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Economic Development and Public Goods Dependency

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Introduction

Developing countries have witnessed numerous failures of investment projects: roads become run down in a few years due to lack of maintenance ability; newly built schools are abandoned because students lack transportation means to go to school; modern textile factories are closed because of irregular power outage (Easterly, 2002). Despite the anecdotal evidence, the importance of complements and matching among different types of public goods in the process of economic development has not been fully recognized. The success of a particular public investment hinges largely upon the provision levels of other public goods. However, investment projects have often been driven by fashions among the international donor community, from emphasis on road development in the sixties and seventies, trade and market development in the eighties, to focus on education and health in the nineties. Few studies have systematically documented the interdependency among different types of public goods and their impact on economic development. This papers aims to develop a methodological framework to evaluate the degree of interdependency and identify the weakest link of public goods provisions.

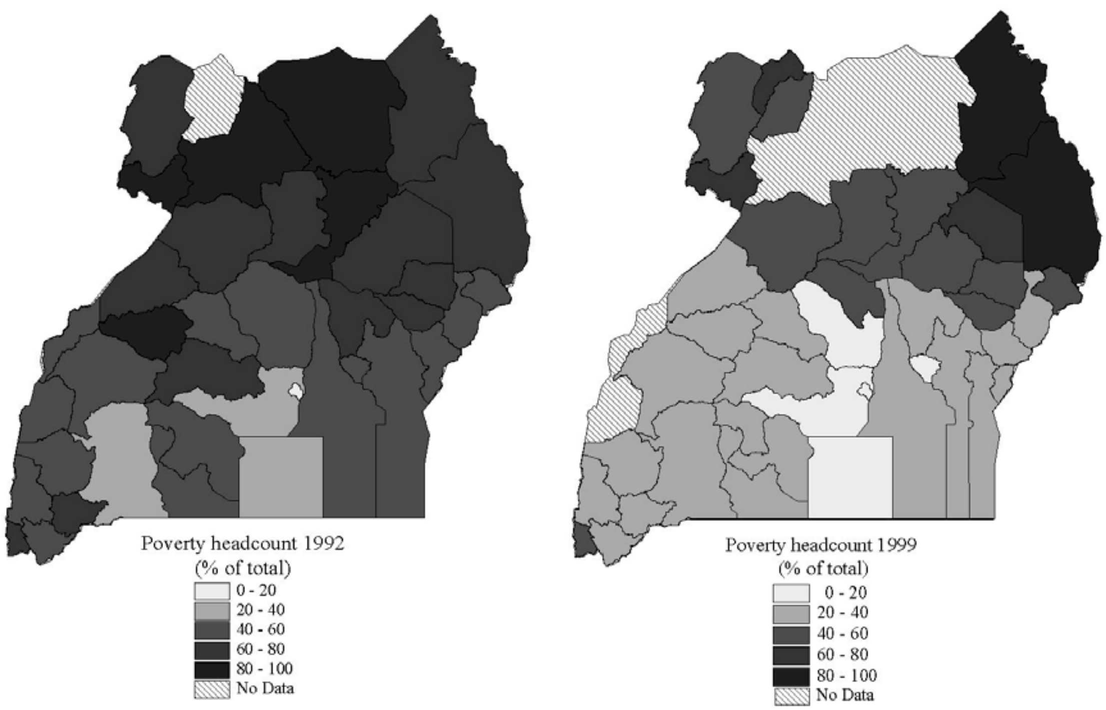
In empirical and theoretical analysis on the role of public goods, different types of public goods are usually treated as independent and the interactions among them are often ignored. In this study, instead of assuming public goods are independent of each other, we assume they are dependent although the way of dependency may adopt different functional forms. Based on a unique survey data set at the household and community level in Uganda for 1999, we empirically test whether public goods are dependent with each other using a factor analysis. We show that public goods are indeed interdependent and the O-ring type of production technology developed by Kremer (1993) provides the best fit in the income generation process. This finding calls for a more comprehensive evaluation of complementarities among different types of public goods when making large investments for a particular project. We argue that it is better to use a composite infrastructure development indicator than choosing any single, specific variable as a proxy.

The paper is arranged as follows. The next section describes the background and data used in analysis. The third section analyzes the interdependence among different types of public infrastructure. The last section concludes.

Data

Between 1991 and 2000, despite the continuing ravages of poverty, disease and in some areas, insecurity, real per capita GDP in Uganda grew from \$240 to \$330 – an average growth rate of some 4 percent per year (WDI 2002). This rapid growth was even more remarkable given that Uganda's population continued to increase at about 3.4 percent a year, adding another 8 million Ugandans between 1991 and 2002 (UBOS, 2003). Survey-based evidence suggests that the poor shared in this broader economic growth, and that the incidence of poverty (headcount) reduced from around 54 to 36 percent (Deininger and Okidi 2003) and is shown disaggregated by district in Figure 1. In their analysis, they use household electricity as a proxy for infrastructure. Because there are more than a dozen infrastructure variables in the survey, it is not clear whether the policy implications on poverty reduction drawn based on this single indicator is robust or not. As debate continues about how Uganda's growth momentum can be maintained, a consensus is to improve the efficiency of public investment allocations, in particular among the international donor communities.

Figure 1: Poverty headcount in 1992 and 1999 as percent of total population



The data used in this analysis are from the Uganda National Household Surveys (UNHS) in 1999/2000. From the household survey, we calculate per capita consumption and aggregate them up to the community level. From the community surveys, we obtain all the available infrastructure indicators, including distances to tar road, the most common consumer markets, employment center, post office, phone call box, bank, primary school, clinic, and hospital as well as the availability of electricity and clean water in the community.

Interdependency of public infrastructure

In empirical analysis on the impact of public infrastructure, one usually picks one variable from many alternatives as a proxy for public infrastructure. Several problems arise from doing this. First, many available information are not utilized. Second, economists may pick up an indicator in supporting their hypotheses, thereby creating a selection bias. Third, the interdependency and complementarities among different types of public infrastructure are not taken into account.

In determining the relationship between per capital consumption and different types of public infrastructure, we use factor analysis to create a composite infrastructure indicator, which is a linear combination of all the original variables. Factor analysis can usefully simplify large quantities of data, so that underlying regularities can be identified, even when an adequate theoretical model has not been developed and interactions among variables are extremely complex. Using the composite indicator enables us to use all of the information available to us and to avoid arbitrarily picking variables

Table 1 presents the correlation matrix among per capital consumption and different types of infrastructure variables. Several features are apparent from the table. First, most types of public infrastructure are significantly related to each other. For some infrastructures, it may be more profitable to coexist, such as post office and phone box, as shown by the high correlation (0.694) between these two. The correlation coefficient between post office and hospital is high at 0.581, suggesting that for certainly types infrastructure, such as hospital and post office, it requires a critical mass of population to sustain. This might be a reason why most of them are located in towns or cities. Second, the newly created composite infrastructure indicator is significantly correlated with all infrastructure variables but extension. Third, employment opportunities may also depend upon the availability of various public infrastructures as shown by the significant correlation coefficients between distance to the nearest factory with more than 10 employees and most of other variables.

Factor analysis is a good tool to identify the degree of interdependency among different infrastructures. When variables are less dependent, there would be more than one dominant factor. Our factor analysis includes 12 variables and the first common factor accounts for 89% of total variation, suggesting the first factor represents the 12 variables rather well. The first common factor can be expressed as a linear combination of the 12 variables as shown in Table 2. The result shows that the infrastructures variables are rather interdependent.

Figure 2 graphs the patterns between the composite infrastructure indicator and per capita consumption. Clearly, there exists a positive relationship between these two. The relationship is less obvious between per capita consumption and any other infrastructure variables. Figure 3 shows the relationship between distance to tar road and per capital consumption. The correlation in Figure 3 appears to be weaker than that in Figure 2.

Conclusions

Using a data set at the household and community level from Uganda, this paper examines the interdependency among different types of public infrastructure. Several findings are salient. First, there does exist strong assortive matching among different types of infrastructure. From the 12 infrastructure variables considered, there appears to be a dominant common factor, which explains nearly 90% of total variation. Second, the composite indicator generated from the factor analysis has a stronger correlation with the overall economic development indicator, per capital consumption, than all variables except for the variable of electricity availability. This suggests that one should use the composite indicator rather any particular indicator. The composite indicator enables us to use as much information as available and avoid biases from arbitrary selections. In addition, having shown the existence of multicollinearity among the infrastructure variables, it is highly likely that the results would be less robust if including more than one original infrastructure variables in any regression analyses.

The finding also sheds light on foreign aid. Most donor agencies do not talk to each other when providing investment projects. Thereby, there often lack complementarities among different projects, limiting their potential impact.

Acknowledgements

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Table 1 The correlation matrix

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Per capita consumption	1												
2. Composite indicator	**0.354**	1											
3. Tar road	**-0.156**	**-0.555**	1										
4. Consumer markets	**-0.116**	**-0.393**	**0.121**	1									
5. Factory	**-0.278**	**-0.681**	**0.489**	**0.153**	1								
6. Post office	**-0.276**	**-0.777**	**0.309**	**0.348**	**0.424**	1							
7. Phone call box	**-0.292**	**-0.873**	**0.438**	**0.220**	**0.543**	**0.694**	1						
8. Bank	-0.278	**-0.878**	**0.474**	**0.314**	**0.552**	**.0565**	**0.757**	1					
9. School	**-0.147**	**-0.309**	**0.105**	**0.091**	**0.194**	**0.170**	**0.162**	0.176	1				
10. Clinic	**-0.105**	**-0.306**	**0.102**	**0.131**	**0.125**	**0.222**	**0.203**	**0.253**	**0.216**	1			
11. Hospital	**-0.244**	**-0.631**	**0.288**	**0.365**	**0.371**	**0.581**	**0.489**	**0.449**	**0.224**	**0.099**	1		
12. Extension coverage	-0.094	-0.073	0.011	0.057	0.062	**0.076**	**0.089**	0.025	0.005	**-0.013**	-0.026	1	
13. Clean water	**0.156**	**0.310**	-0.060	**-0.182**	**-0.158**	**-0.213**	**-0.213**	**-0.236**	**-0.169**	-0.141	**-0.150**	-0.048	1
14. Electricity availability	**0.477**	**0.561**	**-0.240**	**-0.252**	**-0.381**	**-0.359**	**-0.416**	**-0.474**	**-0.219**	**-0.252**	**-0.276**	**-0.225**	**0.2985**

Note: The bold numbers are significant at the five percent.

Table 2 Scoring coefficients

Variables	Scoring coefficient
Tar road	-0.081
Consumer markets	-0.067
Factory	-0.134
Post office	-0.172
Phone call box	-0.257
Bank	-0.266
School	-0.055
Clinic	-0.041
Hospital	-0.111
Extension coverage	-0.006
Clean water	0.043
Electricity availability	0.120

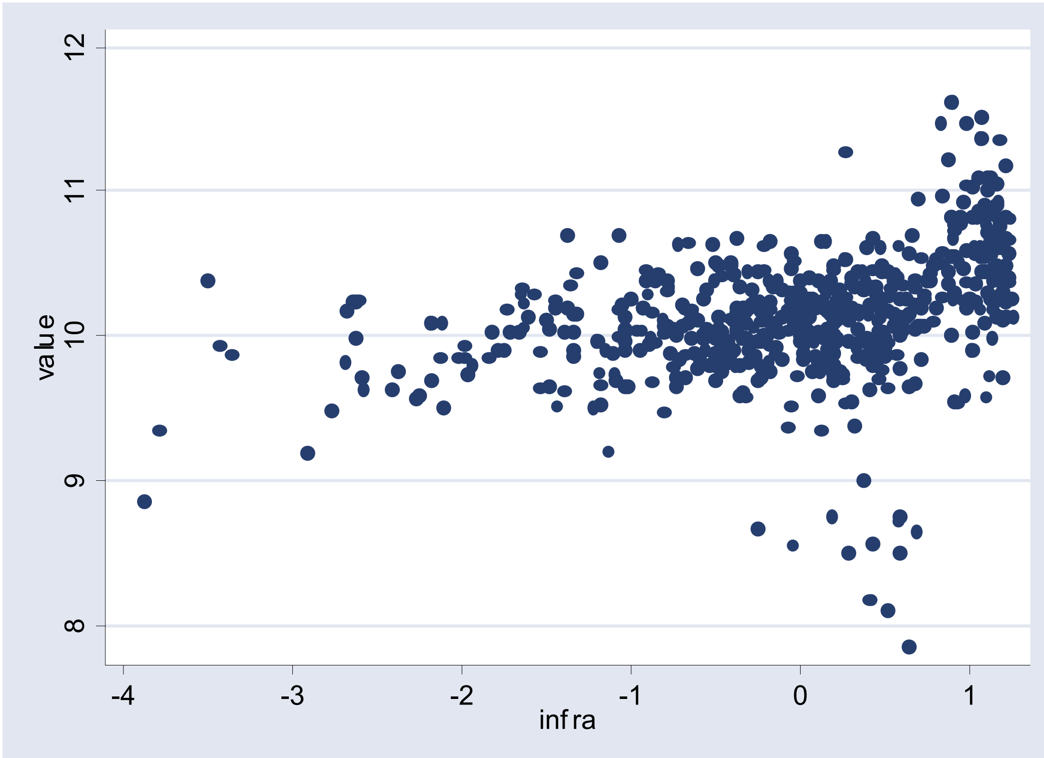

Figure 2 Infrastructure and per capita consumption

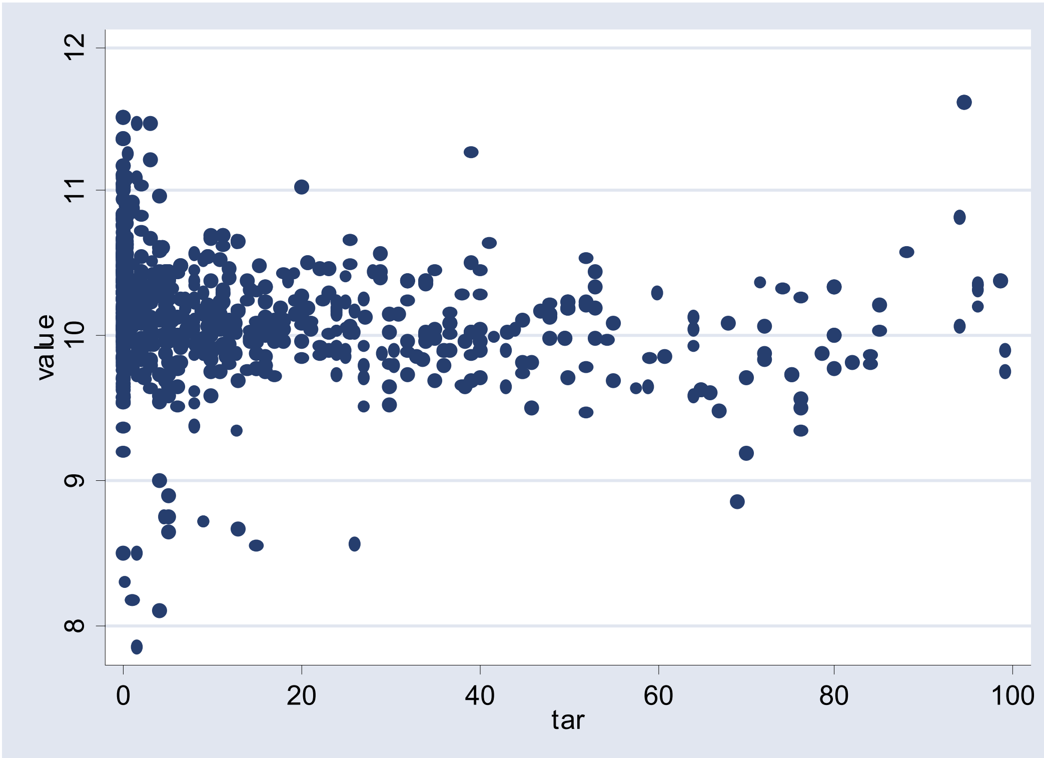

Figure 3 Distance to tar road and per capita consumption