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Efficiency-Adjusted Public Capital and Growth☆

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Summary. — This paper constructs an efficiency-adjusted public capital stock series and re-examines the public capital and growth relationship. The paper also examines the effects of four specific stages of the public investment process—appraisal, selection, implementation and evaluation—on capital accumulation and growth. The results show that public capital is a significant contributor to economic growth. The quality of public investment, as measured by variables capturing the adequacy of project selection and implementation, is statistically significant in explaining variations in economic growth, a result mainly driven by low-income countries.

Key words — public capital stock, public investment efficiency, appraisal, selection, implementation and evaluation of public investment, growth accounting

> "...less-accountable poor-country governments are likely to be disproportionately less efficient (relative to the private sector) than rich country ones. Hence, there are good reasons to expect the government to play an especially detrimental role in the productivity of investment in poor countries. This implies that the 'effective' variance of K is larger than in the baseline model."
>
> Caselli (2005, Chap. 4)

1. INTRODUCTION

One of the main questions in economics is why some countries are rich while many others remain poor. Recent advances in growth and development accounting suggest that the contribution of factors of production, such as capital (physical and human), is about the same as the contribution of the productivity from using these same factors. While much attention in the existing literature is focused on productivity and human capital, much less work has been done on distinguishing the contributions of private and public physical capital. A typical approach for constructing capital stocks is using an aggregate measure of private and public investment series from Penn World Tables. As Pritchett (2000) claims, and later on Caselli (2005, Chap. 4) reiterates, however, public investment in many developing economies is much more inefficient than private investment.

More specifically, many developing countries have a long legacy of failed public projects. Besides negating potential benefits that could have flowed from these projects, the poor record in undertaking public investments has bred skepticism about the ability of these countries to scale up public investment. At the same time, developing countries are under pressure to invest more on infrastructure in order to accelerate and/or sustain growth. The effectiveness of public investment also depends on institutional factors, such as the quality of project selection, management, and evaluation, and the regulatory and operational frameworks. It is generally believed that such institutions are relatively weak in developing countries. Observing a poor track record and weak institutions, it is not uncommon for skeptics to ask if public capital is at all productive in developing countries.

With these issues in mind, this paper takes a close look at the productivity of public capital. In doing so, it makes three contributions: First, it constructs a new dataset of total capital stock for a large number of developing countries and disaggregates it into private and public capital. A particularly novel feature of the dataset is that the public capital stock is adjusted for the efficiency of public investment. This paper is the first to construct such a measure of public capital stock, which has been suggested by Pritchett (2000), Caselli (2005, Chap. 4), and Agénor (2009). Public investment efficiency is measured by Public Investment Management Index (PIMI) as constructed by Dabla-Norris, Brumby, Kyobe, Mills, and Papageorgiou (2011). Second, following the literature on the public capital–growth nexus (see e.g., Romp & De Haan, 2007; Arslanalp, Bonhorst, Gupta, & Sze, 2010; Bom & Ligthart, 2010) the paper investigates the effect of adjusted public capital on growth. Third, taking advantage of the subcomponents of PIMI, the paper examines the effects of four specific stages of the public investment process—appraisal, selection, implementation, and evaluation—on capital accumulation and growth.

The paper yields two main findings: First, there is a statistically significant but relatively small contribution of this efficiency-adjusted public capital to total income. The public capital share is larger in middle-income than in low-income countries. Also, while the share of public capital is small in low-income countries, the marginal product of public capital is relatively large because of the lower efficiency-adjusted capital stock. Second, when specific stages of the public investment process are incorporated in the analysis, project selection and implementation turn out to be important contributors to public capital and growth.

The remainder of the paper proceeds as follows. Section 2 provides a brief review of the literature on public investment

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and growth, paying particular attention to the relationship between public investment efficiency and growth. Section 3 describes in detail the construction of the private and efficiency-adjusted public capital series. Section 4 discusses estimation issues and presents the baseline results as well as various robustness tests. Section 5 summarizes the main findings and draws conclusions.

2. LITERATURE REVIEW

Substantial research has been devoted to measuring the productivity of public capital. Sturm, Kuper, and De Haan (1998) and Romp and De Haan (2007) are two excellent surveys of the literature. Many studies are based on the production function approach with the public capital stock added as an additional input factor. Some relied on a cost or profit function in which the public capital stock is included, while others used the VAR approach, which imposed as few restrictions as possible to address the problems raised by production function and behavioral approaches.

The early strand of papers typically found that public capital is productive, notwithstanding the wide range of theoretical and empirical frameworks employed. Aschauer (1989, 1998) was the first to hypothesize that there is an important role for public capital in explaining the fall in productivity observed in the US in the 1970s and 1980s. The literature that followed Aschauer also found a large impact of public capital on growth. Munnell's (1990a) estimates of the impact of public capital on growth (0.31–0.39) are consistent with those of Aschauer's. [1] In a similar setting, Lynde and Richmond (1993) found that the services of public capital are an important part of the production process, and that about 40% of the productivity decline is explained by a fall in the public capital–labor ratio. Several other papers reached similar conclusions. [2]

The elasticities reported in this first wave of papers were substantial and suggested large effects of public capital on growth. However, over time these estimates were questioned on the grounds that they were fraught with methodological and econometric problems Gramlich (1994). Issues ranking high on the list of potential problems included reverse causation from productivity to public capital and spurious correlation due to non-stationarity of the data. This controversy sparked a new generation of research. Compared to the results surveyed by Sturm *et al.* (1998), these studies estimated substantially lower effects of public capital on growth (Romp & De Haan, 2007). Moreover, these studies unveiled large heterogeneity among countries, regions, and sectors. This is not surprising, as the effects of new investment spending depend on the quantity and quality of the capital stock in place. In general, the larger the stock and the better its quality, the lower will be the impact of additions to this stock. The network character of public capital, notably infrastructure, also results in non-linearities, and explains some of the heterogeneity. The effect of new capital will crucially depend on the extent to which investment spending aims at alleviating bottlenecks in the existing network. [3]

Bom and Ligthart (2010) assessed the output elasticity of public capital by means of a meta-regression analysis using results of previous studies. They find that the average output elasticity of public capital is positive and significant despite a wide variation in primary estimates. They estimate the output elasticity to be 0.15 but suggest substantial heterogeneity across countries. They also find that studies that impose constant returns to scale restrictions across private labor and capital (Mas, Maudos, Pérez, & Uriel, 1993; Otto & Voss, 1994; Kavanagh, 1997), control for the business cycle (Aschauer, 1989; Hulten & Schwab, 1991; Sturm & De Haan, 1995), and incorporate some measure of education (Garcia-Mila & McGuire, 1992) find larger output elasticities of public capital, whereas studies that include energy prices (Tatom, 1991) tend to find lower estimates. [4] Their results also suggest that the high output elasticities found in the early time-series literature are compatible with long-run (cointegrating) estimates found more recently. The conditional output elasticity of public capital in their benchmark specification which captures typical study characteristics is estimated to be 0.17, which is not that far from its unconditional (without controlling for study design parameters) value of 0.15. These values imply a marginal productivity of public capital for the United States in the range of 28.8–32.6% in 2001.

There are, however, important limitations in the extensive literature on the subject. First, most studies focused on advanced countries, in part because of data problems. Given these data limitations and the difficulty in constructing public capital stock series for developing countries, the empirical literature on these countries looked directly at the impact of public investment on economic growth (Devarajan, Swaroop, & Zou, 1996). Second, almost all studies were based on public capital series constructed by cumulating depreciated public investment effort.

Arslanalp *et al.* (2010) revisited this debate by estimating a production function for 48 developed and developing countries, using public capital stock as the explanatory variable. The effect of public capital on growth is estimated to be stronger for developed countries in the short-term (0.13), while it is stronger for developing countries in the long-term (0.26). In some countries, they find that the positive impact of public capital on output is partially or wholly offset if the initial ratio of the capital stock to GDP is high. A number of policy implications were drawn for developing countries from their results. First, while debate on fiscal space has centered on creating room in the budget for higher public investment, the results show that certain types of constraints (financing or the ability to absorb) can limit the growth benefits of higher capital stock. Second, unlike advanced countries, the benefits of new investment tend to accrue over time. This would necessitate extending the timeframe of debt sustainability frameworks so that developing countries can take into account the long-term effects of public investments.

Last but not least, Pritchett (2000) has criticized the conclusions drawn from the empirical studies that relate public investment or capital to growth. He argues that cross-country empirical research using investment rates or Cumulated Depreciated Investment Effort (CUDIE) cannot be used to derive the impact of public capital or investment on growth. This is because such studies ignore the efficiency with which public investment is turned into productive physical capital. And it is this gap in the literature that this paper aims to fill.

3. A FIRST LOOK AT THE DATA

The empirical literature has focused on searching for a relationship between economic activity and the cumulated public investment effort, using the perpetual inventory method for estimating public capital stock. The methodology for building the capital stock series is similar to that used by Collier, Hoeffler, and Pattillo (2001), Kamps (2006) and Arslanalp *et al.* (2010) (see Appendix A for the country list and Appendix B for a detailed description of the methodology). It is based on the perpetual inventory equation: