E C O N O M I C S B U L L E T I N

Demographic Transition Towards Smaller Household Sizes and Basic Infrastructure Needs in Developing Countries

Amadou Bassirou Diallo
World Bank

Quentin Wodon
World Bank

Abstract

A key component of Poverty Reduction Strategies in developing countries consists in assessing the needs of the population in terms of access to basic services such as education, health care, and basic infrastructure. Using Demographic and Health Surveys from 40 countries, this note shows that the needs for household-level services such as connections to the water and electricity networks is likely to be substantially underestimated if governments do not take into account the impact of the demographic transition towards smaller household sizes apart from the impact of population growth. The basic infrastructure needs stemming from the trend towards smaller household sizes is of an order of magnitude equal to half of the needs from population growth.

The views expressed here are those of the authors and need not reflect those of the World Bank, its Executive Directors or the countries they represent.

Citation: Diallo, Amadou Bassirou and Quentin Wodon, (2007) "Demographic Transition Towards Smaller Household Sizes and Basic Infrastructure Needs in Developing Countries." *Economics Bulletin,* Vol. 15, No. 11 pp. 1-11
Submitted: June 26, 2007. **Accepted:** July 17, 2007.
URL: http://economicsbulletin.vanderbilt.edu/2007/volume15/EB-07O20001A.pdf

1. Introduction

Many developing countries are preparing Poverty Reduction Strategies. The objectives of these strategies are often defined in terms of achieving targets such as those included in the Millennium Development Goals (MDGs) framework. Most of the targets included in the MDGs are in the areas of the reduction of poverty and hunger, education and gender outcomes, health outcomes, and access to basic infrastructure. A key component of Poverty Reduction Strategies consists in assessing the cost of providing basic services to the population in these areas.

Estimating the cost of development targets is needed not only for budgeting and planning purposes, but also in order to inform trade-offs between different targets given the limited resources available to governments (Christiaensen et al., 2002). However, the costs of achieving certain targets often tend to be underestimated. This is for example the case when costs are computed for improving outcomes for primary education, but without taking into account the spillover effects that an improvement in access to primary education may have on enrollment (and thereby costs) at the secondary and higher levels. Underestimation of costs is also a risk when the impact of demography on the needs of a population in not properly taken into account.

In the area of basic infrastructure, clearly the cost of improving access in developing countries is high because providing the services is expensive, and because access rates (as well as existing capacity, for example for electricity generation) remain low, so that there is a long way to go (see for example Komives et al., 2003, 2005). Following work by Fay (2000) and Fay and Yepes (2003), estimates of future expenditure requirements in infrastructure can be obtained using expenditure demand functions at the macroeconomic level. In these simulations, future spending needs must cover not only new investments but also appropriate operation and maintenance costs. On the basis of key factors driving past trends in infrastructure, and especially on the basis of the requirements in infrastructure for future growth, it has for example been suggested that sub-Saharan Africa alone may well need US$40 billion a year for 10 years to reach the MDGs (Estache and Wodon, forthcoming).

Apart from relying on macroeconomic estimates of infrastructure needs, it is also useful to conduct an analysis of the specific subset of infrastructure needs that relates to the objective of providing access to water or electricity for residential customers. Within the infrastructure needs of residential customers, one key dimension is the requirement to provide new connections to the networks, whether for electricity or piped water. The number of new connections to the electricity and water networks that are required in the population in order to achieve certain coverage targets can be multiplied by estimates of the unit costs of providing those connections in order to assess the total cost of increasing coverage (noting that any increase in access to the service in the population requires also an increase in generation or production capacity).

In this note, we focus on one narrow, but still important aspect of the estimation of the residential infrastructure needs of the population in developing countries. The idea is to rely on household surveys to measure the number of connections to the electricity and water networks that are required in the population in order to achieve coverage targets. It is obvious that new connections to the networks are necessary to simply maintain access rates in a context of population growth. But there is another factor that adds to the cost of expanding access: this is

the fact that household sizes are decreasing in many countries so that the number of connections to the networks has to increase faster than population growth just to maintain access rates at their current levels. Based on data from 40 Demographic and Health Surveys, we estimate that basic infrastructure needs stemming from the trend towards smaller household size since the mid 1990s are of an order of magnitude equal to half of the needs stemming from population growth. The methodology used to obtain this result is extremely simple. Estimates of the change in household size obtained from the surveys are combined with data on population growth for the countries in the sample to provide estimates of increase in number of households. The annual rate of increase in the number of households is our estimate of the rates of increase in new connections to the electricity and water networks that are required each year in order to simply to keep average access rates to basic infrastructure services constant at their current level.

The note is structured as follows. In section two, we provide estimates of the change in mean household sizes over time for the countries in our sample (i.e., the countries for which Demographic and Health Surveys are publicly available on the web with surveys for at least two points in time), as well as the data on population growth that enables us to estimate the required increase in connections needed to keep access rates constant. A brief conclusion follows.

2. Data and empirical estimates

The demographic transition to smaller household sizes in developing countries is due to a many factors, including lower rates of fertility for women, higher rates of urbanization and related changes in behavior, the adoption of nuclear as opposed to extended family structures, and the impact of HIV-AIDS. While it has been argued that Africa is lagging in many aspects of its demographic transition (Conley et al., 2007), household sizes have been declining in many countries. In general, a number of consequences from the demographic transition have been identified, some positive, others negative (Lee, 2003). Yet, the increase in the needs of households implied by the demographic transition to smaller household sizes does not appear to have been discussed much.

As noted by Diallo and Wodon (2007), one aspect of the issue relates to the fact that if there are economies of scale in consumption, a reduction in household sizes implies that the average need of a typical individual in the population will increase when household size is reduced. This in turn means that a positive level of real GDP growth is required to simply keep social welfare unchanged after a reduction in household size. The required rate of growth to offset the demographic transition in household size is non-trivial. Under reasonable values for economies of scale within the household, Diallo and Wodon (2007) suggest that half a point in real GDP growth is needed to offset the impact of the shift to smaller household sizes in a sample of 40 countries for which data on trends in household sizes are available over time from repeated Demographic and Health Surveys.

In this note, we build on the work of Diallo and Wodon (2007) in order to look at another important cost of the demographic transition to smaller household sizes, namely the impact of this transition on household needs in terms of connections to the electricity and water networks.

The idea is very simple. If households sizes decline, an increase in the number of connections to basic infrastructure networks is required simply to keep average access rates constant.

Table 1 provides the average household sizes observed in a sample of 40 developing countries between the mid 1990s and the early 2000s. The estimates are based on the unit level data from the corresponding Demographic and Health Surveys. While there has been an increase in household size for a few countries over time (this could happen for example if a country experiences hard times, so that households have to combine forces to cope with a degradation in their living conditions; other reasons may also lead to larger household sizes over time, even if fertility is decreasing), these are rather exceptions. In most cases, household sizes have decreased between surveys, as expected. Consider for example the first two countries in the sample. In Burkina Faso, the average household size has decreased from 6.65 in 1993 to 6.47 in 2003. The decrease in Benin is larger, from 5.99 in 1996 to 5.18 in 2001. The per capita GDP is provided for information. Figure 1 shows that there is a relationship between the level of GDP per capita of the country (on the horizontal axis) and the reduction in household size per year (on the vertical axis). On average, developing countries may expect a reduction in their household size of 0.05 persons per year, but as shown by the logarithmic curve that approximates the relationship between the two variables, the decrease is typically slightly larger in the countries that are richer and therefore presumably further along in their demographic transition.

Table 1 also provides estimates of the cumulative population growth rate in each country between the two surveys, using data from the World Bank's World Development Indicators. For example over the ten years separating the two surveys in Burkina Faso the country's population increased by 34 percent, which translates into an annual growth population rate of 2.93 percent. For Benin, over five years, the increase in the population was at 16 percent, which translates into an annual growth rate of 3.02 percent. Taking into account the average household size computed from the Demographic and Health Surveys, the next column in the table provides an approximate value for the cumulative increase in the number of households in each country (defined as the ratio of the population in the first survey year divided by the household size in that year, to the population in the second survey year divided by the average household size in that second year). In most countries, since household sizes have been reduced, the cumulative growth rate in the number of households is larger than the cumulative population growth rate.

The last two columns in table 1 provide the annual rate of growth in the number of households in each country, and the annual growth rate in the number of households minus the annual population growth rate for each country between the two surveys – this is thus the impact of the transition towards smaller household sizes. In Burkina Faso for example, the estimates suggest that the reduction in household sizes has added 0.29 percent to the population growth rate of 2.93 percent, so that the increase in basic infrastructure needs in terms of the number of connections to the network required for keeping access rates constant is 3.22 percent. Of that total, about one tenth is due to the demographic transition to smaller household sizes. In Benin, due to a sharper reduction in household size over a shorter period, half of the annual increase in the number of households between the two surveys is due to the reduction in household size.

For the sample as a whole, the average rate of population growth is 2.09 percent, and the average increase in the number of households is 2.99 percent, so that the impact of the transition toward smaller household sizes (0.90 percent) represents about one third of the total needs in terms of new connections to the network required to keep access rates constant. In the case of African countries, which account for about half of the sample, the average rate of population growth is 2.47 percent, and the average increase in the number of households is 3.18 percent. Thus the impact of the transition toward smaller household sizes is smaller (0.71 percent), but still far from being negligible.

In Figures 2 to 4, the needs from population growth and from changes in household sizes are represented for easier visual interpretation. Figure 2 shows that as per capita GDP increases (in US$), the population growth rate of the country tends to decrease, thereby reducing the need for investments in new connections for households. In Figure 3 by contrast, it is clear that the needs from changes in household sizes are larger at higher levels of economic development, probably due among others to faster urbanization rates, faster declines in fertility, as well as higher economic resources which enable households to move towards nuclear family settings because they do not need to rely as much on the economies of scale provided by larger household sizes in order to survive. As mentioned earlier the growth in the number of households is on average at about 3 percent, one third of which comes from the impact of the transition to smaller household sizes. But it is striking from Figure 4 that in general, countries with higher GDP per capita may not expect a smaller increase in needs than poorer countries, because the gains from lower population growth in terms of residential infrastructure connection for comparatively richer countries needs are offset by the faster changes in household sizes.

Before concluding, it is worth noting that the data presented in this paper is based on an approximation of the increase in the number of households over time, since we rely on trends in average household size. In future work, it would be useful to rely on the detailed changes in the exact distribution of household sizes over time. Using simulations techniques taking into account data on consumption of water and electricity as well as household characteristics, his could help to understand more finely how the demographic transition may affect future patterns of consumption of different types of households (identified among others by their size).

3. Conclusion

In this note, we have shown in a very simple way that the cost of achieving targets for access to basic infrastructure services such as electricity and piped water may be substantially underestimated if the impact of the demographic transition toward smaller household sizes through which many countries are going is not properly taken into account. The basic infrastructure needs stemming from the trend towards smaller household size is of an order of magnitude equal to a half of the needs from population growth itself. Furthermore, while the rate of population growth is smaller in higher income countries, the transition to smaller household sizes is faster in those countries, so that the total needs in terms of the number of connections to the electricity and water networks that are required for example to keep access rates constant tend to be similar for both low income and lower middle income countries. While our estimates of basic infrastructure needs have been based on changes in average household

sizes, changes in the overall distribution of household sizes over time could be used instead in future work to test whether this would affect the results presented here in any significant way.

References

Christiaensen, L., C. Scott, and Q. Wodon, 2002, Development Targets and Costs, in J. Klugman, editor, A Sourcebook for Poverty Reduction Strategies, Volume 1: Core Techniques and Cross-Cutting Issues, World Bank, Washington, DC.

Conley, D., G. C. McCord, and J. D. Sachs, 2007, Africa's Lagging Demographic Transition: Evidence from Exogenous Impacts of Malaria Ecology and Agricultural Technology, NBER Working Paper No. 12892, National Bureau of Economic Research.

Diallo. A. B., and Q. Wodon, 2007, Growth and Welfare Under Demographic Transitions and Economies of Scale, mimeo, World Bank, Washington, DC.

Estache A., and Q. Wodon, forthcoming, Infrastructure Reform and Poverty in Africa, World Bank, Washington, DC.

Fay, M. (2000), Financing the Future: Infrastructure Needs in Latin America, 2000-05, Policy Research Working Paper No. 2545, World Bank, Washington DC.

Fay, M. and T. Yepes (2003), Investing in Infrastructure: What is needed from 2000-2010, Policy Research Working Paper No. 3102, World Bank, Washington DC.

Komives, K., D. Whittington, and X. Wu, 2003, Infrastructure Coverage and the Poor: A Global Perspective, in P. Brook and T. C. Irwin, Infrastructure for poor people: Public policy for private provision, World Bank, Washington, D.C.

Komives, K., V. Foster, J. Halpern, and Q. Wodon, with support from R. Abdullah, 2005, Water, Electricity, and the Poor: Who Benefits from Utility Subsidies?, World Bank, Washington, DC.

Lee, R. (2003), The Demographic Transition: Three Centuries of Fundamental Change, Journal of Economic Perspectives, 17:167-90.

Table 1: Population growth and average household size by country, DHS data

Country	DHS survey year	Population	Average household size	GDP per capita (constant 2000 US$)	Cumulative population growth index (base = 1.00)	Annual population growth (%)	Cumulative growth in number of households (base = 1.00)	Annual growth in number of households (%)	Annual household minus pop. growth (%)
Burkina Faso	1993	9299056	6.65	214.59					
	2003	12417649	6.47	246.60	1.34	2.93%	1.37	3.22%	0.29%
Benin	1996	6398470	5.99	286.70					
	2001	7425465	5.18	318.85	1.16	3.02%	1.34	6.05%	3.03%
Cote d'Ivoire	1994	14338732	6.21	579.42					
	1999	16382824	6.17	658.40	1.14	2.70%	1.15	2.86%	0.16%
Cameroon	1991	11982233	5.59	705.86					
	2004	16037746	4.76	736.71	1.34	2.27%	1.57	3.54%	1.27%
Ethiopia	2000	64298000	4.82	122.01					
	2005	71256000	5.03	140.59	1.11	2.08%	1.06	1.23%	-0.85%
Ghana	1993	16826814	3.76	222.62					
	2003	21211860	4.03	268.81	1.26	2.34%	1.18	1.65%	-0.69%
Guinea	1999	8260931	6.62	369.73					
	2005	9402098	6.09	384.02	1.14	2.18%	1.24	3.61%	1.43%
Kenya	1993	25737392	4.79	414.22					
	2003	32733766	4.35	418.00	1.27	2.43%	1.40	3.43%	0.99%
Madagascar	1992	12763361	5.17	242.56					
	2004	18112724	4.62	229.06	1.42	2.96%	1.59	3.93%	0.97%
Mali	1996	10423839	5.60	186.38					
	2001	11993751	5.32	226.42	1.15	2.85%	1.21	3.88%	1.03%
Malawi	1992	9819300	4.46	127.55					
	2004	12608271	4.38	153.58	1.28	2.11%	1.31	2.27%	0.16%
Mozambique	1997	16747151	4.62	182.68					
	2003	19052198	4.85	261.72	1.14	2.17%	1.08	1.34%	-0.83%
Nigeria	1990	90557312	6.28	357.51					
	2003	125912256	4.97	387.30	1.39	2.57%	1.75	4.42%	1.85%
Niger	1992	9017953	6.27	160.13					
	1998	10997018	5.93	166.82	1.22	3.36%	1.29	4.32%	0.96%
Namibia	1992	1503056	6.00	1745.43					
	2000	1894436	5.05	1801.88	1.26	2.94%	1.50	5.16%	2.23%

Source: Authors' estimation using DHS data. Population data are from the World Bank's database.

Table 1 (continued): Population growth and average household size by country, DHS data

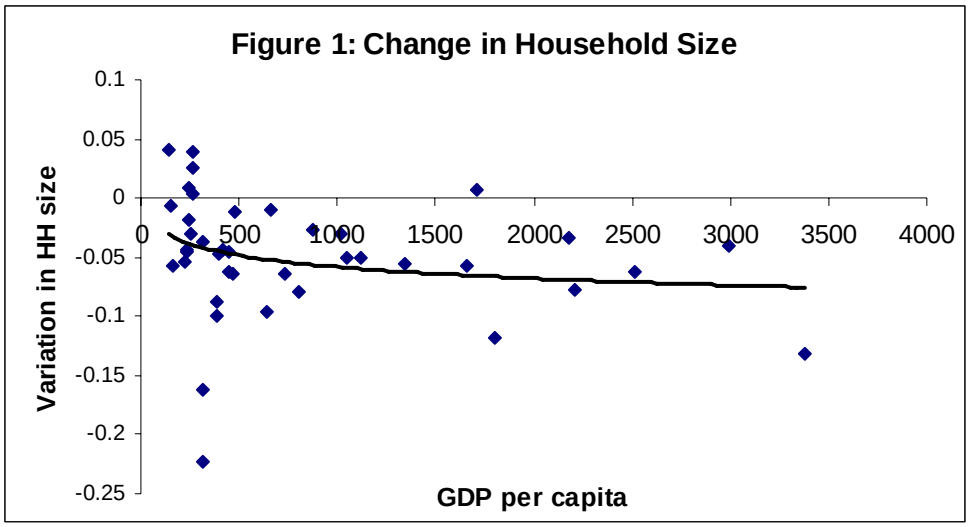
Country	DHS survey year	Population	Average household size	GDP per capita (constant 2000 US$)	Cumulative population growth index (base = 1.00)	Annual population growth (%)	Cumulative growth in number of households (base = 1.00)	Annual growth in number of households (%)	Annual household minus pop. growth (%)
Rwanda	1992	6391335	4.97	287.70					
	2005	9037690	4.57	257.79	1.41	2.70%	1.54	3.37%	0.66%
Senegal	1993	8656856	8.83	377.32					
	2005	11658172	8.69	478.41	1.35	2.51%	1.37	2.66%	0.14%
Chad	1997	7469206	5.33	175.06					
	2004	9447944	5.35	260.67	1.26	3.41%	1.26	3.35%	-0.06%
Tanzania	1992	28106800	5.31	248.44					
	2004	37626916	4.87	314.20	1.34	2.46%	1.46	3.21%	0.75%
Uganda	1995	20892272	4.75	206.65					
	2001	25110890	4.80	247.68	1.20	3.11%	1.19	2.94%	-0.17%
Zambia	1992	8856117	5.61	335.82					
	2002	11101816	5.24	316.02	1.25	2.29%	1.34	2.98%	0.70%
Zimbabwe	1994	11608500	4.67	614.80					
	1999	12475708	4.19	643.96	1.07	1.45%	1.20	3.70%	2.25%
Egypt	1992	57915908	5.63	1197.97					
	2005	74032880	4.88	1661.95	1.28	1.91%	1.47	3.03%	1.13%
Morocco	1992	24929848	6.02	1099.42					
	2004	29823706	5.35	1348.59	1.20	1.50%	1.35	2.50%	1.00%
Indonesia	1991	181320352	4.63	655.72					
	2003	214674160	4.32	872.36	1.18	1.42%	1.27	2.02%	0.60%
Philippines	1993	65450296	5.33	869.26					
	2003	80166344	4.81	1044.65	1.22	2.05%	1.35	3.08%	1.03%
Vietnam	1997	75460000	4.72	349.10					
	2002	80423992	4.40	443.66	1.07	1.28%	1.14	2.68%	1.40%
Bolivia	1994	7315414	4.50	926.04					
	2003	8835246	4.22	1019.69	1.21	2.12%	1.29	2.84%	0.72%
Brazil	1991	151857600	4.75	3079.66					
	1996	163819248	4.08	3376.81	1.08	1.53%	1.25	4.63%	3.10%
Colombia	1990	34969640	4.62	1869.41					
	2005	45600244	4.11	2173.88	1.30	1.79%	1.47	2.58%	0.80%

Source: Authors' estimation using DHS data. Population data are from the World Bank's database.

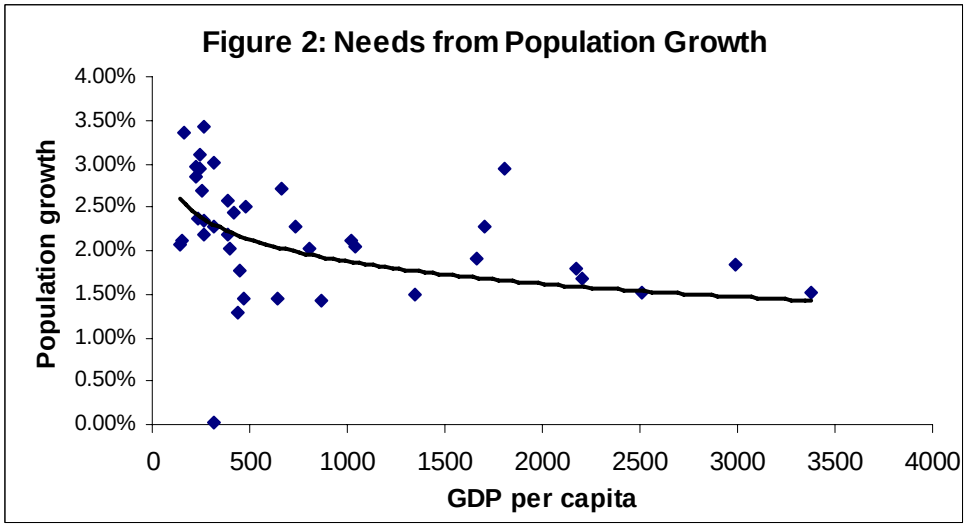
Table 1 (continued): Population growth and average household size by country, DHS data

Country	DHS survey year	Population	Average household size	GDP per capita (constant 2000 US$)	Cumulative population growth index (base = 1.00)	Annual population growth (%)	Cumulative growth in number of households (base = 1.00)	Annual growth in number of households (%)	Annual household minus pop. growth (%)
Dominican Republic	1991	7209699	4.60	1548.30					
	2002	8513900	3.92	2511.81	1.18	1.52%	1.39	3.01%	1.48%
Guatemala	1995	9970367	5.25	1593.93					
	1999	10910275	5.27	1706.52	1.09	2.28%	1.09	2.15%	-0.13%
Haiti	1995	7391265	5.01	446.19					
	2000	7938791	4.69	468.06	1.07	1.44%	1.15	2.78%	1.34%
Nicaragua	1998	4765647	5.52	741.28					
	2001	5059290	5.29	801.08	1.06	2.01%	1.11	3.51%	1.49%
Peru	1992	22597344	5.25	1620.81					
	2004	27562392	4.33	2206.33	1.22	1.67%	1.48	3.32%	1.65%
Kazakhstan	1995	15815626	3.81	1022.93					
	1999	14928426	3.60	1115.95	0.94	-1.43%	1.00	-0.07%	1.37%
Turkey	1993	59491000	4.51	2723.61					
	1998	65157000	4.31	2989.40	1.10	1.84%	1.15	2.77%	0.94%
Bangladesh	1994	113945872	5.44	294.86					
	2004	139214528	4.96	401.35	1.22	2.02%	1.34	2.96%	0.93%
Nepal	1996	22226052	5.51	205.55					
	2001	24975144	5.29	232.14	1.12	2.36%	1.17	3.21%	0.85%
India	1993	899329024	5.66	334.73					
	1999	999016000	5.38	444.08	1.11	1.77%	1.17	2.61%	0.84%

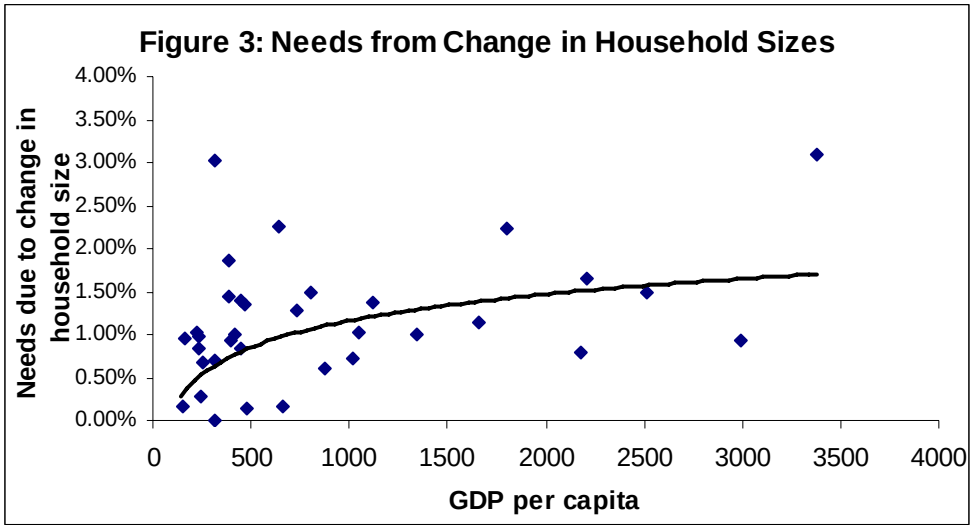
Source: Authors' estimation using DHS data. Population data are from the World Bank's database.



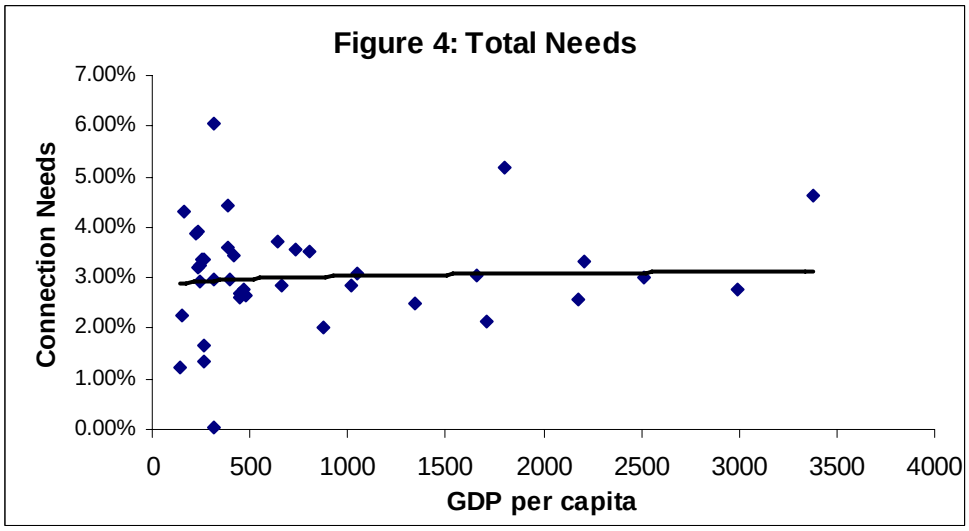
Source: Authors' estimates using DHS data.



Source: Authors' estimates using DHS data.



Source: Authors' estimates using DHS data.



Source: Authors' estimates using DHS data.