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The Global Infrastructure Gap: Potential, Perils, and a Framework for Distinction

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Abstract

One billion people live more than 2 kilometers from an all-weather road, and 1.2 billion have no access to electricity. In 2015, the World Bank claimed that rich-country private capital could: (i) close the infrastructure services gap in poor countries, (ii) achieve the sustainable development goals, and (iii) make money by moving from "billions to trillions" of investment in poor-country infrastructure. We introduce a simple framework that distinguishes those poor countries in which the Bank's three-fold claim is tenable from those where it is not. For a given poor country, the framework reveals that investing a dollar in infrastructure is efficient if the social rate of return on infrastructure in the poor country clears two hurdles: (a) the social rate of return on private capital in the poor country, and (b) the social rate of return on private capital in rich countries. Applying the framework to the only comprehensive, cross-country data set of social rates of return on infrastructure indicates that in 1985 just 7 of 53 poor countries cleared the dual hurdles in both paved roads and electricity generating capacity. Where it was efficient to invest in infrastructure, however, the potential for excess social returns was significant—seven times larger, on average, than the excess financial returns that existed in publicly traded emerging-market stocks before foreigners were permitted to own shares. These results suggest that the dual-hurdle framework provides a template which savers, investors, and policymakers can use to prioritize poor-country infrastructure investments with maximal potential to drive greater growth, asset returns, and sustainability, even as new data become available.

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1. Introduction

Since the mid-twentieth century, which saw the revolutionary expansion of and unprecedented economic gains brought by infrastructure investment during the Eisenhower Era, leaders in the United States and other advanced nations have repeatedly hung their hopes of faster economic growth on domestic infrastructure projects. Following the 1990–91 recession, for example, American policymakers seized on Aschauer (1989) as intellectual justification for more infrastructure spending (U.S. Conference of Mayors 1992). But Munnell (1992) and others demonstrated that Aschauer's estimates of the infrastructure elasticity of output were implausibly large, with Fernald (1999) concluding that "the massive road-building of the 1950s and 1960s offered a one-time boost to the level of productivity, rather than a path to continuing rapid growth…". Even so, and despite Gramlich's (1994) observation that the surge of interest in infrastructure is "out of proportion to its likely long run importance," we have more recently experienced a déjà-vu moment. Weak recovery after the Great Recession, talk of secular stagnation (Eichengreen 2015; Gordon 2015; Summers 2015), and the Biden Administration's Build Back Better Legislation have revived the recurrent hypothesis that more infrastructure investment in advanced economies offers an untapped route to greater output gains.

Although the evidence suggests that the US does reap long-run benefits from infrastructure spending (Ramey 2021), theory predicts that the largest unexploited efficiency gains from greater infrastructure investment lie not in America or other rich countries, but in poor ones—the emerging market and developing economies (EMDEs) in which: (1) Latin America has 1/4 the infrastructure capital per capita of North America; (2) Emerging and Developing Asia have less than 1/5 that of Advanced Asia; and (3) the 48 countries of Sub-Saharan Africa, generate roughly the same amount of electricity as Spain (IMF 2014).

It is fundamental to recognize that the unrealized gains from greater infrastructure investment in poor countries outstrip those in the rich world. But is equally important to acknowledge that, just as in the U.S., the policy decisions in EMDEs on which the potential gains from infrastructure turn, are also susceptible to the perils of recurring fads (Estache and Fay 2007). Consider the widely cited "global infrastructure gap," defined as the trillion-dollar difference between the quantity of infrastructure investment scheduled to take place globally from 2015 to 2030 and the estimated amount needed to achieve the projected growth rate of global GDP over that time frame (McKinsey Global Institute 2016). Scarcity in EMDEs notwithstanding, the McKinsey Global Institute (MGI) definition minimizes the challenge of exploiting the unrealized efficiency gains from cross-country differences in infrastructure, because it does not acknowledge a critical fact. The discrepancy between scheduled and "needed" infrastructure spending is an equilibrium outcome of the demand for infrastructure services, on the one hand, and, on the other, the propensity of savers and investors to supply infrastructure capital given the incentives they have to do so.

In failing to embrace the discipline of equilibrium, the notion of a "global infrastructure gap" bears a striking similarity to its intellectual antecedent—the "financing gap," which gave rise to the field of development economics (Domar 1946; Harrod 1939). Like the MGI conception, the Harrod-Domar Model asserts that a desired rate of growth requires a target level of investment. Given national savings (or scheduled investment in the case of MGI), target investment implies a financing gap equal to the difference between the two quantities. Armed with this framework, bilateral and multilateral donors from rich countries sought to help poor countries grow by filling the gap with aid. These donors failed, because they did not ask whether filling the gap with "needed" investment would actually correct a market failure, incentivize production, and endogenously raise incomes (Easterly 2001).[1]

Beyond the failure of the 1950s aid-driven growth agenda, Figure 1 provides a sobering reminder of the complex relationship between infrastructure and output in EMDEs. Growth of the public capital stock increased from 4 percent per year in the 1960s to almost 7 percent per year by the mid-1970s. Aggregate productivity growth, in contrast, slowed precipitously and actually turned negative. Of course, we would not expect greater infrastructure spending to increase productivity immediately, public capital is an imperfect proxy for infrastructure capital (Fay, Lee, Mastruzzi, Han, and Cho 2019), and exogenous shocks (e.g., the 1979 Oil Crisis and the 1980–82 Volker Recession) reduced output everywhere. Nevertheless, productivity did not begin rising in poor countries until the mid-1990s. Even allowing for the possibility that infrastructure investment has a long-delayed impact on efficiency, it is hard to believe that increased spending on public capital raised productivity with a twenty-year lag.

There is an abundance of evidence, however, that the 1970s spike in poor-country expenditure on public capital contributed to the Third World Debt Crisis (Rogoff 1991). Given signs of financial distress—even before the onset of COVID-19—in countries that signed non-concessional infrastructure loan agreements under China's Belt and Road Initiative (Bataineh, Bennon, and Fukuyama 2019; Gallagher and Ray 2020; Reinhart 2020; Signé 2018), Figure 1 underscores the potential for another era of crises and wasted resources if decision makers adhere to gap thinking. Defaults on Belt and Road loans (e.g., Sri Lanka's Hambantota Port) may have strategic value for China, but they are not consistent with the goal of Pareto-improving capital flows that are a pillar principle of the international financial system in the post–Bretton Woods

[1]General aid does not raise growth; targeted aid improves health, water, and sanitation (Archibong, Annan, Ekhator-Mobayode 2020; Arslanalp and Henry 2004; Ndikumana and Pickbourn 2017; Ndikumana and Pickbourn 2018).

Era.

A naïve narrative about infrastructure gaps will likely result in an equally naïve allocation of resources into unproductive investments, but the fact remains that 1 billion people live more than two kilometers from an all-season road, and 1.2 billion have no access to electricity (Rozenberg and Fay, 2019). Flooding EMDEs with grants or grids will not cure these shortfalls, but it also strains the imagination to maintain that a paucity of power and roads will yield GDP outcomes that capture the full productive potential of poor nations.

This paper introduces a framework that enables a benevolent social planner to distinguish an efficient global allocation of infrastructure capital from the wasteful one likely to result from approaches predicated on gap thinking. The framework turns away from the exclusive focus on quantities of infrastructure services in poor countries championed by MGI and others, to an equilibrium analysis that incorporates the incentive that suppliers and allocators of capital have to finance the provision of infrastructure services.

For a given poor country, the cornerstone of the framework is a comparison of the country's social rate of return on public capital—i.e., infrastructure—with the social rate of return on two different stocks of private capital. The first comparison is with the poor country's own social rate of return on private capital. Given a dollar of savings in a poor country, it is efficient for the benevolent social planner to invest that dollar in the poor country's infrastructure if the social rate of return on infrastructure in the poor country exceeds the social rate of return on its private capital. In effect, the poor country's social rate of return on private capital is a hurdle rate that prospective investments in its infrastructure must clear to be the most productive allocation of a dollar of local savings.

The second comparison is less obvious but equally important. Consider a dollar of savings in a typical rich country, in which “typical” means that the rich country’s social rate of return on private capital exceeds its social rate of return on infrastructure. Because the rich country’s social rate of return on private capital exceeds its social rate of return on infrastructure, the rich country’s social rate of return on private capital is also the binding constraint for determining whether a dollar of rich-country savings can be used more productively at home or in the poor country. Specifically, if the social rate of return on infrastructure in the poor country is greater than the social rate of return on private capital in the rich country, then it is efficient for the planner to reallocate the dollar of savings from the rich country to finance investment in public capital in the poor country. Therefore, the social rate of return on private capital in the rich country constitutes a second hurdle rate for the poor country—one that the poor country’s social rate of return on infrastructure must clear for public capital in the poor country to be an efficient destination for rich-country savings.

Taking the dual-hurdle-rate framework to the data produces two revelations. First, there is a dearth of knowledge about the social rate of return on infrastructure investment in poor countries. Despite serial campaigns emphasizing the importance of infrastructure for development (World Bank 1994, 2005, 2007), including a 2015 communiqué touting the opportunity for private capital to leverage multilateral resources and move the world from “billions to trillions” of investment in infrastructure to achieve the sustainable development goals (World Bank 2015), successive presidents and boards of the World Bank have failed to marshal the wealth of talent under their direction to produce a common and current repository of estimates of the social rate of return on infrastructure that governments, savers, and investors can use to drive fact-based decisions about the efficiency of infrastructure investment in poor countries. To the best of our knowledge, the only existing source of explicit, comprehensive cross-country estimates of the social rates of return on infrastructure (e.g. roads and electricity) in poor countries is a paper, Canning and Bennathan (2000), commissioned by the Bank, that is based on data from 1985.

Second, contrary to the communiqué's message that poor countries contain an abundance of efficient infrastructure investment opportunities, only 7 of the 53 poor countries in the Canning and Bennathan (2000) data set cleared the dual-hurdle tests of efficiency in both roads and electricity—a reality that underscores the danger of allowing the infrastructure-gap narrative to proceed unchallenged.

For countries that did clear the dual hurdles, on the other hand, the social rate of return on infrastructure was large. For example, the average social rate of return on roads was 10.2 times greater than the average social rate of return on rich-country private capital. Compare this number with the excess-financial-returns on stock markets in poor countries. Before these stock markets were liberalized (i.e., opened up to foreign investors) in the late 1980s, the expected return on poor-country stocks was 1.5 times greater than the expected return on the Standard and Poor 500 stock market index (Chari, Henry, and Reyes 2021). In other words, the excess-return multiple on the infrastructure of poor countries in 1985 was roughly seven times larger (10.2 divided by 1.5) than the excess-financial-returns on poor-country equity. Stock market liberalizations sparked the creation of a new class of rich-country savings vehicles called emerging-market equity funds (Van Agtmael 2007), now a $759 billion industry (Chari, Dilts Stedman, and Lundblad 2022).

Unlike the flood of savings that poured into emerging equity markets following liberalization, however, there are two reasons why similar quantities of rich-country private capital did not—and still do not—flow into poor-country infrastructure. First, the absence of tradable financial claims on poor-country infrastructure in the 1980s (due in part to the lack of knowledge about social rates of return) made it impractical to pursue, at scale, private, rich-country financing of public, poor-country capital. Tradable claims of this nature now exist, and the dual-hurdle analysis provides a framework for distinguishing those countries where the excess-return multiples on infrastructure may be large enough to incentivize the economically productive creation of further such claims from those countries where they are not. Indeed, the new analysis of old information in this paper: (a) provides a template to apply to updated, cross-country data on social rates of return; and (b) demonstrates the urgency of the World Bank generating, validating, and disseminating that data as soon as possible.

Second, current and reliable information about prospective social rates of return on poor-country infrastructure is not sufficient to generate a globally efficient allocation of capital. When deciding where to put their money, rich country savers care about what is optimal for them, not what is efficient for society. This means that they will allocate their savings in accordance with their prospective private rates of return, not the social ones. Because social returns may diverge from private returns, unless the World Bank and other international financial institutions can find a way to address this divergence, savings will remain frozen in rich countries, powerless to facilitate efficient public capital formation in poor ones.

2. The Distinction Between Private and Public Capital

Figure 2, Panel A, illustrates the traditional approach to evaluating the efficiency of capital allocation across rich and poor countries: one type of non-differentiated capital (*K*), two social rates of return (*r*-Rich and *r*-Poor), and an emphasis on the magnitude of *r*-Poor relative to *r*-Rich. Under standard neoclassical assumptions, there are no externalities so that social rates of return and private rates of return coincide, and *r*-Poor is greater than *r*-Rich. Accordingly, a multitude of articles (e.g., Alfaro, Kalemli-Ozcan, and Volosovych 2008) focus on the empirical merits of the four hypotheses that Lucas (1990) puts forth as potential explanations for why capital does not flow from rich to poor countries: (1) differences in human capital; (2) human capital externalities; (3) political risk; and (4) restrictions on foreign investment. Because the Lucas hypotheses and their subsequent evaluations are predicated on a single type of capital, however, they are silent on the degree to which international disparities in incomes and rates of return stem from an inefficient allocation of private versus public capital (e.g., infrastructure).

The distinction between private and public capital matters, because, across countries, social rates of return on public capital vary much more than social rates of return on private capital. If social rates of return on public capital were equalized across countries, world GDP would be approximately 9 percent higher than its current level, and this potential gain is roughly 4.8 times larger than the gain that would accrue from equalizing cross-country differences in social rates of return on private capital (Lowe, Papageorgiou, and Perez-Sebastian 2018).

Because social rates of return on public capital vary more than social rates of return on private capital, with large attendant welfare implications that the traditional approach to cross-country allocative efficiency is unable to capture, the schematic in Panel B of Figure 2 augments the traditional approach. It does so by explicitly treating private and public capital as separate stocks. The augmented treatment brings some complexity. In contrast to Panel A, Panel B contains four types of capital—Private-Poor, Public-Poor, Private-Rich, and Public-Rich—and four social rates of return: *r*-Private-Poor, *r*-Public-Poor, *r*-Private-Rich, and *r*-Public-Rich. With four social rates of return and two countries, instead of one cross-country return comparison required to assess allocative efficiency (*r*-Poor versus *r*-Rich) as in Panel A, there are now four choose two comparisons of both cross- and within-country social rates of return: (i) *r*-Private-Poor vs. *r*-Public-Poor; (ii) *r*-Private-Rich *vs.* *r*-Public-Poor; (iii) *r*-Private-Rich vs. *r*-Public-Rich; (iv) *r*-Public-Poor vs. *r*-Public-Rich; (v) *r*-Private-Poor vs. *r*-Private-Rich; and (vi) *r*-Private-Poor vs. *r*-Public-Rich.

In principle, all six country-sector-return comparisons have efficiency implications, but there are compelling reasons to focus on the first two, with the other four set aside through a practical process of elimination. Comparison (i) is essential because any analysis that does not ask whether it is more productive to direct a dollar of a poor country's savings to investment in its public capital than it is to allow that dollar to be invested in its private capital is destined to fail. Comparison (ii) is central to determining whether the World Bank's presumption that private savings in rich countries can be more efficiently deployed to finance public capital in poor ones is an empirical reality or an article of faith. Comparison (iii) is known: *r*-Public-Rich is almost everywhere less than *r*-Private-Rich (Caballero, Farhi, and Gourinchas 2017); this means that Comparison (ii) rather than Comparison (iv) is the binding consideration for whether rich-country savings can efficiently finance Public-Poor capital. Comparison (v) is also known: *r*-Private-Poor largely converged to *r*-Private-Rich after restrictions on capital flows into poor countries were eased in the late 1980s and early 1990s (Henry 2003, 2007). Taken together, Comparisons (iii) and (v) render Comparison (vi) a non-binding consideration.

2A. The Large and Variable Nature of *r*-Public-Poor

Table 1 gives greater context for the comparisons just described. It does this by providing descriptive statistics on *r*-Private-Rich, *r*-Public-Rich, *r*-Private-Poor, and *r*-Public-Poor. The data in the table are the social rates of return that Canning and Bennathan (2000) computed for:

(a) the aggregate capital stock (their proxy for private capital); and (b) paved roads and electricity generating capacity (public capital). The 69 countries in the table are categorized into two groups—Rich, of which there are 16; and Poor, of which there are 53, subcategorized by geographic location: Latin America and the Caribbean (17), Africa (19), and Asia (17). Data on the aggregate stock of capital is available for all 69 countries. Disaggregated data on public capital, paved roads and electricity generating capacity (EGC), are more limited. All rich countries except Portugal have data on roads, and Portugal is the only rich country with data on electricity. For the poor countries, 26 have data on roads, 49 have data on electricity, and 22 have data on both.

In accordance with data availability, Canning and Bennathan (2000) employ a two-step procedure to compute social rates of return. Using panel data from 1960 to 1990 and a variety of techniques to remove the effects of reverse causality, they regress the natural log of GDP per capita on the natural log per worker of human capital, aggregate capital, and both measures of public capital to estimate country-specific marginal products of aggregate capital, roads, and electricity. Next, they compute social rates of return by dividing the marginal product of each type of capital by its unit cost, obtained for each country using observable data on the cost of infrastructure construction, and subtracting the rate of depreciation, assumed to be 7 percent per year.[2] The data on construction costs are from 1985, and so too, in effect, are the social rates of return.

Two facts in Table 1 suggest that the non-equalization of worldwide social rates of return on public capital documented by Lowe, Papageorgiou, and Perez-Sebastian (2018) are driven by disparities in social rates of return on public capital between poor countries. First, and consistent

[2]Canning and Bennathan's returns calculations adjust for double-counting of capital and infrastructure.

with the findings of Devadas and Pennings (2018), the dispersion of *r*-Public-Poor is much greater than the dispersion of *r*-Public-Rich. Consider the case of paved roads, for which the standard deviation of *r*-Public-Rich is 15.3 percent. In contrast, the corresponding standard deviations of *r*-Public-Poor are: 309 percent in Latin America and the Caribbean, 54.8 percent in Africa, and 597.5 percent in Asia. For the 53 poor countries as a whole, the standard deviation of *r*-Public-Poor is 369 percent, or 24.1 times the standard deviation of *r*-Public-Rich.

The reality that *r*-Public-Poor varies far more than *r*-Public-Rich has an important corollary. Although public capital is everywhere allocated more inefficiently than private capital, the inefficiency is greater in poor countries. Whereas the standard deviation of *r*-Public-Rich for paved roads is 2.2 times larger than the standard deviation of *r*-Private-Rich (7.1 percent), the corresponding standard deviation of *r*-Public-Poor is 16.3 times larger than the standard deviation of *r*-Private-Poor (22.7 percent).

The second salient fact in Table 1 regarding the non-equalization of worldwide social rates of return follows from the first. To the extent that *r*-Poor differs significantly from *r*-Rich, a contentious issue among the intellectual descendants of Lucas (1990), it is more likely to do so because of disparities in *r*-Public-Poor and *r*-Public-Rich—a topic that has received scant attention in the literature—than it is because of differences in *r*-Private-Poor and *r*-Private-Rich. To see the point explicitly, consider again the case of paved roads. For this type of infrastructure, the ratios of the average value of *r*-Public-Poor to the average value of *r*-Public-Rich across all three geographic subcategories are far larger than the ratio of the average value of *r*-Private-Poor to the average value of *r*-Private-Rich. Specifically, the ratios of the average value of *r*-Public-Poor to the average value of *r*-Public-Rich are: 25.0 (323 divided by 12.9) in Latin America and the Caribbean, 4.9 (63.2 divided by 12.9) in Africa, and 35.9 (463.7 divided by 12.9) in Asia, for an overall average of 21.9. In contrast, the corresponding ratios of the average value of *r*-Private-Poor to the average value of *r*-Private-Rich are: 1.38 (43.2 divided by 31.4), 0.9 (28.4 divided by 31.4), and 1.9 (59.9 divided by 31.4), for an overall average of 1.4.

To place the ratio of the average value of *r*-Private-Poor to the average value of *r*-Private-Rich in historical context, recall the central point of Lucas (1990). He observed that capital had not been flowing from rich to poor countries and emphasized the following explanation: once properly adjusted for cross-country differences in human capital, the implied difference between *r*-Poor and *r*-Rich was not large enough to induce capital to flow from rich to poor. As it turned out, a different hypothesis proposed by Lucas (1990) was at least as relevant: capital did not flow from rich to poor countries, because poor countries maintained legal barriers to private capital inflows. We know the legal-barriers-to-capital-flows hypothesis was relevant, because shortly after the publication of Lucas's article, a number of poor countries eased their restrictions on foreign ownership of domestic stocks as part of a broader process of capital account liberalization (Henry 2000a, 2007; Stulz 1999). Figure 3 documents the ensuing flood of capital from Private-Rich to Private-Poor.

In the five years prior to liberalization, the expected return on emerging-market stocks, as measured by their average earnings yield, was 13.3 percent, or roughly 1.5 times greater than the average earnings yield of 8.6 percent on the S&P 500 over the same period (Chari, Henry, and Reyes 2021). As this excess return was largely arbitraged away following liberalization, with attendant consequences for real investment and manufacturing-sector wages (Chari, Henry, and Sasson 2012; Henry 2000b, 2003, 2007; Stulz 1999, 2005), 1.5 is a reasonable proxy for the pre-liberalization ratio of *r*-Private-Poor to *r*-Private-Rich, and is close to the average of 1.4 in Table 1.

2B. What Drives *r*-Public-Poor?

The large and variable nature of the returns on public capital in Latin America, Africa, and Asia raises questions about what drives *r*-Public-Poor and what drives investment in public capital. Economics matters. Connecting a port to a road network and an electrical grid can correct a market failure, generate positive externalities, and raise the marginal product of non-infrastructure inputs. But politics matters too (Keefer and Knack 2007). Infrastructure projects that deliver private rents instead of public goods will not increase a poor country's rate of GDP growth, and in the second half of the 21st century, government failure eclipsed market failure as an obstacle to economic development (Krueger 1990; Devarajan and Khemani 2018).

Correcting government failures is no small task, but doing so might help to reduce the apparent inefficiencies of public capital allocation in poor countries, and research that explores political economy through the lens of micro principal-agent relationships provides insights about how to proceed. Because political engagement—selection and sanctioning of leaders by citizens—has increased significantly across countries since 1980, greater transparency in the form of better data on the quality with which governments deliver public goods has the potential to increase accountability and "make politics work for development rather than against it" (World Bank 2016).

In the future, heightened engagement and transparency may reduce the incidence of government failure. In the present, it is clear that the large and variable nature of *r*-Public-Poor requires careful thinking to determine whether, for a given poor country, more infrastructure investment is both locally and globally efficient. The next section provides a simple framework to do just that.

3. The Dual-Hurdle Framework

Acknowledging the importance of the distinction between private and public capital, let *K* denote the stock of private capital for a given poor country, and *X* the stock of public capital, which, for simplicity of exposition, we assume to be the same as the stock of infrastructure.[3] Similarly, let $K^*$and X^*denote the stocks of private capital and infrastructure capital in the rich country. Using these definitions, Figure 4 provides a framework for a benevolent social planner to evaluate whether investing in the infrastructure of a given poor country would be an efficient use of both local and rich-country savings. Specifically, Figure 4 simultaneously compares the poor country's social rate of return on infrastructure (*r*-Public-Poor) with: (a) its own social rate of return on private capital (*r*-Private-Poor) and (b) the social rate of return on private rich-country capital (*r*-Private-Rich).

For a given poor country, and category of infrastructure (e.g., paved roads or electricity generating capacity), the horizontal axis gives the ratio of *r*-Public-Poor to *r*-Private-Poor: $\frac{r_X}{r_K}$. Denote this ratio ρ_K^X, and consider its implications for local efficiency. If capital is allocated efficiently within the poor country, then the country's social rate of return on infrastructure will be the same as its social rate of return on private capital and $\rho_K^X = 1$. If the country has too little infrastructure, then its social rate of return on infrastructure will exceed its social rate of return on private capital so that $\rho_K^X > 1$. If, on the other hand, $\rho_K^X < 1$, then the country has too much infrastructure relative to private capital; this does not necessarily mean that the country has stellar infrastructure, but it does imply that infrastructure is not the most efficient marginal allocation of savings given the country's mix of other inputs (i.e., private capital, human capital, labor, technology, policies, and institutions). The vertical dashed line on the figure, defined by

[3] In practice, infrastructure is a subset of public capital. Our subsequent analysis acknowledges the distinction.

the locus of points for which $\rho_K^X = 1$ is, therefore, the domestic "hurdle"; it is efficient for the country to increase its rate of investment in infrastructure (relative to private capital) if its ratio of *r*-Public-Poor to *r*-Private-Poor falls to the right of this line (i.e., $\rho_K^X > 1$).

The vertical axis of Figure 4 gives the ratio of *r*-Public-Poor to *r*-Private-Rich: $\frac{r_X}{r_{K^*}}$. Denote this ratio $\rho_{K^*}^X$. If capital is allocated efficiently across the poor country and the rich country then $\rho_{K^*}^X$=1, and there is no efficiency case for capital to flow from the rich country to infrastructure in the poor one. If $\rho_{K^*}^X$>1 then it is efficient for capital to flow from the rich country to investment in poor-country infrastructure. The opposite is true if $\rho_{K^*}^X$<1. The horizontal dashed line on the figure, defined by the locus of points for which $\rho_{K^*}^X$=1 is, therefore, the foreign "hurdle"; it is efficient to finance infrastructure in the poor country with rich-country savings if the poor country's ratio of *r*-Public-Poor to *r*-Private-Rich lies above this line (i.e., $\rho_{K^*}^X > 1$).

For a variety of reasons ranging from the fact that infrastructure is a public good with an absence of tradable securities that privately capture its economic benefits and thereby incentivize savers to supply the capital required to meet the demand for infrastructure services, to governments that actively pursue policies that prevent the marginal product of capital from converging across sectors or borders, we should not actually expect the social rate of return on infrastructure in a given country to equal the social rate of return on private capital at home or abroad. Accordingly, the prevalence, magnitude, and variation of differences in social rates of return on infrastructure and private capital within and across countries can provide powerful signals about the extent to which the stock of infrastructure capital in place and the attendant flow of services it provides are meeting demand, or whether there are opportunities for a more efficient allocation of scarce resources. To that end, the intersection of the domestic and foreign hurdles divides the $(\rho_K^X, \rho_{K^*}^X)$ plane into four quadrants that sort countries according to their potential for locally and globally efficient investment in infrastructure.

3A. The Prevalence and Magnitude of Efficient Infrastructure Investment Opportunities

Quadrant I ($\rho_K^X > 1$, $\rho_{K^*}^X > 1$) consists of countries in which the return on infrastructure clears both the domestic and foreign hurdle rates for efficient investment. Countries in this quadrant are ripe for more investment in infrastructure, and it is efficient for both local and foreign (rich-country) savings to finance it. Said another way, countries that fall in Quadrant I have infrastructure return characteristics that are consistent with the World Bank's three-fold claim.

We take Figure 4 to the data with the aid of Table 2 (Panels A and B). For each panel, the data are broken into the cluster of rich countries, plus the three poor-country clusters. The table presents ordered pairs of country-infrastructure-return observations $(\rho_K^X, \rho_{K^*}^X)$. For each cluster, the first column lists ρ_K^X; the second column lists $\rho_{K^*}^X$; the third column lists the quadrant into which the country falls given its values of ρ_K^X and $\rho_{K^*}^X$. The most striking observation about the rich countries is that for all of them except Japan, the social rate of return on infrastructure is less than the social rate of return on private capital (i.e., $\rho_K^X < 1$). Again, this means that *r*-Private-Rich is the binding constraint for efficient cross-border investment from rich countries into poor-country infrastructure. For that reason, throughout Table 2 we use the average value of *r*-Private-Rich as the denominator of $\rho_{K^*}^X$.[4] Panel A of the table presents the 26 poor-country-

[4]Because the return on capital is used as a proxy for the return on private capital, our measure of the return on private capital" is actually a weighted average of the return on infrastructure and the return on private capital. If the return on capital is less (greater) than the return on infrastructure, then the return on private capital is also less (greater) than the return on infrastructure. Therefore, ρ_K^X and $\rho_{K^*}^X$ convey the same information about efficiency as they would if they were based on measures of strictly private capital.

infrastructure-return ordered pairs for paved roads. Panel B presents the 49 poor-country-infrastructure-return ordered pairs for electricity generating capacity.

The data reveal a mixed picture about the extent to which poor countries contained opportunities for locally and globally efficient infrastructure investment in 1985. Table 2 indicates that for paved roads, on the one hand, 21 of 26 countries landed in Quadrant I—all 11 countries in Latin America and the Caribbean, 6 of 9 in Africa, and 4 of 6 in Asia. For the 49 countries with data on electricity generating capacity (EGC), on the other, only 18 make it into Quadrant I. Of the 18 countries that land in Quadrant I for EGC, 9 are in Africa, 3 are in Latin America and the Caribbean, 6 are in Asia, and 15 are classified as "low-income." Aggregating across electricity generating capacity and paved roads underscores the extent to which the dual-hurdle framework provides a more discriminating assessment of the true potential for efficient investment in infrastructure than any single metric. Thirty-nine of the 75 country-infrastructure-return observations (distributed across 32 unique poor countries) land in Quadrant I.

Quadrant II ($\rho_K^X > 1$, $\rho_{K^*}^X < 1$) consists of countries in which the social rate of return on infrastructure clears the domestic hurdle but falls below the foreign hurdle. Countries in this quadrant would be better off with more rapid investment in infrastructure but it is not efficient for rich-country savings to finance it. Instead, countries in this quadrant must rely on domestic savings and concessional foreign financing (subject to the usual caveats about foreign aid). Across both categories of infrastructure, only 1 country, Ghana in the case of EGC, falls into Quadrant II.

Quadrant III ($\rho_K^X < 1$, $\rho_{K^*}^X < 1$) consists of countries in which the social rate of return on

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infrastructure clears neither the domestic nor the foreign hurdle. It is not efficient for countries in this quadrant to allocate additional resources (domestic or foreign) to infrastructure relative to private investment. Countries in this quadrant can also look quite different. A country with an excellent private investment climate and therefore a high social rate of return on private capital may land here because it is so well capitalized in infrastructure that the marginal benefit of installing another unit is not an efficient use of either local or foreign savings. It is equally possible for a country to land in this quadrant because it has an abjectly poor investment climate that renders low the social rate of return on private investment, even as it remains relatively overcapitalized in infrastructure. In the case of EGC, 20 countries fall into Quadrant III. For paved roads, the number is 3: Botswana, Tunisia, and Zimbabwe.

Quadrant IV ($\rho_K^X < 1, \rho_{K^*}^X > 1$) consists of countries in which the social rate of return on infrastructure falls below the domestic hurdle, but clears the foreign hurdle. For countries in this quadrant, it would be efficient for governments to stop appropriating domestic savings for infrastructure and let foreign savings finance it instead. For EGC, 10 countries fall into Quadrant IV. In the case of paved roads, there are 2 countries: India and Pakistan.

Returning to Quadrant I for a moment, it is notable that of the 32 unique countries identified as having Quadrant I infrastructure opportunities, in 11 of them—Algeria, Argentina, Bolivia, Central African Republic, Congo, Fiji, Gambia, Liberia, Mali, Uganda, and Zambia—*r*-Private-Poor is less than *r*-Private-Rich. There are, in other words, poor countries to whose private sectors there is no incentive for rich-country savings to flow that are nonetheless. efficient destinations for foreign investment in infrastructure.

And speaking of Quadrant I, not all efficient infrastructure opportunities are created equal. For all of the country-infrastructure-return observations that land in Quadrant I, Table 3

(Panel A, paved roads; Panel B, electricity generating capacity) ranks the magnitude of the infrastructure opportunities in descending order of $\rho_{K^*}^{X}$. The most striking observations across both Panels fall into two categories.

First, when it is efficient to increase investment in infrastructure, the unexploited opportunities for gain can be massive. The welfare consequences of the non-equalization of *r*-Private-Rich and *r*-Public-Poor are orders of magnitude larger than those from the non-equalization of returns between r-Private-Rich and Private-Poor. For each of the 21 countries that sort into Quadrant I for roads, Panel A of Table 3 indicates that $\rho_{K^*}^{X}$, the ratio of *r*-Public-Poor to *r*-Private-Rich, has a mean (median) value of 10.2 (6). Even dropping the outlier of Korea, the mean (median) value of $\rho_{K^*}^{X}$ is 8.2 (5.5). In contrast, we know from the discussion in the last two paragraphs of Section 2A that a reasonable estimate of the ratio *r*-Private-Poor to *r*-Private-Rich is 1.5. This means that when it comes to roads, the excess return multiple for *r*-Public-Poor relative to *r*-Private-Rich ranges from 5.5 (8.2 divided by 1.5) to 6.8 (10.2 divided by 1.5) times larger than the excess return multiple for *r*-Private-Poor relative to *r*-Private-Rich. As for the 18 countries with Quadrant I opportunities for electricity, Panel B indicates that mean (median) value of $\rho_{K^*}^{X}$ for electricity is 2.2 (1.85). This means the excess return multiple for *r*-Public-Poor relative to *r*-Private-Rich in electricity is a less eye-popping 1.5 times (2.2 divided by 1.5) larger than the excess return multiple for *r*-Private-Poor relative to *r*-Private-Rich.

There is a simple reason why the potential welfare gains of capital flows from Private-Rich to Public-Poor are larger than those from Private-Rich to Private-Poor. The ratio of *r*-Public-Poor to *r*-Private-Rich divided by the ratio of *r*-Private-Poor to *r*-Private-Rich is ρ_{K}^{X}—the ratio of *r*-Public-Poor to *r*-Private-Poor. As discussed in Section 2A, the dispersion of the ratio of *r*-Public-Poor to *r*-Private-Poor in 1985 was much greater than the dispersion of *r*-

Public-Rich to *r*-Private-Rich. Again, this implies that infrastructure was even less efficiently allocated in poor countries than in rich countries. It is also worth noting that this dispersion may be increasing over time. Between 1990 and 2005 the standard deviation of the marginal product of aggregate capital in poor countries remained roughly constant, even as the standard deviation of the marginal product of private capital fell (Lowe, Papageorgiou, and Perez-Sebastian 2018). This means that unless the covariance of *r*-Public-Poor with *r*-Private-Poor has also increased, the standard deviation of *r*-Public-Poor rose, both in absolute terms and relative to the standard deviation of *r*-Private-Poor.

The second striking observation about Table 3 is that nothing in the table remotely suggests anything optimal about a broad-based drive for more infrastructure investment in all poor countries. Of the 22 countries for which there are data on returns for both paved roads and electricity, only 7—Argentina, Bolivia, Honduras, Indonesia, Kenya, Malawi, and the Philippines—appear in both Panel A and Panel B. The reality that less than one-third of the countries for which we have data on both categories of infrastructure present a clear case for investment in both roads and electricity ought to give pause about big-push approaches to infrastructure investment in poor countries. Furthermore, there are a total of 21 countries that do not appear in either panel. This means that almost 40 percent of the 53 developing countries for which data are available have no returns-based case for investment in infrastructure. Where there is a case to be made, it is stronger in roads than electricity.

3B. Electricity, Roads, and the Rural-Urban Distinction

The absence of widespread evidence for the aggregate economic benefits of increased investment in electricity infrastructure for poor countries is consistent with Lee, Miguel, and

Wolfram (2020a) who, using a randomized control trial approach, document minimal gains of household electrification in rural Kenya and conclude that providing electricity to rural households may not be an economically productive, high-return activity in the world's poorest countries.[5] Although Table 2 indicates that Kenya is, in fact, among the limited number of countries that sort into Quadrant I for electricity, the figures in Table 2 are based on the estimated impact of increased electrification to countries as a whole, not just to rural households.

The distinction between rural and aggregate electrification matters. In contrast to the evidence that rural electrification yields minimal consumer benefits, consider the impact of electrification on industrial and urban production. Results from *World Bank Enterprise Surveys*, conducted on 47,179 firms in 108 countries from 2006 to 2010, indicate that 41 percent of managers consider lack of access to electricity a "major or very severe" obstacle to their operations and the biggest challenge to their businesses—ahead of crime, access to finance, and an inadequately educated labor force (Geginat and Ramalho 2015).[6] If the return to increased electrification for industrial and urban production is high, then the cost-benefit trade-off associated with aggregate electrification may be positive, even as the costs of electrification for rural consumption outweigh the benefits.

The importance of the rural–aggregate electrification distinction is thrown into relief by trends of demographics and urbanization. Between 2000 and 2030, cities in poor countries, African countries in particular, will double their population from 2 billion to 4 billion and triple their land area, making preparation for ongoing urbanization a common priority (Angel 2008;

[5] Earlier studies documented the benefits of rural electrification for increases in labor supply (Dinkelman 2011; Grogan and Sadanand 2013), school attainment (Khandker et al. 2014, Akpandjar and Kitchens 2017), and respiratory health (Barron and Torero 2017). More recent studies find the impact of rural electrification economically and statistically significant (Foster and Rana 2020; Lee, Miguel and Wolfram 2020b).
[6] Aberese (2020) and Aberese, Ackah, and Asuming (2021) estimate the impact of electricity shortages on firm-level investment and productivity in Ghana.

United Nations 2016). Urbanization is inevitable, but poor countries' maximization of productivity gains from the process is not.

Good jobs—ones in which workers learn more and experience faster increases in productivity—arise naturally in large urban areas with both a local platform that facilitates rapid inter-city connections and links to global supply chains. The creation of such platforms requires intra-city infrastructure such as roads, water, and sanitation, in addition to power (Bertaud 2018; Romer 2018). Cities make workers and firms more productive when urbanization increases the effective size of the labor market, and the effective size of a city's labor market is a function of both its population and the speed with which people can travel from home to work (Prud'homme and Lee 1999). Because the average number of jobs per worker that are reachable within a one-hour, one-way commute is an effective proxy for a city's productivity, policies that maximize that number have profound potential to impact growth (Bertaud 2018).

There are 22 poor countries with data for social rates of return on both electricity and paved roads. Of these, the dual-hurdle framework indicates that it would have been efficient to increase investment in paved roads for 17 of them, whereas increased investment in electricity would have been efficient for only 8. Plainly stated, in 1985 it was 2 times more likely that greater investment in roads in a given poor country was efficient than greater investment in electricity. To the extent that in subsequent decades the cost of constructing roads has changed relative to the cost of installing electricity, so too has the two-fold difference in likelihoods.

Whether the difference in likelihoods remains current or not, it underscores the importance of comparing the social rate of return on investing in roads to the social rate of return on investing in electricity—or other infrastructure, such as hospitals, schools, water and sanitation—to prioritize large-scale expenditure on public capital in a way that maximizes growth, given equity considerations. To that end, the dual-hurdle framework can be used as readily for determining which individual infrastructure projects within a given country fall into Quadrant I as it can for making aggregate, country-level assessments.

The more general point about any changes in relative costs since 1985, of course, is that yesteryear's roads and grids may not be today's infrastructure, and they are even less likely to be tomorrow's transportation and power solutions (Foster and Rana 2020). The rapid evolution of technology in conjunction with the immutable nature of certain physical infrastructure (e.g., it is extremely costly to move a bridge once built) gives rise to non-trivial challenges in thinking about when and how to implement public investments to maximize their future social return. Leifman, Fay, Nicolas, and Rozenberg (2019) elaborate on the complexities involved in trying to forecast the exact configuration of the infrastructure of the future and sketch a range of possible outcomes, but given the uncertainty and quasi-permanence of infrastructure, the most efficient course of action for leaders may be, a la Dixit and Pindyck (1994), to retain the option, but not the obligation to make decisions about the installation of public capital. Maximizing the future value of building roads in response to the ongoing process of urbanization provides a tangible example.

Accordingly, Angel (2008) articulates a powerful real-options strategy for urban roads that distinguishes between infrastructure capital (materials for building roads) and land for infrastructure (the intra-city arterial dirt grid upon which future roads will be built).[7] His approach focuses on the essential function of arterial roads to minimize commuting time and maximize the number of reachable jobs per worker per hour. Executing the strategy requires governments to make just one up-front commitment: obtaining the land to lock in the rights-of-

[7]An arterial grid is a network of roads that carry intra-urban traffic, public transportation, and trunk infrastructure.

way for trunk infrastructure in advance of urban development. The sooner rights-of-way are secured, the lower their cost and therefore the higher the benefit-cost ratio of securing them. Because the strategy rises above the tactical complexity of questions like what type of vehicles will drive on the roads (e.g., autonomous or traditional), or what type of material will be used for paving, it requires minimal knowledge at the time of commitment about the future path of technology. Indeed, from a real-options perspective, Angel's central insight is that the highest social return on roads in poor countries may come not from pouring asphalt, *per se*, but rather from the foresight to acquire land now that enables cities to engage in low-cost adaptation to the transportation realities of the future.

Speaking of foresight, past infrastructure spending was efficient when it provided the labor-abundant countries of East Asia with the transportation and power infrastructure required to convert their comparative advantage in low-wage labor into export-led manufacturing growth strategies (Kuroda, Kawai, and Nangia 2007). Today, other nations have positioned themselves as next in line to reap the benefits of infrastructure-enabled, labor-abundance-driven industrialization: wages in Vietnam, for example, are half what they are in China, and wages in Ethiopia are half those of Vietnam (Dinh et al. 2012; Standard Chartered Global Research 2016). But automation continues to reduce the share of labor in the cost of manufacturing—thereby eroding poor countries' advantage of a vast, low-wage workforce (Basu 2016)—and the technological changes afoot, in combination with premature de-industrialization (Rodrik, 2016), beg the question of whether investment in infrastructure will remain a high-return proposition in countries that pass the dual-hurdle test.

In spite of automation, a number of poor countries will continue to have a comparative advantage in traditional export-led industrialization (Hallward and Nayyar 2018). Others will reinvent themselves for a niche in the manufacturing-cum-services value chain. And some may pursue a radically different path that heavily leverages information and communications technology (ICT) and the digital economy. But even if the power infrastructure of the future looks very different than that of the past, without reliable electricity it is not possible to build e-commerce platforms for growth using ICT. The point is fundamental, because faster internet connections in Sub-Saharan Africa, for example, increase innovation, employment and productivity (Chiplunkar and Goldberg 2022; Chuku, Simpasa, and Akpan 2019; Hjort and Poulsen 2019).[8] The question, therefore, is less whether properly screened investments in infrastructure will still bring efficiency gains in a world of automation and premature de-industrialization, than how, given scarce resources, changes in the manufacturing landscape will alter the ordering of infrastructure priorities in the years ahead.

3C. Joint Prospects for Roads and Electricity

Because strategically-laid-out roads and reliable electricity form the common denominator of maximally productive cities, interpreting data on the joint prevalence of opportunities for roads and electricity requires caution. Aggregating across roads and electricity in Table 2, for example, indicates that 39 of the 75 country-infrastructure-return observations sorted into Quadrant I. Little more than half of all observations clearing the dual hurdles does not suggest ubiquitous potential for efficient investments in poor-country infrastructure. Again, the 39 Quadrant I observations are distributed across 32 countries, meaning that 21 of the 53 poor countries in the sample did not clear the dual hurdles for either type of infrastructure and were therefore not candidates for additional investments in either roads or electricity. Said another

[8]For more on the challenges of infrastructure in Africa see Ajakaiye and Ncube (2010), Ndulu (2006).

way, 40 percent of the 53 poor countries for which data are available had no returns-based case for more investment in infrastructure relative to other forms of capital. Digging still deeper, of the 32 countries with projects that did clear the dual hurdles, there were only 7—Argentina, Bolivia, Honduras, Indonesia, Kenya, Malawi, and the Philippines—whose return ratios made a case for investment in both roads and electricity.

The reality that less than one in seven countries in the only comprehensive dataset of social rates of return on infrastructure in poor countries presented a data-driven case for investment in both roads and electricity in 1985 raises questions about the wisdom of the World Bank pushing a "billions to trillions" agenda in infrastructure three decades later without first charging its research department to update and validate the infrastructure-returns data required to distinguish those countries that have an economic case for greater infrastructure investment from those that do not.

On the other hand, because the classifications in Table 2 reflect average rather than marginal returns, it is possible that they understate the prevalence of efficient infrastructure projects that arise at the intersection of roads and electricity—particularly in cities—versus for countries as a whole. The nuances of interpretation that arise from the distinctions between rural versus urban infrastructure, roads versus electricity, and so on have important implications—both for poor-country governments trying to decide on economic priorities, and for rich-country savers and asset managers deciding whether to fund investment in those priorities.

3D. Non-Economic Considerations

The discipline of data and the dual-hurdle framework notwithstanding, there are legitimate non-economic reasons for increasing infrastructure investment in poor countries.

Rozenberg and Fay (2019), for instance, push the global infrastructure debate away from a myopic emphasis on more money, predicated on gap-thinking, toward an approach of more efficient spending for a given set of equity-related goals. Specifically, Fay and Rozenberg (2019a) argue that instead of setting general targets for expenditure, countries should establish specific infrastructure objectives—some of which may be non-economic—and drive the most cost-effective means of achieving them. Building on that premise, the authors use extensive scenario analyses to demonstrate that there are feasible investment paths along which low- and middle-income countries (LMICs) can: (1) meet the infrastructure-related Sustainable Development Goals with investments of 4.5 percent of GDP while staying on track to limit climate change to 2°C; (2) accomplish (1) at a cost no greater than more-polluting alternatives; and (3) reduce by more than 50 percent the total life-cycle cost of these investments by making maintenance of infrastructure as high a priority as capital expenditure.

Useful as it is to produce cost-efficient options for a given set of equity-driven infrastructure objectives, it is also critical to know how the investments required to achieve those objectives compare to the investments that could be made if, instead, the goal was to maximize productive efficiency in LMICs. While there are legitimate reasons for setting some infrastructure objectives that are geared toward equity rather than efficiency—and there is certainly a role for judgment and practical experience in sketching an aspirational, carbon-neutral vision of countries' infrastructure—it is also instructive to let the data on social rates of return speak. To the extent that the Fay-Rozenberg objectives-based approach to guiding the allocation of equitably minded infrastructure is broadly consistent with considerations of productive efficiency, we should see, on average, the largest prospective social returns on infrastructure in precisely those sectors identified as "high priority."

While returns on infrastructure need not always prove dispositive, a pattern of prospective returns in high-priority sectors that are consistently lower than prospective returns elsewhere should raise yellow flags about the economic sustainability of the overarching objectives.[9]

4. Paucity of Prevalence and the Lucas Conjecture

Returning to strictly economic considerations, it is reasonable to ask whether the underwhelming presence of efficient poor-country investment opportunities, particularly in electricity, is not simply an infrastructure-specific manifestation of the conjecture that after adjusting for differences in the productivity of human capital, the implied return on physical capital in poor countries is not significantly higher than it is in rich ones (Lucas 1990). To examine the extent to which the Lucas Conjecture can explain the underwhelming presence of Quadrant I observations in Table 2, define $\rho_{X^{*}+K^{*}}^{X+K}$as the ratio of the poor-country's social rate return on all capital (not just infrastructure) to the rich-country's social rate of return on all capital. If the modest occurrence of Quadrant I infrastructure opportunities documented in Table 2 is merely a variation on the Lucas Conjecture, then the values of $\rho_{X^{*}+K^{*}}^{X+K}$, which are based on the Canning and Bennathan (2000) estimated elasticities that control for cross-country differences in human capital, should not differ systematically from 1.

Table 4 (Panel A) demonstrates that this is not the case. The average (median) value of $\rho_{X^{*}+K^{*}}^{X+K}$ for the 53 poor countries in the Canning and Bennathan dataset is 1.4 (1.3). By region, the average (median) values of $\rho_{X^{*}+K^{*}}^{X+K}$ are:1.4 (1.3) for Latin America and the Caribbean; 1.9 (1.8) for Asia; and 0.9 (0.76) for Africa, the only region where the average (median) value of

[9]Again, as discussed in Section 3B, low average returns need not mean there are no good projects.

$\rho^{X+K}_{X^*+K^*}$ is less than 1.

Moving from regions to individual nations reinforces the consistency of the observation. Thirty-five, or roughly two-thirds, of the 53 poor countries have a value of $\rho^{X+K}_{X^*+K^*}$ that is greater than 1. With the exceptions of Algeria, Argentina, which was in the midst of hyperinflation, and Jamaica, which was recovering from a decade-long economic collapse, all of the poor countries for which $\rho^{X+K}_{X^*+K^*}$ is less than 1—Bolivia, Central African Republic, Congo, Fiji, Gambia, Ghana, Mali, Liberia, Mozambique, Nicaragua, Niger, Papua New Guinea, Uganda, and Zambia—were classified as low-income nations by the World Bank in 1985. Indeed, the Lucas Conjecture seems only to apply to the poorest of the poor. Of the 38 poor countries that were not classified as "low income," 35 have a value of $\rho^{X+K}_{X^*+K^*}$greater than 1. The average (median) value of $\rho^{X+K}_{X^*+K^*}$ for low-income (i.e., extremely poor) African countries is 0.79 (0.80), while the average (median) value of $\rho^{X+K}_{X^*+K^*}$ for the other poor countries is 1.61 (1.53).

The facts in Panel A are not peculiar to the Canning and Bennathan (2000) dataset from which they are drawn. Panels B and C of Table 4 present additional sets of calculations of $\rho^{X+K}_{X^*+K^*}$. Using data on 68 rich and poor countries from Monge-Naranjo, Sanchez, and Santaeulalia-Llopis (2016), Lowe, Papageorgiou, and Perez-Sebastian (2018) compute rates of return on all capital in 1996 and 2005. Because the countries covered by the Lowe *et al.* calculations differ to some extent from those listed in Canning and Bennathan (2000), Panel B and Panel C present figures on returns for only those countries that are covered in both papers. For the rich countries, every country that appears in Panel A also appears in Panel B (1996 returns) and Panel C (2005 returns). For the poor countries, Panels B and C contain 30 of the 53 countries in Panel A. As for the figures themselves, the values of $\rho^{X+K}_{X^*+K^*}$ reported in Panel B are similar to those in Panel A. For all capital, $\rho^{X+K}_{X^*+K^*}$ in Panel B is 1.3 in 1996, and 1.1 in 2005

(Panel C). Furthermore, 23 of the 30 poor countries in Panel B have a value of $\rho_{X^*+K^*}^{X+K}$ that is greater than 1. Nineteen of 30 countries in Panel C have a value of $\rho_{X^*+K^*}^{X+K}$ greater than 1.

In addition to the Lucas Conjecture's inability to account for the absence of widespread infrastructure opportunities in poor countries, the Conjecture is also at odds with a significant number of the efficient infrastructure opportunities that did, in fact, exist. For instance, of the 32 unique countries identified as having had Quadrant I opportunities for investment in either paved roads or electricity, 11 of them—Algeria, Argentina, Bolivia, Central African Republic, Congo, Fiji, Gambia, Liberia, Mali, Uganda, and Zambia—had a social return on all capital that was less than the social return on all capital in rich countries. Furthermore, of the 7 countries that sorted into Quadrant I for both roads and electricity, 2—Argentina and Bolivia—had a social return on all capital below that of the rich-country average. There were, in other words, poor countries to whose private sectors rich-country private capital had little incentive to flow that nonetheless had the potential to be efficient destinations for Private-Rich investment in infrastructure.

The counterintuitive observation that infrastructure investment can, in principle, be productively deployed in countries with badly functioning private sectors is readily explained by the dual-hurdle framework. The binding constraint for market-driven flows of capital from Private-Rich to Public-Poor is *r*-Private-Rich. Therefore, a poor country whose social return on all capital is less than the social return on all capital in rich countries—and thereby satisfies the Lucas Conjecture—can nonetheless have infrastructure opportunities that are an efficient destination for rich-country savings if: (a) *r*-Public-Poor exceeds *r*-Private-Rich and (b) r-Public-Poor exceeds *r*-Private-Poor. As demonstrated by the data in the previous paragraph, this kind of outcome is not a theoretical curiosum, but a practical reality that highlights the empirical relevance of future research on the distinction between private and public capital.

5. Plausibility, Foundations, and Limitations

The dual-hurdle framework brings the clarity of equilibrium to the global infrastructure debate, but it also has limitations that are readily apparent from the literature. First and foremost, the economy-wide estimates of the elasticity of GDP with respect to infrastructure (and other factors of production), on which calculations of social rates of return on infrastructure depend, are rightly subject to skepticism because of data constraints, endogeneity, and other potential concerns. A consensus has emerged that: (a) the econometric challenges of macroeconomic data are manageable with careful attention to regression techniques and thoughtful interpretation of the estimated parameters; and (b) infrastructure does, in fact, have a causal impact on growth (Estache and Fay 2007; Calderón and Servén 2010). Nevertheless, the calculations that determine the value of $\rho^X_{K^*}$—the ratio of *r*-Public-Poor to *r*-Private-Rich—depend on the sensitivity of estimates of the infrastructure elasticity of output in poor countries, as well as on the availability of data. Deeper scrutiny of the fundamentals that determine whether $\rho^X_{K^*}$ is greater or less than 1 can, therefore, provide information about the precision of $\rho^X_{K^*}$ as a signal of the efficiency of rich-country financing of poor-country infrastructure.

Accordingly, because the numerator of $\rho^X_{K^*}$, *r*-Public-Poor, and the denominator, *r*-Private-Rich, are functions of the marginal product of infrastructure and the marginal product of capital, for a given poor country, it is useful, as in Canning (1999) to write:

$$Y = AK^{\alpha}H^{\beta}X^{\gamma}L^{1-\alpha-\beta-\gamma} \quad (1).$$

A is total factor productivity; K is the stock of private capital; H is the stock of human capital; X is the stock of infrastructure capital; and L is the stock of labor. The rich country production function is given by the parallel expression for Y^*. Reformulating (1) in intensive form, $y =$

$k^{\alpha}h^{\beta}x^{\gamma}$, so that output, capital, human capital, and infrastructure are all expressed in per capita terms, it follows that the marginal product of infrastructure in the poor country is $mpx = \gamma \frac{y}{x}$, and its return to infrastructure is $r_x = \frac{mpx}{P_x}$, where P_x is the unit price of infrastructure in the poor country. Similarly, let $mpk^* = \alpha^* \frac{y^*}{k^*}$ denote the marginal product of private capital in the rich country, so that the rich-country return on private capital is $r_{k^*} = \frac{mpk^*}{P_{k^*}}$, where P_{k^*} is the unit price of private capital in the rich country. Using the definitions of r_x, r_{k^*}, and performing a little algebra, yields the following equation:

$$\rho_{K^*}^{X} = \frac{r_x}{r_{k^*}} = \frac{k^*}{y^*} \cdot \frac{y}{x} \cdot \frac{P_{k^*}}{P_x} \cdot \frac{\gamma}{\alpha^*} \qquad (2).$$

Moving in order from left to right, consider each of the four ratios on the right-hand side of (2).

The first, $\frac{k^*}{y^*}$, is the rich-country ratio of capital to output. Using the U.S. as a rich-country proxy gives a value of about 2.9 (Jones 2002).

For the second, $\frac{y}{x}$, the poor-country ratio of output to infrastructure, we make a reasonable, if admittedly rough, inference by observing that $\frac{y}{x} = \frac{y}{y^*} \cdot \frac{y^*}{x^*} \cdot \frac{x^*}{x}$. For $\frac{y}{y^*}$, the ratio of poor-country GDP per capita to developed-country GDP per capita is roughly 1/5 (Maddison 2003, p. 234). Taking the U.S. as a proxy for $\frac{y^*}{x^*}$ (the rich-country ratio of GDP to infrastructure), the ratio of GDP to nondefense infrastructure is roughly 4/3 (Fair 2019, Figure 4). Finally, for $\frac{x^*}{x}$, the stock of infrastructure per capita in rich countries is between 8 and 20 times that of poor countries (Dethier and Moore 2012, Table 1). Taken together, the three sets of numbers in this paragraph give low- and high-end figures for $\frac{y}{x}$ of 2.13 and 5.33.

The third ratio on the right-hand side of (2) is the price of private capital in rich countries divided by the price of infrastructure capital in poor countries. We can make an educated guess about the average value of $\frac{P_{k^*}}{P_x}$ by noting that $\frac{P_{k^*}}{P_x} = \frac{P_{k^*}}{P_k} \cdot \frac{P_k}{P_x}$. Because the price of capital goods in poor countries is two to three times higher than in rich ones (Hsieh and Klenow 2007, p. 563), we know that $\frac{P_{k^*}}{P_k}$ ranges from 1/2 to 1/3. For $\frac{P_k}{P_x}$, the price of producer durables in poor countries is 1.34 times the price of construction (Lee 1995, Table 1, Column 3). From these two facts, a reasonable estimate of $\frac{P_{k^*}}{P_x}$ is a number between 0.447 (1/3 times 1.34) and 0.67 (1/2 times 1.34).

The fourth and final ratio on the right-hand side of (2) is the elasticity of output with respect to infrastructure in the poor country, γ, divided by the elasticity of output with respect to capital in the rich country, α^*. Historically, the data suggest that α^*= 1/3. Arriving at a consensus for γ requires a quick synthesis of the literature.

Using a panel of 88 countries and an index of infrastructure, Calderón, Moral-Benito, and Servén (2011) estimate an infrastructure elasticity of output that is between 0.07 and 0.1. They do not find that the elasticity varies systematically with population, GDP per capita, or endowment of infrastructure per capita. Candelon, Colletaz, and Hurlin (2013), employing panel data from Canning (1998), also find that the elasticity of output with respect to infrastructure is not significantly related to the level of GDP per capita. The invariance of γ with respect to country income levels is somewhat surprising, because most infrastructure is provided through networks, which are characterized by economies of scale and threshold effects, which would suggest that the infrastructure elasticity of output varies in a non-linear way with the development of the infrastructure network (for which population, GDP per capita, and infrastructure per capita serve as proxies).

Network effects imply that when the stock of infrastructure is extremely low, the marginal product of infrastructure will be the same as for private capital. After reaching a certain threshold, where the network is functional but not complete, the marginal product of infrastructure will exceed the marginal product of private capital. Once the network is complete, the marginal product of infrastructure will be no higher (and perhaps lower) than the marginal product of private capital. Roads are a classic example of a network, and accordingly, Fernald (1999) demonstrates that although the building of the interstate highway system in the U.S. during the 1950s and 60s generated abnormally large productivity gains, the data cannot reject the hypothesis that investment in US roads today offers a normal (or even zero) rate of return. Candelon, Colletaz, and Hurlin (2013) find strong evidence of Fernald-like non-linearities in the marginal product of infrastructure as a function of the state of completion of electricity and road networks.

Although there is little evidence that countries' infrastructure elasticities of output vary systematically with GDP per capita, the data do indicate that countries' elasticities of output with respect to electricity and roads taken separately depend on the state of completion of each of those networks, as well as the country's per capita endowment of non-infrastructure productive inputs. All in all, and including the Bom and Lighthart (2008) meta-study which finds an elasticity of 0.087, the literature points to a value of γ that ranges from 0.07 to 0.1. This suggests that $\frac{\gamma}{\alpha^*}$ ranges from 0.21 to 0.3.

Taking the product of the complete set of permutations of all four ratios on the right-hand side of (2) yields a minimum value of $\rho_{K^*}^{X}$ of 0.58, and a maximum value of 3.1. These two numbers—crude bounds (in the spirit of the concluding sentence of Banerjee, Duflo, and Qian 2020) on what theory and the relevant literature tell us should be a workable poor-country average for $\rho_{K^*}^{X}$—are not wildly out of line with the numbers in Table 2, where the mean (median) value of $\rho_{K^*}^X$ is 6.5 (2.9) for the 26 paved-road observations, and 1.3 (1.1) for the 49 observations of electricity.[10] As the upper and lower bounds on $\rho_{K^*}^X$ differ by a factor of 5.4 (3.1 divided by 0.58), they demonstrate that although it may be plausible for some poor countries to be efficient destinations for rich-country financing of investment in infrastructure: (a) it is not a foregone conclusion that all poor countries will clear the foreign threshold of the dual-hurdle test; and (b) $\rho_{K^*}^X$ is likely to vary widely, according to which end of the range countries fall for certain parameters.

The variation in these back-of-the-envelope calculations serves as an important reminder, per Hall and Jones (1999), that relative to rich countries, poor ones vary widely in the extent to which they possess the private capital, human capital, institutions, technology, and policies that drive growth. This means that the optimal mix of sectoral investments will also vary widely from country to country. To that point, the next subsection describes the data challenges involved in producing and interpreting country-specific estimates of $\rho_{K^*}^X$.

5A. Country-Specific Infrastructure Returns and Data Limitations

As part of their process for producing country-specific calculations for infrastructure returns, Canning and Bennathan (2000) explore how countries' infrastructure elasticities of output vary with levels of physical, human, and infrastructure capital per worker. Specifically, the authors calculate elasticities (γ) for three imaginary countries: (1) a moderately poor country with each of the three factor inputs at the lower quartile for the 53-country sample; (2) an average country with each input at the median; and (3) a moderately rich country with each input at the top quartile. For electricity, the elasticity is 0.06 at the lowest quartile, 0.09 at the median

[10] The numbers for roads exclude Korea. With Korea, the mean (median) is 8.5 (3.4).

quartile, and 0.07 at the top. For roads, the elasticity is 0.05 at the lowest quartile, 0.09 at the median, and 0.04 at the top. From these estimates, the authors conclude that roads and electricity exhibit rapidly diminishing returns when taken in isolation but are complementary to physical and human capital. Given that infrastructure spending on schools is likely to increase the stock of human capital, which then raises the social return on roads and electricity, as well as that on private capital, this finding further cautions against monolithic pushes for more roads or electricity in isolation and redoubles the need for prioritization discussed in Section 3B.

On its own, infrastructure investment does not generate large changes in output, but it can be very productive in economies with sufficiently high levels of physical and human capital, as infrastructure investment raises the efficiency of both (Isham and Kaufmann 1999; Shamdasani 2021). Said another way, the data are more consistent with an interpretation that a shortage of infrastructure constrains growth than one in which investment in infrastructure drives it.

Traffic congestion in the city of Bangkok provides a powerful example of infrastructure-constrained growth. In the absence of an arterial grid of intra-city roads, the average one-way commute time to work in Bangkok is 90 minutes, second worst in the world (Angel 2000) and 1.5 times the amount Bertaud (2018) identifies as the maximum average commute time a city can have and remain maximally productive. Beyond Thailand, the Asian Development Bank estimates that Asian economies lose 2-5 percent of GDP every year due to road congestion, the attendant lost time, and higher transportation costs.[11] Similarly, the lack of infrastructure in Sub-Saharan Africa is a significant bottleneck to regional integration on the continent (Mbekani 2010).

While the social rates of return on infrastructure to which we applied the dual-hurdle

[11] See *Asian Development Bank Key Priorities*: https://www.adb.org/sectors/transport/key-priorities/urban-transport

framework are based on country-specific estimates of γ that account for differences in human capital, physical capital, and other factors, the age of the data used in the computation of $\frac{mpx}{P_x}$ imposes limits on how to interpret the results at present. For instance, the numerator, mpx, equals $\gamma \frac{y}{x}$, and the time-series data used to estimate γ for each country in the sample ends in 1990. Because the growth rates of poor countries accelerated in the mid-1990s as they implemented productivity-enhancing reforms (Chari, Henry, and Reyes 2021; Chari and Henry 2014, Patel, Subramanian, and Sandefur 2021), it is tempting to conclude that mpx rose also, suggesting that the number of countries that contain productive infrastructure opportunities today is significantly greater than the number the dual-hurdle framework identified using the returns from Canning and Bennathan (2000). Even if we stipulate that the growth of infrastructure in poor countries has not kept pace with their growth of output, such a conclusion would be valid only if γ has been constant (or risen) within countries. It is not possible to know if this is the case without updating the underlying data and using it to estimate current country-specific values of γ.

Turning to the denominator of $\frac{mpx}{P_x}$ reveals similar age limitations with respect to data on the costs of building roads and installing electricity generating capacity discussed in Section 3B. Holding mpx constant, to the extent that the costs of constructing paved roads and installing electricity generating capacity has fallen by more in developed countries than in developing ones over the past 35 years, $\rho_{K^*}^{X}$ will have decreased. The opposite is true if relative costs have moved in the other direction.

Resolving these and other unanswered questions about infrastructure requires current data (Estache and Fay 2007), and Chapter 4 of Rozenberg and Fay (2019), for example, suggests that the World Bank has compiled numbers, as recently as 2017, on the cost of road construction in poor countries. Compilation, however, is not sufficient. The World Bank commissioned the Canning and Bennathan study in 2000 and then spearheaded the "billions to trillions" agenda in 2015 without producing updated estimates of social rates of return. Given these two facts, the Bank's leadership has a responsibility to charge its research department with the mission of using all available data—and collecting more if necessary—to keep the cross-country estimates of social rates of return on infrastructure current, have them independently validated, and make them publicly available. Doing so would provide a timely and common repository of trusted cross-country infrastructure returns that governments and suppliers of capital could use to systematically and independently make informed investment decisions. In the meantime, there are at least two benefits of using the existing data.

First, despite the volume of discussion about poor countries' infrastructure gaps, Canning and Bennathan's 1985-based estimates represent the frontier of empirical knowledge on social rates of return on infrastructure in a wide range of poor countries. Bougheas, Demetriades, and Mamuneas (2000) and Esfahani and Ramirez (2003) implicitly consider the importance of returns by using panel data regressions to estimate the elasticity of GDP with respect to various measures of infrastructure, but they do not explicitly compute the returns on infrastructure implied by their estimated elasticities. More recent papers such as Bivens (2017) document a litany of studies on the return on infrastructure in rich countries, but Canning and Bennathan (2000) provide the only explicit and comprehensive estimates of the economy-wide social rate of return on infrastructure in poor ones.

A recent quasi-exception is Lowe, Papageorgiou, and Perez-Sebastian (2018), who employ data on public capital as a proxy for infrastructure and use it to calculate rates of return in developing countries. In the absence of other data, public capital provides a useful proxy for gauging the flow of infrastructure investment, but there are limitations to its utility for capturing returns, because public capital includes all public structures, not just infrastructure. To the extent that governments install public capital that does not fit the economic definition of infrastructure, figures on the stock of public capital will overstate the true stock of infrastructure and therefore understate its prospective rate of return (Estache and Garsous 2012). Therefore, while the data on total stock of infrastructure and IMF data on public capital are highly correlated (Suárez-Alemána, Serebrisky, and Perelman 2018), it is wise to keep in mind the shortcomings of using public capital as a proxy for infrastructure (Fay, Lee, Mastruzzi, Han, and Cho 2019).

As a complement to panel data approaches, a number of individual country studies that document significant effects of infrastructure on various measures of output provide relevant, if indirect, evidence on the social rate of return on infrastructure in poor countries. The introduction of the railroad in colonial India, for example, raised output levels by 16 percent (Donaldson 2018). Data from the modern era in India indicate an important effect of power-related infrastructure on the efficiency of Indian manufacturing (Allcott, Collard-Wexler, and O'Connell 2016; Rud 2012; Aberbese 2017). At a more micro level, World Bank project evaluations suggest that the economic return on individual infrastructure projects has tended to exceed the cost of capital (Estache and Fay 2007; Shafik 2005; Briceño, Estache, and Shafik 2004; Estache and Liu 2004; Herrera 2005). Although micro project evaluations provide helpful reality checks against which to benchmark aggregate estimates of social rates of return, aggregate estimates are also important because the economic rate of return on individual projects can miss significant country-wide externalities (Canning and Bennathan 2000; Estache and Fay 2007).

The second benefit of using existing estimates of the social rate of return on infrastructure is that history matters. Understanding the optimality of investments in infrastructure today requires information about the extent to which past infrastructure investments were guided by their prospective rates of return, as well as information about the extent to which investments so made actually delivered the expected results. An examination of the 1985 data on prospective social rates of return can provide important clues to that effect.

India, for example, had no Quadrant-I opportunities for roads or electricity in 1985. Consistent with the attendant diagnosis that a shortage of infrastructure was not a bottleneck to development at that time, the well-documented acceleration in GDP growth that commenced in India *circa* 1992 was not triggered by an accelerated accumulation of public capital. The country's real average annual growth rate of public capital was 6.8 percent per year from 1980–85 and then slowed consistently in each of the three subsequent five-year increments: 5.7 percent from 1986–91; 4.1 percent from 1992–97; and 3.3 percent from 1998–2003.

Keeping in mind that social rates of return on infrastructure in India and other poor countries may be quite different today than they were in 1985, the next section explains why it matters if the return differentials still persist, and discusses what, if anything, can be done to capitalize on the unrealized opportunities for efficiency gains that they embody.

6. Frozen Capital

To the extent that the social rates of return on infrastructure in certain poor countries today remain substantially higher than the social rate of return on private capital in rich countries, the world would be better off if rich-country private savings flowed to finance public capital formation in poor destinations—particularly green capital that would avoid further commitment to carbon-intensive technologies (Obstfeld 2021; Fay and Rozenberg 2019; Foster and Rana 2020; Stern 2015). Indeed, given more than a decade of low real interest rates due to slowing productivity growth and birthrates in rich countries (Council of Economic Advisors 2015), a shortage of rich-country safe assets (Caballero, Farhi, and Gourinchas 2008), and the global savings glut (Bernanke 2005), a significant reallocation of savings from rich countries to the financing of efficient infrastructure investments in poor ones could raise both poor-country growth and the rate of return on rich-country savings (Summerhill 2003, pg. 100-102).

Why do these investments not happen naturally? Instead, for all intents and purposes, the pipeline from the pool of savings in rich countries to infrastructure projects in poor countries remains frozen. For a start, when deciding where to put their money, rich country investors care about private rates of return, not social ones. Even if rich-country investors have the requisite information to know that the social rates of return on specific poor-country infrastructure projects are greater than the private rate of return on rich-country private capital, if those investors' private rates of return on poor-country infrastructure are less than the social rates of return, they may not want to invest.

In theory, there are many reasons why rich country investors' private returns on poor-country infrastructure may be less than their social returns. In the context of infrastructure, one of the most practical consideration may be the presence of strategic complementarities. Strategic complementarities to investment are prevalent among the various subsectors of infrastructure, such as roads, ports, and power. Bad roads inhibit the overland transport of goods from producers to consumers, and substandard ports effectively isolate domestic producers from foreign markets. Therefore, whatever the estimated social rate of return on investment in electricity generating capacity may be, for example, a foreigner considering whether to make a financial commitment to the project will do so only if they know that others will make similar investments in roads and ports. The positive externalities harnessed through effective coordination of strategic complementarities—good roads, ports, and power enable and incentivize firms and households to engage in production and consumption, as well as the accumulation of knowledge and private capital—are some of the reasons that China has experienced positive domestic growth benefits of local infrastructure projects such as its high-speed rail system, but there is a fine line between productive coordination and wasteful government intervention (Bataineh, Bennon, and Fukuyama 2019).

Moving beyond the challenge posed by strategic complementarities, there are a variety of risks associated with investing in poor-country infrastructure that may cause private savings to remain frozen in rich countries. Many of these risks fall under one of two broad categories: asymmetric information or moral hazard/agency problems. Asymmetric information can inhibit foreign investment in two ways. First, potential foreign investors in infrastructure, who have limited knowledge of a given poor country, may worry about adverse selection or the "lemons" problem, wherein only countries with the lowest prospective returns on infrastructure offer foreigners the opportunity to invest. The lemons problem can also take the form of poor countries with high future social returns on infrastructure in the aggregate, allowing foreigners to bid only on those individual projects that local government officials know to be less than stellar.

Second, even if all poor countries seeking infrastructure financing from abroad offer foreigners the opportunity to invest in promising projects, foreign investors may not have the information they need to assess the public sector's capacity to govern to make private finance feasible over the long term. Public sector actions that make private finance possible, such as allowing private suppliers to set a price high enough to sustain quality provision of the infrastructure service, can also reduce the ability of potential users in poor countries to pay for the service. Resolving the tension between feasibility and inclusivity requires local officials to have a set of leadership skills that are scarce and may not be readily observable by foreign investors. As a tangible example, consider the case of Aguas del Illimani, a consortium owned by the French water and sanitation company, Suez, and a group of minority shareholders, including the International Finance Corporation. Aguas del Illimani bought the water and sewage system of the city of El Alto, Bolivia, during a July 1997 privatization sale, but Bolivian authorities terminated the consortium's contract in 2007 due to community protests that Aguas del Illimani was overcharging poor residents and failing to expand the provision of service.

Whereas asymmetric information about the quality of projects or the public sector's leadership capacity creates doubt about the ability of a country to pay for the value of infrastructure services, moral hazard creates doubt about the government's "willingness" to pay.[12] For governments with skilled leaders who initiate good projects with high social rates of return, their ability to attract private foreign financing nonetheless requires a sustained willingness to service the capital borrowed to undertake the project, which cannot be taken for granted given competing political priorities (Bulow and Rogoff 1989a,b; Stulz 2005; Gulati, Panizza, Weidemaier, and Willingham 2020).

Elections, for example, may present (to the party in power) short-run political benefits of nonpayment that outweigh the costs, reputational or other—especially if those costs will not be borne until far into the future. And even if the party currently in power is willing to pay, the regime that succeeds it may not feel obligated to honor previous commitments. Either scenario would represent an abrogation of contracts. Faced with political uncertainties about long-run

[12] Per the Aguas del Illimani example, in the case of infrastructure projects built and owned by a foreign investor (or consortium of investors), willingness to pay can be interpreted as the extent to which the government honors the terms of the underlying operating agreement, such as the pricing arrangement for infrastructure services.

contract enforcement (as in Bulow 20002; Reinhart, Rogoff, and Savastano 2003)—also known as sovereign risk—foreigners will under-invest relative to the social optimum.

Sovereign risk is just one example of the moral hazard risks that foreigners face when considering investments in countries with "deficiencies in the institutional environment regarding the rule of law, property rights, and enforceability of contracts […] that render the appropriability of the returns that private investment generates highly uncertain" (Montiel 2006). Measuring institutional quality as a composite political safety index—with components consisting of government stability, internal conflict, external conflict, non-corruption, militarized politics, religious tensions, law and order, ethnic tensions, democratic accountability, and bureaucratic quality—Alfaro, Kalemli-Ozcan, and Volosovych (2008) find that institutional quality is an important determinant of capital flows.[13] Furthermore, economic policies that produce high inflation, currency devaluations, and macroeconomic instability are: (a) themselves a type of moral hazard; (b) as bad for economic growth as poor institutions (Growth Report 2008; Henry and Miller 2009); and (c) therefore as much of a deterrent to foreign capital flows as poor institutional quality.

Although developing countries have lower average institutional and policy quality than developed countries, we also know that they experienced a significant increase in the flow of private foreign capital to their private sectors in the late 1980s and early 1990s (World Bank 1997; Stulz 1999).[14] It is therefore natural to ask: was the structural change of capital account liberalization that unleashed a surge of capital from Private-Rich to Private-Poor sufficient to

[13]Institutional quality is particularly vexing to measure when trying to account for the influence of foreign and supranational institutions (Davis 2014, 2018).
[14]In addition to liberalization, there was an increase in the number of investment treaties in the late 20th century (Elkins, Guzman, and Simmons 2006). It is not clear whether these treaties boosted investment in poor countries by reducing adverse selection and moral hazard problems (Bonnitcha, Poulsen, and Waibel 2017; Sykes 2019).

trigger an analogously transformational flow of capital from Private-Rich to Public-Poor, or were there additional impediments to infrastructure-specific capital inflows that prevented such a change from occurring? While the question remains unresolved, a comprehensive study by Foster and Rana (2020) documents that the private sector has accounted for slightly greater than 40 percent of new power generation in poor countries since 1990, and its share in renewable power generation is almost twice as high—between 70 and 80 percent.

Looking beyond the power sector to private investment in infrastructure more broadly, Engel, Galetovic, and Fischer (2020) use data on public, private partnerships (PPPs) from the Public Private Infrastructure Advisory Facility (PPIAF) to document that private investment in poor-country infrastructure increased from 1990 through 1997. We are unaware, however, of any systematic attempt to assess the economic or statistical significance of this increase in private infrastructure investment relative to its behavior before the onset of capital account liberalization. An obstacle to such inquiry is that the PPIAF data only go back to 1990. It is unclear how to overcome this absence of historical information, but the issue's importance merits further investigation.

Whatever the pre-1990 data may show, a carefully constructed new dataset by Fay, Lee, Mastruzzi, Han, and Cho (2019) indicates that the private sector accounts for only 9 to 13 percent of total infrastructure investment in low- and middle-income developing countries. We can infer that this modest fraction is smaller than it is for rich countries because Engel, Galetovic, and Fischer (2020) calculate that for the world as a whole, private investment makes up roughly 33 percent of total infrastructure investment, with PPPs accounting for roughly 3 percent of total world infrastructure spending and 8 percent of private infrastructure spending.

Modest as it is, the total value of PPPs in poor countries remains below its pre-Global

Financial Crisis level, and a potential explanation for this fact may lie in the market for project finance. Beck (2018) points out that project finance lending to emerging economies did not recover following the Global Financial Crisis the way it did for advanced economies. He asks whether anticipation of implementation in 2019 of the Basel III regulations—particularly increased capital requirements for project finance lending and liquidity requirements under the Net Stable Funding Ratio and the Liquidity Coverage Ratio—may have made banks more reluctant to fund private investment in emerging-market infrastructure.

Similarly, Rojas Suarez (2018) documents that cross-border lending to emerging markets has continued to fall, even as it rebounded in advanced economies after 2013. She shows that as cross-border bank lending has fallen, cross-border issuance of debt securities by EMDEs has increased. The ability of poor countries to issue debt, particularly in local currency terms, is positive. Still, the rising levels of financial distress—even pre-COVID—outlined in the introduction raises the age-old question of why so little external finance to poor countries is state-contingent (Chari, Henry, Reyes 2021; Henry 2007; Obstfeld 1998; Rogoff 1999).

The case of equity shares for the Electricity Generating Authority of Thailand (EGAT) provides a useful example of state-contingent external financing of infrastructure investment in the developing world. As the name suggests, EGAT generates electricity and then sells it to electricity distribution companies. Officially part of the North Bangkok Power Plant Block 1 Infrastructure Fund (EGATIF), which trades on the Stock Exchange of Thailand (SET), EGAT went public through a partial state divestiture in July 2015 that was initially worth $600 billion. EGATIF's three largest shareholders are EGAT (committed to holding 25 percent for at least five years), Thai Life Insurance (11.99 percent), and EGAT Saving and Credit Cooperative (8.34 percent). Foreigners currently hold approximately 3 percent of the Fund, and there is a 49 percent limit on foreign ownership.

One successful data point does not the case for state-contingent financing make, but EGATIF is far from the only publicly traded infrastructure fund in the developing world. The Standard and Poor Emerging Markets Infrastructure Index, for instance, was launched in 2007 to give savers exposure to 30 of the largest publicly traded companies in emerging markets whose core operations are in infrastructure. However, more than 40 percent of the index is weighted to China, and it contains no African companies. Additionally, the world remains a long way from having publicly tradable financial claims on the incremental additions to GDP generated by building another kilometer of roads or installing another kilowatt of electricity generating capacity in poor countries.

At a minimum, for the creation of such claims to occur, the social return on infrastructure in poor countries must exceed the private return on rich-country private capital by a margin large enough to: (a) absorb the administrative and institutional fixed costs of creating the claims, and (b) compensate private-rich savers for the various risks of holding them, even while leaving sufficient surplus to incentivize economically productive arbitrage. The data examined in this paper suggest that there were—and still may be—places with surpluses potentially this large. If it is helpful to take seriously the feasibility of GDP-linked bonds in rich countries (Kamstra and Shiller 2009; Benford, Ostry, and Shiller 2018), then the sheer magnitude of the return differentials at stake in certain poor countries cry out for research on the risk-reward characteristics of their prospective publicly traded contingent claims (Walter 2017).

7. Conclusion

In 2015 the World Bank, together with regional development banks and the International

Monetary Fund, issued a communiqué which claimed that by leveraging multilateral resources, private capital in rich countries could alleviate the shortage of infrastructure in poor countries, achieve the sustainable development goals, and make money. Not to be outdone, in 2016 the McKinsey Global Institute launched its own claim—that of a trillion-dollar global infrastructure investment gap, which in turn has captured the imagination and sustained attention of institutions from JP Morgan Chase to the United States Treasury.[15]

While there is undoubtedly a shortage of infrastructure services in the developing world, the dual-hurdle framework demonstrates the importance of distinguishing between poor countries where the World Bank and MGI's claims are tenable from those where they are not. Furthermore, the dual-hurdle approach reveals the importance of many other infrastructure distinctions—roads versus electricity, urban versus rural, inter-city versus intra-city, and so on—that have significant implications for the setting of efficient and equitable investment priorities, as well as the criticality of the research needed to inform attendant decisions. In short, the dual-hurdle framework provides direction for the data on infrastructure returns required to enable more fruitful future analysis and decision making, as well as a template that can be applied to the very same data as they become available.

The distinctions highlighted in this paper matter, because the working-age population in rich countries is stagnant or falling. This means that the large discrepancies in infrastructure per worker between rich and poor countries is on course to widen in places like Nigeria, whose population ranks seventh globally and will expand between 2.6 and 3 percent per year for the next decade (Lam 2014). All told, between now and 2030, a systemically important subset of

[15] See https://www.jpmorgan.com/solutions/cib/investment-banking/2020-dfi-announcement and https://dialogochino.net/en/infrastructure/37481-what-is-america-crece-the-us-response-to-the-belt-and-road-in-latin-america/

poor countries (e.g., Egypt, Bangladesh, India, Pakistan, and the Philippines) will add 1.7 million new workers per month to their labor force—almost twice the 1.1 million per month that China added during its unprecedented growth episode from 1978 to 2012.

In principle, the reallocation of savings from aging rich countries to the financing of publicly efficient infrastructure investments in poor countries where the working-age population is booming has the potential to boost growth for the poor and private returns for the rich. Without this reallocation, however, the demographic shift underway will portend increased pressure on immigration-averse rich countries to absorb an ever-greater exodus of workers from poor countries that will lack the productive capacity to generate jobs for their local populations. Achieving the positive-sum outcome will require policy, and the research that informs it, to tread a fact-driven path between the Utopian trap of financing and infrastructure gaps on the one hand and, on the other, nihilistic adherence to a view that regards the status quo as Pareto optimal.

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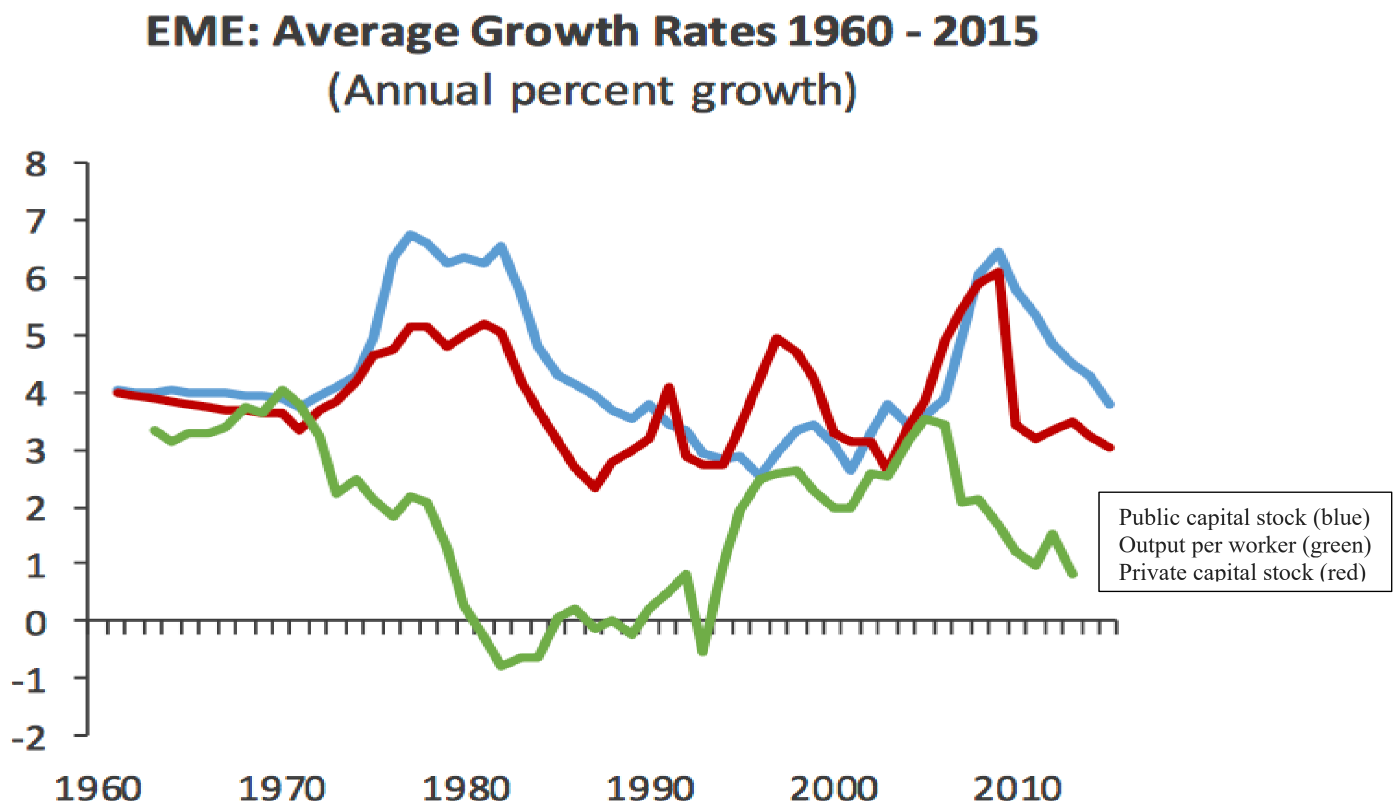
Figure 1. The sharp increase in the growth rate of the public capital stock in emerging-market economies in the 1970s was accompanied by a steep decline in their growth rate of productivity.



Taken from: International Monetary Fund (2017)

Figure 2, Panel A. The traditional approach to cross-country efficiency of investment does not distinguish between private and public capital.

Type of Country

Type of Capital	Poor	Rich
K	r-Poor	r-Rich

Figure 2, Panel B. The infrastructure-augmented approach to cross-country efficiency of investment distinguishes between private and public capital.

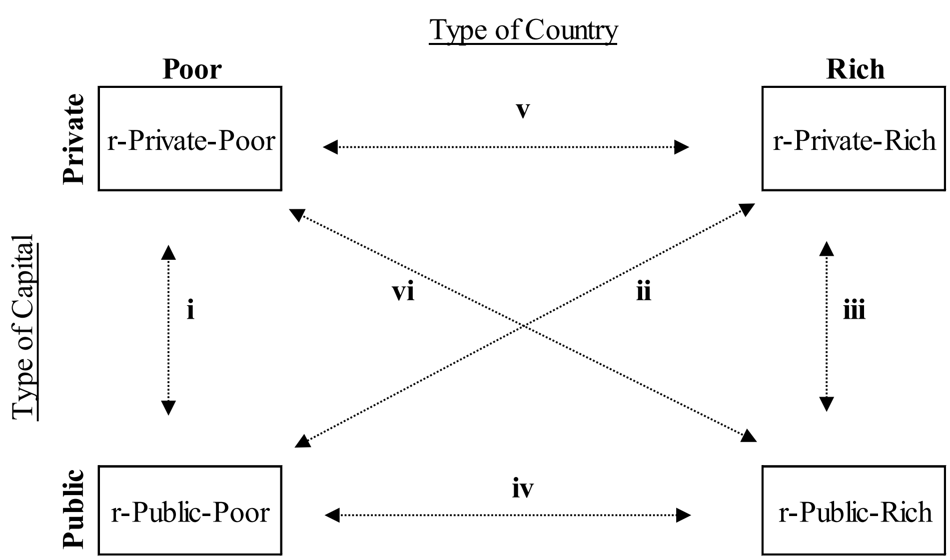


Figure 3. Net inflows of portfolio equity to poor countries soared after they eased restrictions on foreign ownership of domestic stocks in the late 1980s and early 1990s.

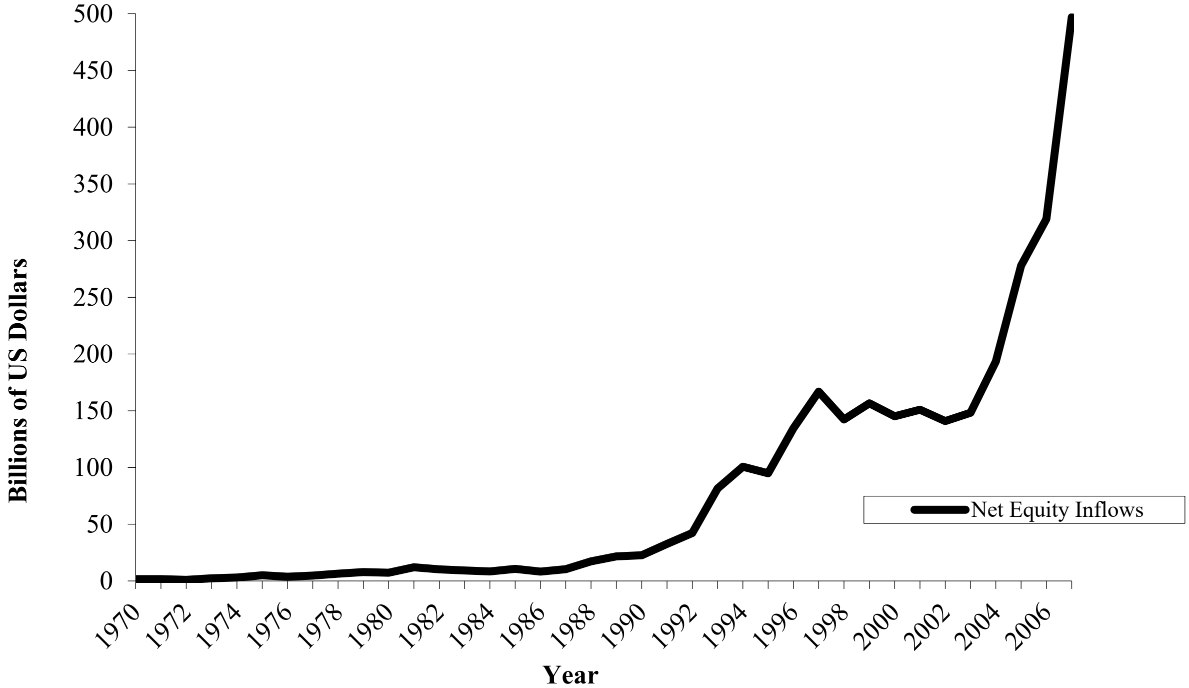


Figure 4. For a given poor country and type of infrastructure, the Dual-Hurdle Framework sorts each country-infrastructure observation into one of four quadrants according to whether it clears the hurdle for efficient: (a) domestic investment, and (b) foreign investment.

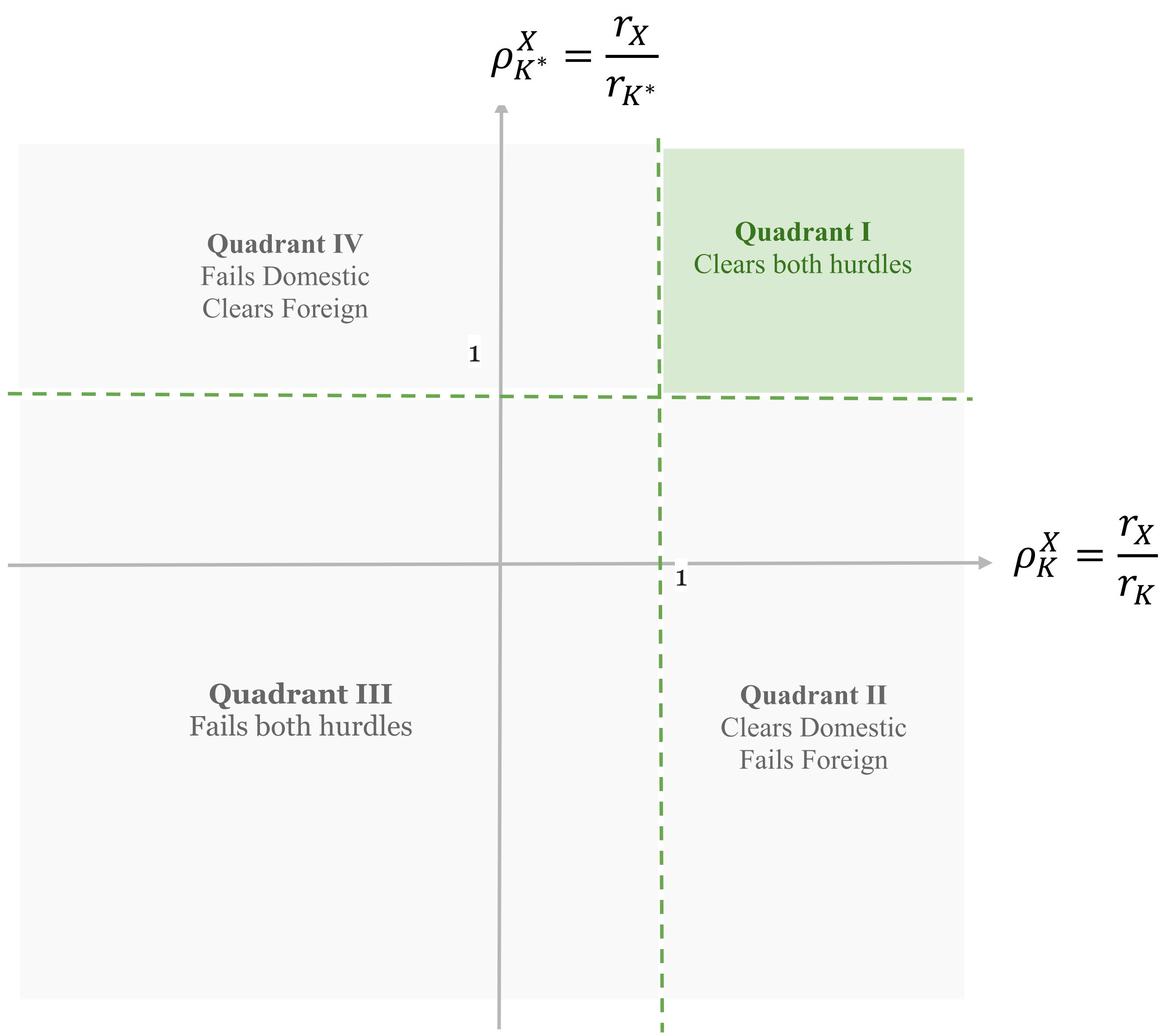


Table 1. Public capital is allocated less efficiently than private capital in both rich and poor countries, but the inefficiency is larger in poor countries.

Rich				LAC				Africa				Asia			
	K	PR	EGC		K	PR	EGC		K	PR	EGC		K	PR	EGC
Australia	30	-1	NA	Argentina	29	385	46	Algeria	15	NA	63	Bangladesh	80	NA	61
Austria	29	0	NA	Bolivia	21	796	92	Botswana	58	20	NA	China	41	NA	54
Belgium	40	6	NA	Brazil	58	61	10	Cameroon	35	188	NA	Fiji	30	NA	32
Denmark	30	12	NA	Chile	73	524	41	C.A.R.	12	NA	40	India	78	74	24
Finland	22	15	NA	Colombia	55	947	28	Congo	25	NA	114	Indonesia	83	203	106
Germany	29	16	NA	Costa Rica	37	196	25	Egypt	50	NA	45	Jordan	42	NA	40
Ireland	36	6	NA	D.R.	61	NA	25	Gambia	23	NA	105	Korea	45	1576	31
Italy	34	26	NA	Ecuador	51	197	45	Ghana	18	NA	25	Malaysia	44	NA	77
Japan	20	62	NA	El Salvador	47	111	17	Kenya	35	53	125	Myanmar	33	NA	34
Netherlands	32	15	NA	Guatemala	38	76	18	Liberia	15	104	NA	Nepal	56	NA	40
N. Zealand	36	8	NA	Honduras	34	39	95	Malawi	40	60	54	Pakistan	117	52	18
Norway	21	2	NA	Jamaica	20	NA	11	Mali	24	NA	51	P. N. Guinea	24	NA	6
Portugal	46	NA	7.0	Mexico	52	NA	51	Mozambique	17	NA	-7	Philippines	40	719	44
Sweden	29	6	NA	Nicaragua	30	NA	20	Niger	13	NA	12	Sri Lanka	86	NA	27
U.K	39	13	NA	Panama	38	218	21	Senegal	45	48	6	Syria	80	NA	35
USA	29	7	NA	Peru	40	NA	21	Tunisia	43	16	40	Thailand	61	NA	42
				Uruguay	51	NA	30	Uganda	2	NA	80	Turkey	78	158	32
								Zambia	24	65	NA				
								Zimbabwe	45	15	5				
Min	20	-1	7		20	39	10		2	15	-7		24	52	6
Max	46	62	7		73	947	95		58	188	125		117	1576	106
Mean	31.4	12.9	7		43.2	323	35.1		28.4	63.2	50.5		59.9	463.7	41.4
Median	30	8	7		40	197	25		24	53	45		56	180.5	35
St. Dev	7.1	15.3	NA		14.5	309	25.1		15.3	54.8	40.8		25.5	597.5	23.3

(i) Table 1 presents the social rates of return from Canning and Bennathan (2000: Table 6 and Table 7) computed for: (a) the aggregate capital stock (their proxy for private capital); and (b) paved roads and electricity generating capacity (public capital). The 69 countries in the table are categorized into two groups--Rich and Poor, subcategorized by geographic location: Latin America and the Caribbean, Africa, and Asia. (ii) In the case where a country with data on both paved roads and electricity generating capacity had competing values of K, the highest K was selected. For a complete list of countries that satisfy this condition, please refer to the read-me file.

Table 2, Panel A. Twenty-one of twenty-six poor countries pass the dual hurdle test of efficiency for paved roads.

Rich Countries				Poor Countries											
				LAC				Africa				Asia			
	ρ_K^X	$\rho_{K^*}^X$	Quad.		ρ_K^X	$\rho_{K^*}^X$	Quad.		ρ_K^X	$\rho_{K^*}^X$	Quad.		ρ_K^X	$\rho_{K^*}^X$	Quad.
Australia	-0.03	-0.03	III	Argentina	13.3	12.3	I	Botswana	0.34	0.64	III	India	0.95	2.4	IV
Austria	0	0	III	Bolivia	37.9	25.4	I	Cameroon	5.4	6	I	Indonesia	2.4	6.5	I
Belgium	0.15	0.19	III	Brazil	1.1	1.9	I	Kenya	1.5	1.7	I	Korea	35	50.2	I
Denmark	0.4	0.38	III	Chile	7.2	16.7	I	Liberia	6.9	3.3	I	Pakistan	0.44	1.7	IV
Finland	0.68	0.48	III	Colombia	17.2	30.2	I	Malawi	1.5	1.9	I	Philippines	18	22.9	I
Germany	0.55	0.51	III	Costa Rica	5.3	6.2	I	Senegal	1.1	1.5	I	Turkey	2	5	I
Ireland	0.17	0.19	III	Ecuador	3.9	6.2	I	Tunisia	0.37	0.51	III				
Italy	0.76	0.83	III	El Salvador	2.4	3.5	I	Zambia	2.7	2.1	I				
Japan	3.1	2	I	Guatemala	2	2.4	I	Zimbabwe	0.33	0.48	III				
Netherlands	0.47	0.48	III	Honduras	1.1	1.2	I								
N. Zealand	0.22	0.25	III	Panama	5.7	6.9	I								
Norway	0.1	0.06	III												
Sweden	0.21	0.19	III												
U.K.	0.33	0.41	III												
U.S.A.	0.24	0.22	III												
Countries	15	15			11	11			9	9			6	6	
Min	-0.03	-0.03			1.1	1.2			0.33	0.48			0.44	1.7	
Max	3.1	2			37.9	30.2			6.9	6			35	50.2	
Mean	0.49	0.41			8.8	10.3			2.2	2			9.8	14.8	
Median	0.24	0.25			5.3	6.3			1.5	1.7			2.2	5.7	
St. Dev	0.76	0.49			10.9	9.8			2.4	1.7			14	19	

Table 2 presents ordered pairs of country-infrastructure-return observations ($\rho_K^X, \rho_{K^*}^X$). For each cluster, the first column lists ρ_K^X; the second column lists $\rho_{K^*}^X$; the third column lists the quadrant into which the country falls given its values of ρ_K^X and $\rho_{K^*}^X$. Table 2 uses the average value of *r*-Private-Rich as the denominator of $\rho_{K^*}^X$. Panel A shows the 26 poor-country-infrastructure-return ordered pairs for paved roads.

Table 2, Panel B. Eighteen of forty-nine countries pass the dual hurdle test of efficiency for electricity generating capacity.

Rich Countries				Poor Countries											
				LAC				Africa				Asia			
	ρ_K^X	$\rho_{K^*}^X$	Quad.		ρ_K^X	$\rho_{K^*}^X$	Quad.		ρ_K^X	$\rho_{K^*}^X$	Quad.		ρ_K^X	$\rho_{K^*}^X$	Quad.
Portugal	0.15	0.22	III	Argentina	1.6	1.5	I	Algeria	4.2	2	I	Bangladesh	0.76	1.9	IV
				Bolivia	4.4	2.9	I	C.A.R.	3.3	1.3	I	China	1.3	1.7	I
				Brazil	0.17	0.32	III	Congo	4.6	3.6	I	Fiji	1.1	1	I
				Chile	0.56	1.3	IV	Egypt	0.9	1.4	IV	India	0.31	0.76	III
				Colombia	0.51	0.89	III	Gambia	4.6	3.3	I	Indonesia	1.3	3.4	I
				Costa Rica	0.68	0.8	III	Ghana	1.4	0.8	II	Jordan	0.95	1.3	IV
				D.R.	0.41	0.8	III	Kenya	3.6	4	I	Korea	0.69	0.99	III
				Ecuador	0.88	1.4	IV	Malawi	1.4	1.7	I	Malaysia	1.8	2.5	I
				El Salvador	0.36	0.54	III	Mali	2.1	1.6	I	Myanmar	1	1.1	I
				Guatemala	0.47	0.57	III	Mozambique	-0.41	-0.22	III	Nepal	0.71	1.3	IV
				Honduras	2.8	3	I	Niger	0.92	0.38	III	Pakistan	0.15	0.57	III
				Jamaica	0.55	0.35	III	Senegal	0.13	0.19	III	P. New Guinea	0.25	0.19	III
				Mexico	0.98	1.6	IV	Tunisia	0.93	1.3	I	Philippines	1.1	1.4	I
				Nicaragua	0.67	0.64	III	Uganda	40	2.5	I	Sri Lanka	0.31	0.86	III
				Panama	0.55	0.67	III	Zimbabwe	0.11	0.16	III	Syria	0.44	1.1	IV
				Peru	0.53	0.67	III					Thailand	0.69	1.3	IV
				Uruguay	0.59	0.96	III					Turkey	0.41	1	IV
Countries	1	1			17	17			15	15			17	17	
Min	0.15	0.22			0.17	0.3			-0.41	-0.22			0.15	0.19	
Max	0.15	0.22			4.4	3			40	4			1.8	3.4	
Mean	0.15	0.22			0.98	1.1			4.5	1.6			0.78	1.3	
Median	0.15	0.22			0.56	0.8			1.4	1.4			0.71	1.1	
St. Dev	0	0			1.1	0.8			10	1.3			0.44	0.74	

Table 2 presents ordered pairs of country-infrastructure-return observations ($\rho_K^X, \rho_{K^*}^X$). For each cluster, the first column lists ρ_K^X; the second column lists $\rho_{K^*}^X$; the third column lists the quadrant into which the country falls given its values of ρ_K^X and $\rho_{K^*}^X$. Table 2 uses the average value of *r*-Private-Rich as the denominator of $\rho_{K^*}^X$. Panel B shows the 49 poor-country-infrastructure-return ordered pairs for electricity generating capacity.

Table 3. For countries with Quadrant-I infrastructure opportunities, the potential for cross-border efficiency gains is much larger in paved roads than in electricity generating capacity.

Panel A – Paved Roads		Panel B- Electricity Generating Capacity	
	$\rho_{K^*}^X$		$\rho_{K^*}^X$
Korea	50.2	Kenya	4
Columbia	30.2	Congo	3.6
Bolivia	25.4	Indonesia	3.4
Philippines	22.9	Gambia	3.3
Chile	16.7	Honduras	3
Argentina	12.3	Bolivia	2.9
Panama	6.9	Uganda	2.5
Indonesia	6.5	Malaysia	2.5
Ecuador	6.2	Algeria	2
Costa Rica	6.2	China	1.7
Cameroon	6	Malawi	1.7
Turkey	5	Mali	1.6
El Salvador	3.5	Argentina	1.5
Liberia	3.3	Philippines	1.4
Guatemala	2.4	C.A.R.	1.3
Zambia	2.1	Tunisia	1.3
Brazil	1.9	Myanmar	1.1
Malawi	1.9	Fiji	1
Kenya	1.7		
Senegal	1.5		
Honduras	1.2		
Mean	10.2	Mean	2.2
Median	6	Median	1.9
St. Dev.	12.5	St. Dev.	0.95

Table 3 (Panel A, paved roads; Panel B, electricity generating capacity) ranks the magnitude of the infrastructure opportunities in descending order of $\rho_{K^*}^X$ for all of the country-infrastructure-return observations that land in Quadrant I.

Table 4, Panel A (1985 Returns). With the exception of Africa, the social rate of return on capital is generally higher in poor countries than in rich ones.

Rich Countries			LAC			Africa			Asia			Poor Countries	
	r_K	$\rho^{X+K}_{X^*+K^*}$		r_K	$\rho^{X+K}_{X^*+K^*}$		r_K	$\rho^{X+K}_{X^*+K^*}$		r_K	$\rho^{X+K}_{X^*+K^*}$	r_K	$\rho^{X+K}_{X^*+K^*}$
Australia	30	0.96	Argentina	29	0.92	Algeria	15	0.48	Bangladesh	80	2.5		
Austria	29	0.92	Bolivia	21	0.67	Botswana	58	1.8	China	41	1.3		
Belgium	40	1.3	Brazil	58	1.8	Cameroon	35	1.1	Fiji	30	0.96		
Denmark	30	0.96	Chile	73	2.3	C.A.R.	12	0.38	India	78	2.5		
Finland	22	0.7	Colombia	55	1.8	Congo	25	0.8	Indonesia	83	2.6		
Germany	29	0.92	Costa Rica	37	1.2	Egypt	50	1.6	Jordan	42	1.3		
Ireland	36	1.1	D.R	61	1.9	Gambia	23	0.73	Korea	45	1.4		
Italy	34	1.1	Ecuador	51	1.6	Ghana	18	0.57	Malaysia	44	1.4		
Japan	20	0.64	El Salvador	47	1.5	Kenya	35	1.1	Myanmar	33	1.1		
Netherlands	32	1	Guatemala	38	1.2	Liberia	15	0.48	Nepal	56	1.8		
N. Zealand	36	1.1	Honduras	34	1.1	Malawi	40	1.3	Pakistan	117	3.7		
Norway	21	0.67	Jamaica	20	0.64	Mali	24	0.76	P. New Guinea	24	0.76		
Portugal	46	1.5	Mexico	52	1.7	Mozambique	17	0.54	Philippines	40	1.3		
Sweden	29	0.92	Nicaragua	30	0.96	Niger	13	0.41	Sri Lanka	86	2.7		
U.K.	39	1.2	Panama	38	1.2	Senegal	45	1.4	Syria	80	2.5		
USA	29	0.92	Peru	40	1.3	Tunisia	43	1.4	Thailand	61	1.9		
			Uruguay	51	1.6	Uganda	2	0.06	Turkey	78	2.5		
						Zambia	24	0.76					
						Zimbabwe	45	1.4					
Min	20	0.64		20	0.64		2	0.06		24	0.76	2	0.06
Max	46	1.5		73	2.3		58	1.8		117	3.7	117	3.8
Mean	31.4	1		43.2	1.4		28.4	0.9		59.9	1.9	43.2	1.4
Median	30	0.96		40	1.3		24	0.76		56	1.8	40	1.3
St. Dev	7.1	0.22		14.5	0.46		15.3	0.49		25.5	0.81	22.7	0.72

Table 4, Panel A computes the rates of return on all capital using Tables 6 and 7 from Canning and Bennathan (2000). "Poor Countries" denote all countries under LAC, Africa, and Asia.

Table 4, Panel B (1996 Returns). With the exception of Africa, the social rate of return on capital is generally higher in poor countries than in rich ones.

Rich Countries			LAC			Africa			Asia			Poor Countries	
	r_K	$\rho_{X^*+K^*}^{X+K}$		r_K	$\rho_{X^*+K^*}^{X+K}$		r_K	$\rho_{X^*+K^*}^{X+K}$		r_K	$\rho_{X^*+K^*}^{X+K}$	r_K	$\rho_{X^*+K^*}^{X+K}$
Australia	12	0.91	Argentina	28	2.1	Cameroon	9	0.68	China	9	0.68		
Austria	11	0.83	Bolivia	16	1.2	Kenya	12	0.91	India	11	0.83		
Belgium	13	0.98	Brazil	34	2.6	Mozambique	25	1.9	Indonesia	21	1.6		
Denmark	14	1.1	Chile	26	2	Niger	14	1.1	Jordan	10	0.75		
Finland	12	0.91	Colombia	22	1.7	Senegal	17	1.3	Korea	10	0.75		
Germany	10	0.75	Costa Rica	15	1.1	Tunisia	14	1.1	Malaysia	26	2		
Ireland	23	1.7	D.R	30	2.3				Philippines	34	2.6		
Italy	15	1.1	Ecuador	17	1.3				Sri Lanka	14	1.1		
Japan	12	0.91	Guatemala	23	1.7				Thailand	19	1.4		
Netherlands	7	0.53	Honduras	9	0.68				Turkey	35	2.6		
N. Zealand	10	0.75	Mexico	16	1.2								
Norway	11	0.83	Panama	15	1.1								
Portugal	19	1.4	Peru	24	1.8								
Sweden	13	0.98	Uruguay	26	2								
U.K.	14	1.1											
USA	16	1.2											
Min	7	0.53		9	0.68		9	0.68		9	0.68	9	0.68
Max	23	1.7		34	2.6		25	1.9		35	2.6	35	2.6
Mean	13.3	1		21.5	1.6		15.2	1.1		18.9	1.4	19.4	1.5
Median	12.5	0.94		22.5	1.7		14	1.1		16.5	1.2	17	1.3
St. Dev	3.8	0.29		7	0.53		5.5	0.41		9.9	0.75	8	0.61

Table 4, Panel B computes the rates of return on all capital in 1996 for 68 rich and poor countries from Monge-Naranjo, Sanchez, and Santaeulalia-Llopis (2016) and Lowe, Papageorgiou, and Perez-Sebastian (2018). "Poor Countries" denotes all countries under LAC, Africa, and Asia.

Table 4, Panel C (2005 Returns). With the exception of Africa, the social rate of return on capital is generally higher in poor countries than in rich ones.

Rich Countries			LAC			Africa			Asia			Poor Countries	
	r_K	$\rho^{X+K}_{X^*+K^*}$		r_K	$\rho^{X+K}_{X^*+K^*}$		r_K	$\rho^{X+K}_{X^*+K^*}$		r_K	$\rho^{X+K}_{X^*+K^*}$	r_K	$\rho^{X+K}_{X^*+K^*}$
Australia	14	0.94	Argentina	19	1.3	Cameroon	10	0.67	China	12	0.8		
Austria	13	0.87	Bolivia	2	0.13	Kenya	8	0.54	India	16	1.1		
Belgium	15	1	Brazil	22	1.5	Mozambique	22	1.5	Indonesia	16	1.1		
Denmark	14	0.94	Chile	22	1.5	Niger	6	0.4	Jordan	15	1		
Finland	15	1	Colombia	19	1.3	Senegal	14	0.94	Korea	16	1.1		
Germany	14	0.94	Costa Rica	17	1.1	Tunisia	15	1	Malaysia	10	0.67		
Ireland	22	1.5	D.R	29	1.9				Philippines	20	1.3		
Italy	16	1.1	Ecuador	14	0.94				Sri Lanka	12	0.8		
Japan	13	0.87	Guatemala	19	1.3				Thailand	14	0.94		
Netherlands	14	0.94	Honduras	9	0.6				Turkey	39	2.6		
N. Zealand	18	1.2	Mexico	24	1.6								
Norway	13	0.87	Panama	28	1.9								
Portugal	10	0.67	Peru	28	1.9								
Sweden	16	1.1	Uruguay	17	1.1								
U.K.	16	1.1											
USA	16	1.1											
Min	10	0.67		2	0.13		6	0.4		10	0.67	2	0.13
Max	22	1.5		29	1.9		22	1.5		39	2.6	39	2.6
Mean	14.9	1		19.2	1.3		12.5	0.84		17	1.1	17.1	1.2
Median	14.5	0.97		19	1.3		12	0.8		15.5	1	16	1.1
St. Dev	2.6	0.18		7.5	0.5		5.8	0.39		8.2	0.55	7.6	0.51

Table 4, Panel C computes the rates of return on all capital in 2005 for 68 rich and poor countries from Monge-Naranjo, Sanchez, and Santaeulalia-Llopis (2016) and Lowe, Papageorgiou, and Perez-Sebastian (2018). "Poor Countries" denotes all countries under LAC, Africa, and Asia.