see the high global level of concentration. Asia and Oceania, Latin America and Europe (both East and West) are once again the two regions in which the concentration levels are the highest.

While the concentration indicators are useful, once more, they do not tell the full story. First, it may be useful to point out that in 2003, China Telecom, Deutsche Telekom and SBC shared almost 50% of the market controlled by these 11 companies in the world. Second, firms relatively small at the global level can be very important at the regional level. This is the case for Telstra which is big in Asia and Oceania but relatively small globally. Finally, however strong the presence of these firms may be in developing areas, for most of them the core business continues to be in developed countries, most importantly in Western Europe and North America.

⁹ For NTT and NTT DoCoMo we only consider their activities in Japan.

	GLOBAL	Africa	Asia & Oceania	Latin America	North America	Eastern Europe	Western Europe
Market indicator	Number of working lines per country						
HH_{min}	2171	888	3239	2859	524	2075	3443
HH_{max}	3706	2342	5097	3929	1796	4499	4570
Aggregate market share	41%	23%	51%	46%	30%	45%	48%
Number of firms	11	2	4	4	3	2	6
Number of countries	35	6	4	9	2	3	11
Cases	44	6	6	12	4	4	12
Main players	Bell South, BT, China Telecom, Deutsche Telekom, France Telecom, NTT, SBC, Telecom Italia, Telefonica de España, Telstra, Verizon	France Telecom, SBC	China Telecom, France Telecom, NTT Telstra	SBC, Telecom Italia, Telefonica de España, Verizon	Bell South, SBC, Verizon	Deutsche Telekom, France Telecom	BT, Deutsche Telekom, France Telecom, SBC, Telecom Italia, Telefonica de España

Table 4: Regional HHI for Telecoms – fixed**3.2.2 Telecoms mobile**

Globally, based on our sample of 65 countries in which the top 11 operators are present, the measure proposed here suggests that it is difficult to make an assessment of the degree of market power in the sector. The HHmax is fairly high but the HHmin is below the 1000 threshold level that makes the indicator inconclusive. The fact that 11 firms cater to 41% of the market seems to suggest a relatively large number of firms. But this does not tell the full story. Indeed, in 2003 Vodafone controlled 28% of the number of working lines credited to these 11 companies. Telefonica de España, SBC and Verizon added up to a further 31% of that total. This suggests that at the global level, 4 firms are particularly important.

	GLOBAL	Africa	Asia & Oceania	Latin America	North America	Eastern Europe	Western Europe
Market indicator	Number of working lines per country						
HH_{min}	994	1113	663	1507	464	1000	1222
HH_{max}	2778	2748	2808	3576	2521	2584	3402
Aggregate market share	38%	31%	27%	48%	36%	38%	50%
Number of firms	11	4	8	7	5	6	7
Number of countries	65	10	13	16	2	9	15
Cases	127	12	16	36	6	19	38
Main Players	Bell South, Deutsche Telekom, France Telecom, SBC, Telecom Italia, Telefonica de España, Telstra, Verizon and Vodafone	France Telecom, SBC, Telefonica de España, Vodafone	Bell South, China Telecom, Deutsche Telekom, France Telecom, NTT DoCoMo SBC, Telstra, Vodafone	Bell South, France Telecom, SBC, Telecom Italia, Telefonica de España, Verizon, Vodafone	Bell South, Deutsche Telekom, SBC, Verizon and Vodafone	Deutsche Telekom, France Telecom, SBC, Telecom Italia, Verizon, Vodafone	Bell, South, Deutsche Telekom, France Telecom, SBC, Telecom Italia, Telefonica de España, Vodafone

Table 5 Regional HHI for Telecoms – mobile

Although the test are inconclusive at the regional level, in the case of Africa, Latin America and the two European Regions, the fact that the HH min is above the 1000 threshold suggests that a presumption of concentration could be argued by an hypothetical supranational competition agency. For North America and Asia and Oceania, the presumption would go the other way around.

To get a fuller sense of the situation, it is useful to point out that like in the fixed line business, there is a regional specialization of the main firms. In 2003, Deutsche Telekom and Vodafone were the major firms in Western Europe who together controlled 35% of that regional market for the 11 leading companies of the world. They were followed at a distance by France Telecoms and Telefonica de España who add up to about 10% of that market. Deutsche Telekom and Vodafone were also very strong in North America, Eastern Europe, Asia and Oceania. The developing world market is largely dominated by France Telecom, Telefonica de España, Telecom Italia, SBC, Verizon and Vodafone. These companies do seem to have regional specialization. Telefonica de España is, as in the case of fixed lines, the main player in Latin America but with a strong presence of Telecom Italia, SBC and Verizon. France Telecom is a leader in Eastern Europe (with Deutsche Telekom) and in Africa (with Vodafone).

3.3 Water and sanitation

We consider the seven most important private firms that provided water and sanitation around the world in 2003. These companies are present in at least 61 countries. The set is made by: Ondeo, Veolia, RWE, Saur, United Utilities (UUT), Anglian Waters (AWG) and Severn Trent (SET).¹⁰ The information is provided by each firm in its annual report (2003) available from the website of these companies or from the national stock market commission for listed companies. We also relied on information collected from the website of the Public Services International Research Unit and by a 2003 report on the sector by Lehman Brothers.¹¹

The total information available is, per country and firm, the population coverage by water service and sewerage. In addition, there is a set of 19 more private firms present in these 62 countries. Typically, these are spin-offs of local construction companies. The water business is increasingly popular indeed in the construction sector in developing countries. Most of the Brazilian market for instance is catered to by Brazilian construction firms. The global information is however limited and we can only determine how many of these firms there are per country as well as the share of the total population they cover. We call this set as “Other Private Providers” (OPP).¹² They represent about one third of the global market and their share in regional markets varies from less than 15% in Eastern Europe to almost 60% in Latin America where all the local construction companies have become such big players in many countries that they control the largest market of the region (that is Brazil). Hall et al. (2004) for instance document the role of many Asian companies in Asia, alone or in partnerships with OECD companies (Veolia, Ondeo/Suez and Thames). From Hong Kong, Citic Pacific, NWS Holding, China Everbright and China Water are all active in the Chinese market. In Malaysia, Pucak Niaga, Ranhill Utilities and Taliworks Corp are three of the larger water and sanitation companies in the country. Other

¹⁰ Bechtel is probably the only major player missing from this list but we did not have enough information to include it.

¹¹ Missing from the report are the British Biwater and the Dutch Ne-on who often team up as consortia during the 1990s in particular in East Asia.

¹² The information available on OPPs includes urban and country population covered by these OPPs in each country together with the number of these firms per country. Therefore, it is not possible to compute the market share of each OPP. However, to compute the CRM, this information is not required since the aggregate market share and the number of the OPPs per country is enough.

Malaysian companies such as Pilecon, PPB/Keary Utilities, PBA Holdings Berhad and Salcom are mostly active in China.

In our assessment of the concentration rates, we distinguish between water and sanitation. In water, we cover 56 countries (23 OECD and 33 non OECD) and in sanitation 38 countries (20 OECD and 18 non OECD). The market is defined in two ways. The first focuses on the share of urban population covered and serves as an upper bound for the degree of concentration. The second is the share of total population in each country and serves as a lower bound. The first may be a good approximation of the appropriate market in developing countries since large private firms tend to specialize in urban water systems. It may not be the right proxy for developed economies where full coverage has been achieved.

3.3.1 Water

Somewhat surprisingly given the publicity given to the high degree of concentration of this market, the indicators for both urban and total population are inconclusive. The presumption from the HH generated by the urban indicator is however that concentration tends to be strong at the regional and global level. In contrast, the presumption is not confirmed by the broader market definition since the HH_{max} for the country population is below 1800, although it is borderline.

At the regional level, Africa is the only region where there is a clear concentration problem in terms of the urban population even if this is not confirmed by the indicator using the country population. The main players are the three large French companies, along with the local private sector. The strong concentration is not surprising however in view of the marginal role played by large foreign operators in the rural parts of the country and in view of the fairly low level of coverage of network water suppliers in general in the region.

North America is the other region in which there may be some scope for concern. This region is in fact the only one in which the two indicators tell a consistent story. Note that it is important to remember that this data does not reflect the acceleration of the concentration process in this sector. As reported by Hall (2002), a series of recent takeovers of US companies by French companies is fueling this process. Suez bought US Water, which was owned by Bechtel and United Utilities, and also a number of Azurix contracts in Mexico. RWE-Thames has bought private water operations in the USA from Anglian Water.

For all of the other regions, there is no conclusive evidence of a major concentration problem based on either indicator. In many countries, there is good evidence of a surprising large role of local private water companies. Their role is the strongest in Latin America where they cater to the needs of roughly 58% of the population, followed closely by a share of 54% of North America's population. In Africa, Asia, Western Europe and Eastern Europe, they represent respectively 29%, 27%, 21% and 13% of the market. These figures help in keeping the HH indices low. They do not however reflect the fact that in Africa or Asia, for instance, the main role of these local operators is to deliver services which the large foreign private sector does not anyway compete for.

In terms of the overall market share of the various companies – defined in terms of the countries' population – there is clear domination of the two large French companies, Odeo and Veolia. When non-global providers (OPPs) are taken into account, they control 43% of the market; when regional and national private players are ignored, they control

two thirds of the market. The next two largest players are RWE and Saur with respectively 7.6% and 6.9% of the global market.

	GLOBAL	Africa	Asia & Oceania	Latin America	North America	Eastern Europe	Western Europe
Market indicator	1. Urban population (upper bound concentration) 2. Country population (lower bound concentration)						
HH_{min} (urban)	1 163	2 990	353	585	1 598	809	643
HH_{max} (urban)	2 857	4 514	2 174	1 874	3 467	2 580	2 536
HH_{min} (country)	514	648	120	263	1 290	423	339
HH_{max} (country)	1 694	2 043	763	1 291	2 777	1 586	1 702
Aggregate market share (urban)	34%	49%	25%	28%	40%	31%	31%
Aggregate market share (country)	23%	23%	14%	21%	35%	22%	24%
Number of firms	7	4	6	5	5	5	7
Number of OPP	19	7	7	16	10	8	16
Number of countries	56	13	8	12	3	7	13
Cases	151	18	29	35	14	12	43
Main players	AWG, RWE, SAUR, SET, ONDEO, VEOLIA, UUT and Others Private Providers (OPP)	RWE, SAUR, ONDEO, VEOLIA, OPP	AWG, RWE, SAUR, ONDEO, VEOLIA, UUT, OPP	AWG, RWE, SAUR, ONDEO, VEOLIA, OPP	RWE, ONDEO, SET, VEOLIA, UUT, OPP	AWG, RWE, SAUR, ONDEO, VEOLIA, OPP	AWG, RWE, SAUR, SET, ONDEO, UUT, VEOLIA, OPP

Table 6: Regional HHI – water

3.3.2 Sanitation

In the sanitation sector, there is no clear case of concentration either at the global level or at the regional level. Although Ondeo and Veolia clearly have the largest market shares they are followed closely by the large German group RWE. There are also other private operators (OPP). These OPP include many local players in a number of the countries we consider, and serve about a third of the population of the world.

	GLOBAL	Africa	Asia & Oceania	Latin America	North America	Eastern Europe	Western Europe
Market indicator	1. Urban population (upper bound concentration) 2. Country population (lower bound concentration)						
HH_{min} (urban)	782	231	457	260	1 738	1 016	989
HH_{max} (urban)	2 246	951	1 063	1 466	3 504	3 072	3 416
HH_{min} (country)	476	51	156	171	1 407	536	534
HH_{max} (country)	1 542	452	565	1 095	2 837	1 914	2 391
Aggregate market share (urban)	31%	19%	21%	25%	45%	35%	40%
Aggregate market share (country)	23%	13%	11%	20%	40%	24%	31%
Number of firms	7	2	1	5	5	5	7
Number of OPP	19	7	0	0	7	13	13
Number of countries	37	6	5	8	2	5	11
Cases	102	9	15	27	12	2	37
Main players	AWG, RWE, SAUR, SET, ONDEO, VEOLIA, UUT and Other Private Providers	ONDEO, VEOLIA, OPP,	AWG, RWE, ONDEO, UUT, VEOLIA, OPP	AWG, RWE, SAUR, ONDEO, VEOLIA, OPP	RWE, ONDEO, SET, VEOLIA, UUT, OPP	AWG, RWE, SAUR, ONDEO, VEOLIA, OPP	AWG, RWE, SAUR, SET, ONDEO, UUT, VEOLIA,

	(OPP)						OPP
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Table 7: Regional HHI – sanitation

North America, is, once again, a borderline case under both types of market definition, suggesting that its sanitation market may be subject to some degree of market power by the few operators who dominate the market. The indicator is however formally inclusive. Eastern and Western Europe are also borderline cases when relying on the urban population indicator to define the market.

The developing regions of the world are much less concentrated than sometimes argued. This is largely due to the fact that coverage rates are fairly low. In many countries of the developing world, sanitation is a much less formal activity than in the developed part of the world.

4 Policy implications

In spite of the limitations stemming from the assumptions we had to make as a result of the poor quality of the information available, this quantitative exercise may still be a relevant input for policy. Table 8 summarizes the information for each country grouping in terms of our proposed interpretation of minimum and maximum HH indicies.

	Electricity		Telecoms		Water & Sanitation	
	Generation	Distribution	Fixed	Mobile	Water	Sanitation
Global	Inconclusive towards No	Inconclusive towards Yes	Inconclusive towards Yes	Inconclusive towards No	Inconclusive towards Yes	Inconclusive towards No
Africa	Inconclusive towards No	Inconclusive towards No	Inconclusive towards No	Inconclusive towards Yes	Yes	Inconclusive towards No
Asia & Oceania	Inconclusive towards No	Inconclusive towards Yes	Inconclusive towards Yes	Inconclusive towards No	Inconclusive towards No	Inconclusive towards No
Latin America	Yes	Inconclusive towards Yes	Yes	Inconclusive towards Yes	Inconclusive towards No	Inconclusive towards No
North America	No	-	Inconclusive towards No	Inconclusive towards No	Yes	Inconclusive towards Yes
Eastern Europe	No	Yes	Yes	Inconclusive towards Yes	Inconclusive	Inconclusive towards Yes

					towards No	
Western Europe	Yes	Yes	Yes	Inconclusive towards Yes	Inconclusive towards No	Inconclusive towards Yes

Table 8: Concentration problems diagnostic

The first obvious conclusion is that there are very few certainties in general, and no clear world wide sectoral pattern. There is no scope for simple encompassing regional or sectoral statements because market concentration is region- and sector-specific. The second is that at the global level, the *presumptions* of concentration problems only arise for the industries which have clear natural monopoly features – electricity and water distribution, as well as fixed line phone services. Third, Western Europe is the region with the largest number of actual or potential concentration problems. Fourth, sector wide potential concentration problems appear more pronounced in developed countries. This is somewhat surprising since these are also the regions in theory most committed to competition. Fifth, the telecoms sector is overall the sector with the largest number of potential or actual concentration problems which is also a surprise in view of the widespread sense that the technological revolution made the sector competitive sooner and faster than any other sector. It may be less surprising given the widespread reliance on access and interconnection regulation to achieve competition. Finally, from the viewpoint of one of the poorest regions of the world, it is unfortunate to see that one of the most concentrated sectors is the water sector in Africa, and this in spite of the potential strong role of alternative operators in the region.¹³

5 Concluding comments

This paper has attempted to quantify the degree of market concentration in several key infrastructure markets, at both the regional and global level. The focus of the paper has been on the assessment of the actual degree of concentration in global infrastructure markets rather than on specific evidence of anticompetitive behavior. In doing so, the paper has provided evidence of the complexity of the market structure of the main infrastructure services. No single sector is problematic across all regions, and no single region is problematic in all sectors.

Although clear concentration issues were identified in only about 20% of the cases studied, a presumption of concentration was found in another 30% of the cases. Many of these perceived cases could be more problematic than suggested by the approximation adopted here since cross-ownership is increasingly common and generally underestimated by analysts.¹⁴ On the other hand, it is important to recognize that the evidence on concentration provided here is not necessarily evidence of misbehavior. It would indeed be important to complement this paper with an explicit assessment of the association of concentration with performance outcomes since the linkage between market concentration and negative performance outcomes is certainly not automatic. Similarly, it would be desirable to track the evolution of concentration over time to monitor the direction of any

¹³ See Kariuki, M. and J. Schwartz (2004) for more on small scale operators in water and energy.

¹⁴ An exception is Campos and Vegas (2003) for the impact in Spain.

changes. The snapshot provided here does not say if markets are becoming more or less concentrated.

If high global market concentration is linked to undesirable outcomes, the main issue that follows is whether there is a cross-border institutional solution which has the leverage and mandate to address issues national regulators are neither capable nor mandated to do. There is a growing literature on the options available to organize a supranational agency and this paper contributes empirical evidence on the policy relevance of this literature.

6 Appendix

This appendix explains the measurement of market concentration used in this paper, that allows for cross-firm ownership at the supranational level rather than for the traditional focus on market concentration at the national level. To do so, independently of whether a firm, F_i , in the sample has control or not, we start with the share of each firm i of the local providers, LP_j of each country. To see this more clearly, consider countries a and b in which there are two local providers denoted by LP_1 and LP_2 . Using as an example, the case of electricity generation, the following table shows the distribution of the installed generation capacity (MWs) per country and local provider.

	Local Provider		Market
	LP1	LP2	Total
Country a	10	20	30
Country b	15	5	20

Suppose that in the sample there are two firms denoted by F_1 and F_2 . They have the following shares in each local provider:

	F_1 's shares (%)		F_2 's shares (%)	
	LP_1	LP_2	LP_1	LP_2
Country a	30%	25%	60%	50%
Country b	40%	20%	20%	60%

In this case, they own (weighted by the share) the following MWs:

	F_1		F_2		Market
	LP_1	LP_2	LP_1	LP_2	Total
Country a	3	5	6	10	24
Country b	6	1	3	3	13

And the concentration index is computed as:

	s_1	s_2	CR_m	HHmin	HHma x
Country a	0.27	0.53	0.80	3 200	6 400
Country b	0.35	0.30	0.65	2 113	4 225
Region				2 656	5 313

Formally, let us denote by x_{ij} the amount of, for instance, MWs, customers or lines hold in country i by some local firm j . Let us consider one firm of the sample, to say, firm l . If firm l has $\alpha_{i,j}^l$ shares in firm j in country i , then we argue that firm l is the owner of $X_i^l = \sum_{j \in R(i,j)} \alpha_{ij}^l x_{i,j}$ units in country i where $R(i,j)$ indicates when firm j is active in country i . The market share of firm l is computed as $s_i^l = X_i^l / \sum_{j \in R(i,j)} x_{i,j}$ and the m seller concentration ratio in country i is $CR_m^i = \sum_{l \in G(i,l)} s_i^l$ where m represent the set of firms l that have activity in country i and $G(i,l)$ indicates when firm l in the sample is active in country i .

Using this value, we compute $HH_{\min}$ and $HH_{\max}$ per country. Regional and global concentration indicies are just the average of the individual country concentration indicies across the relevant countries.

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