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POLICY INSIGHT

Future direction for infrastructure research

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ABSTRACT

Contemporary infrastructure research has its origins in the late 1980s as attempts were made to measure the economic impact of public expenditures with early mixed results. In the 1990s, infrastructure assumed greater importance as a policy solution to improve economic performance in low-income economies particularly by multilateral development and official development agencies. This interest led to greater research interest with the examination of infrastructure and economic development, foreign direct investment, the role of institutions and capital markets, procurement, regional economic effects and more recently, the productivity of public investment in specific regions and industries.

This article identifies subjects that warrant further research in the future particularly the shortfall in current investment levels and how this will be met. This is a challenge for both low and high-income countries with fiscal and public debt constraints requiring governments to tap alternative sources of finance. Policy options available to government include wider use of bond markets and private participation in infrastructure provision and management. Other problems facing government include optimism bias and forecasting error that is a particular problem for projects in the transport sector.

Many other research opportunities remain to be explored and this article is designed to provide an overview of several of the subjects that would benefit from further research at the present time.

Keywords: *infrastructure; research*

1. Introduction

Infrastructure was not a widely researched topic until Aschauer (1989) identified the wider economic benefits of investment in the United States during the 1980s. Aschauer's work was a catalyst for further research and debate as researchers tackled the weaknesses in the production function approach to measurement and sought to adjust for two-way causation. The literature that followed confirmed a significant and causal connection between public investment, productivity and output, and research moved to international panel data, regional economies and the relationship between infrastructure investment, output capacity, growth and productivity.

In the late 1990s, research took a greater interest in public infrastructure investment in particular sectors of the economy including telecoms, roads, electricity and transportation. Physical and financial

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measures of investment were used and model specifications continued to evolve. An excellent exposition of the development of the literature on the economic effects of public infrastructure investment can be found in Pereira and Andraz (2013).

More recent research has examined how institutions affect infrastructure investment and the efficiency with which it is managed; the financing of investment; the relationship between infrastructure, transaction costs and trade competitiveness; and infrastructure as an international public good. Research has also extended to infrastructure procurement methods, public-private partnerships (PPPs), relational contracting and the importance of risk sharing and collaboration in project delivery and management.

An immediate problem facing infrastructure investment worldwide is the widely discussed gap between present levels of investment and future demand for infrastructure services, and the capacity of governments to meet the shortfall. The gap is estimated at US\$49t in the period of 2016–2030 (Woetzel *et al.*, 2016) with most of the investment requirement in emerging economies—particularly in the power, road and telecom sectors, which account for over 70% of expenditure. Estimates for the Asia-Pacific, the world’s fastest-growing regional economy, will account for US\$30t in this period (ADB, 2017). Most infrastructures are planned, provided and managed by governments by relying on traditional sources of taxation, public debt, and user-pays principles. Are there alternatives?

2. Financing the infrastructure gap

A major problem for governments is meeting the infrastructure investment gap and the capacity of the government to finance new investment by raising taxes, growing public debt, adopting user charges and asset betterment policies, or reprioritising capital budgets. Bond markets are an option although a combination of short tenors, domestic interest rates and refinancing risk were a deterrent in the past. Private participation in infrastructure has provided an opportunity for governments to transfer construction, funding, lifecycle cost, and market and operational risk to private consortia with collateral benefits in operational efficiency, design and construction innovation, and asset utilisation. However, private participation has been declining since 2010 as private firms push back on full risk transfer and a growing number of projects are not bankable without state support.

The state has several financing options designed to provide an intermediation platform between entrepreneurs, institutional fund managers and domestic savers. This may take the form of tax-exempt public bonds that may be listed on a domestic exchange or issued with a state redemption guarantee. A guarantee may be required to be reported as a contingent liability of the state, although that concern is significantly less with mezzanine bonds issued by a central bank to support privately sourced senior debt. A further option is revenue bonds issued by either the private consortium running a project or the state. All net revenue from the project is used to finance interest paid to bondholders.

Other financing methods include a wider use of sovereign wealth funds and local and domestic institutional investors with long-dated liabilities. Projects that may be difficult for private consortia to finance may be assisted with viability gap funding policies that offer private consortia an up-front capital grant or a subsidy over all or part of the contract term to assist the commerciality of the

transaction. Research with a policy focus that draws on the recent experience in high- and middle-income countries would be timely.

3. The implementation of public transport projects

The economics of transport projects present a challenge for all governments due to growing demand for services, high rates of urbanisation in low and middle-income countries, and systemic public failures at the procurement level that result in few projects delivered on time and within budget. The scale of cost and time overruns of transport projects is heavy with evidence suggesting several endogenous factors as principal causes: changes in project scope and specification, flaws in the business case, the timing of adoption of time and cost estimates, and selection of sub-optimal procurement methods. A further problem is forecasting error, and there is evidence of systematic failure to accurately predict revenue, operating expenses and lifecycle costs as part of the procurement process. Further research is needed to better understand the causes and potential solutions to overruns and forecasting error in transport infrastructure projects, and document best practice case studies in cities that get it right.

4. Infrastructure regulation

Hulten made the observation in 1996 that it is not the quantity of infrastructure that is important but the efficiency with which it is managed (Hulten 1996). Efficiency in this context refers to the many processes required to deliver infrastructure: planning, coordination between government agencies, procurement, operations management and regulation. With the exception of isolated benchmarking studies in ports and transport infrastructure, it is not a subject that has been well researched.

A major aspect of the economics of infrastructure is the regulatory role of the state. Regulatory agencies perform services that include service quality and reliability, contractual compliance, the administration of pricing mechanisms, and oversight of state subsidy payments and community service obligations. Surveys of regulatory efficiency in low- to medium-income countries suggest regulatory agencies have a poor efficiency record with few countries achieving a rating above mid-point in survey rankings (World Bank, 2016). Similar findings were made in the 2016 World Economic Forum Competitiveness Report (World Economic Forum, 2016) and the 2016 Fraser Institute's Economic Freedom survey (Gwartney *et al.*, 2014). Regulatory failure carries economic costs, with evidence suggesting that arbitrary decision-making, delays in regulatory approvals, and political intervention creates political risk and discourages foreign direct investment and private participation in infrastructure. As with many indicators of institutional efficiency, the performance of government agencies is correlated with a country's level of social and economic development, and more needs to be done to identify the institutional constraints and capacity limits that are impediments for improved performance in this aspect of infrastructure management.

Public institutions play a central role in planning, coordinating, procuring and managing economic and, particularly, social infrastructure. Public institutions refers to the legal traditions of a country in matters such as the rule of law, property rights, enforcement of contracts and the state agencies and policies that regulate the economic and social relations between members of

society. The term also embraces less formal but nevertheless influential social institutions including traditional and cultural values. Institutions are dynamic, changing over time in response to underlying changes in the economy, the political and social context, and society. As a country moves along the development path, the economy changes from reliance on factor-based activities such as agriculture to efficiency-based industries such as services and manufacturing.

Given the central role of institutions in economic and social development, why is the effectiveness of national institutions in emerging economies not keeping pace with economic and social development? Research has pointed to a variety of reasons, including public failure, under-resourcing and the low skills base in government agencies, public choice and the poor incentive framework operating in the public sector, and problems associated with vertical fiscal imbalance and the capacity of provincial governments to deliver and manage infrastructure services without the independent technical and financial capacities to do so. Possibly a combination of factors are at work here.

Recent surveys of institutional effectiveness confirm that little progress is being made in low- and medium-income countries. Drawing on data from the World Economic Forum Competitiveness Surveys between 2005 and 2016, institutional efficiency showed less than 1% improvement across a sample of 101 low- and medium-income countries, suggesting a systemic limitation on economic development in these countries with implications for capital productivity, foreign direct investment and growth (World Economic Forum 2006, 2017). Institutions are endogenous and there is no standard formula of a general application for improving institutional efficiency. The challenge is significant because it reaches into nearly all of the functions of government including accountability, transparency, governance, control of corruption, macroeconomic management, regulatory efficiency and an independent judiciary.

5. Alternative methods of infrastructure procurement

Most public infrastructure is delivered by traditional contracts under which a private contractor enters into a relationship with a government agency for civil and construction works pursuant to a specification of works prepared by the agency or on its behalf. The contract may be a guaranteed maximum price arrangement which allocates time and cost risk to the contractor and gives rise to an adversarial relationship, with the contractor prepared to “cut corners” to reduce costs and engage in disputes when costs exceed estimates. Two important characteristics of an adversarial contract are asymmetries of information and the non-alignment of incentives. With infrastructure procurement, traditional contracting methods make a significant contribution to time and cost overruns.

Alternative contracting methods based on collaboration, information and risk-sharing, along with responsive regulatory principles, are eliminating much of the friction associated with infrastructure procurement and long-term incomplete contracts. A distinguishing characteristic of alternative procurement methods such as alliancing and the build-operate-transfer family of contracts is the separation of asset ownership from its management. This permits private contractors operating within a framework of powerful incentives to manage service delivery with the state taking an oversight role that involves planning, network and supply chain management, and regulation at the enterprise level.

A survey that examines global or regional infrastructure procurement practices would inform future policy development in this area and provide insights to help improve public procurement performance in the future.

6. Value for money

‘Value for money’ as an evaluation criterion for the selection of investors and/or contractors was introduced with the public-private partnership procurement programs in the late 1990s and is now applied to the delivery of social and economic infrastructure services in over 80 countries worldwide. In recent years, the value-for-money criterion was subsequently adopted across many other forms of public procurement including traditional procurement contracts. International evidence suggests that public-private partnerships using value-for-money evaluation criterion are delivering better infrastructure services at lower cost than traditional procurement methods. Central to the operation of public-private partnerships is the systematic evaluation of the procurement options available to government; an output specification to encourage private design, risk transfer, construction and operational innovation; the detailed analysis of projects over their operational lifecycle; a rigorous and competitive bidding process; and the selection of proposals that deliver the highest return to government.

Unlike traditional procurement, which is predominantly based on lowest cost to government, value for money is a measure that takes into account both the quantitative and qualitative characteristics of private bids over the term of a contract. It is commonly applied to build-operate-transfer contracts. The quantitative assessment may be determined using evaluation criteria or costing benchmarked to a reference project (or public sector comparator) using a risk-weighted traditional procurement option costed over the project’s lifecycle. The qualitative assessment is made against predetermined criteria that may include the expertise and track record of the contractor, design and construction innovation, early completion and asset utilisation, the sustainability of service delivery over the life of the contract, and improved service quality.

It is argued that value-for-money assessment provides important information to assist the government’s decision-making in matters such as the identification, measurement and allocation of project risk and the lifecycle costing of the service options. It also makes a contribution to the in-house expertise in matters such as specification of service requirements, business case analysis, risk-weighted financial forecasting, project appraisal, multi-stage bidding processes and bid evaluation. However, there is little current comparative research that measures the effectiveness of value for money as a requirement of infrastructure research and other methods.

Value for money may be improved with other features of the procurement process. These include the selection of projects for PPP delivery that offer scope for risk transfer, the preparation of an output specification that creates an incentive framework for sustainable service delivery to requirements, governance and approval arrangements, the pre-qualification of contractors, and a competitive bidding process. International evidence and the international surveys undertaken for this study suggest that public-private partnership policies that adopt value-for-money principles and practices will provide governments with more accurate information to configure optimal procurement solutions for infrastructure service delivery. Value-for-money principles enable governments to derive more from their public-private partnership programs.

7. Infrastructure capital productivity

Productivity is the ratio of output to input in the production process and is a measure of the productive efficiency of the economy. Capital productivity estimates are indexes of real GDP per unit of capital inputs or services used in production. Capital productivity is a partial productivity measure because of its reliance on a single input. In most medium- and high-income countries, the focus of productivity measurement is multifactor productivity that is the product of both labour and capital productivity inputs.

Productivity is important. It is a major contributor to improved living standards, international competitiveness and higher real incomes, and raises profitability at the enterprise level in the long run. Long-run productivity performance is influenced by environmental factors, which refers to economic and social institutional frameworks, a robust market economy, efficient industry regulation, and government policies that favour competition in the market sector, openness to trade and investment, and microeconomic reforms that lower transaction costs at the firm level. These are formidable challenges if the Organisation for Economic Co-operation and Development (OECD) countries are to improve growth in real income per capita in coming decades. While governments can create policy and incentive frameworks to create a favourable environment for productivity change, ultimately performance depends on the actions of individual firms adopting best practice management standards that will achieve greater efficiencies at enterprise level.

A study of the productivity characteristics of economic and social infrastructure is needed to measure and identify differences in the contribution of infrastructure to overall multifactor productivity. To better understand optimal investment levels, information is required about infrastructure capital stocks by sector, annual investment levels, capital write-downs and average age of assets. Information is also sought about the role of environmental factors, the efficiency with which enterprises are managed, the pricing of output based on the cost of production and the separate funding of community service obligations. Capital productivity has an important role as an input to multifactor productivity and medium-term improvement in GDP per capita. It also unlocks embedded technology and would provide guidance for future investment decision-making.

8. The economics of public-private partnerships

Public-private partnership is a method for the delivery of social and economic infrastructure services in over 80 countries worldwide, and generally takes the form of an incomplete contract under which the successful private bidder takes ownership of the project under a powerful incentive framework, meets the full cost of asset construction and service delivery and manages service delivery over terms of up to 40 years. Public-private partnerships use of an output specification transfers design and construction risk to the private firm which creates incentives for innovation. For example, with responsibility for life-cycle costing, the private firm has good reason to design and build a better quality facility that reduces the cost of energy and water, maintenance and depreciation. Moreover, subject to the operating requirements issued with the specification, the private firm receives payment only for the services delivered which requires efficient management over the term of the contract.

This form of procurement is delivering additional benefits: design innovation, lower cost services, improved asset utilization, early completion, improved collaboration and better service outcomes. These performance aspects are not fully documented but have been measured in case studies undertaken for primary and secondary education projects, health services, corrective services institutions and public buildings.

Characteristics of public-private partnership contracts are being adopted into traditional contracting forms in Europe, North America and Australasia, and a fundamental research question is how government can apply the lessons learnt over the past 20 years of public-private partnership experience to future procurement models.

9. Role of the state

Our long-standing understanding of the role of the state in contemporary market economies includes responsibility for the provision of public goods. The concept has a long-standing tradition with evidence of public goods in the form of state-directed irrigation projects in Sumeria around 2,500 BCE and neo-public goods in the form of private roads, punts, water supplies and bridges in the time of Augustus. David Hume (1787) and Adam Smith (1776) understood the need for the state to provide unprofitable services from the public purse with a view to the benefit of society as a whole. In the 20th century, the optimality of provision was explained by marginal utility theory that marginal benefit at the optimum should be equal to marginal cost (Sandmo, 2005). Under Samuelson's definition (1954, 1955), public goods are services provided by government that are non-rival and non-excludable. The Samuelson approach distinguished public and private goods, although the recent adoption of "user pays" principles, public-private partnership delivery of services, asset betterment taxes and asset recycling practices has blurred traditional notions of what a public good is in modern times. A related question is the justification of investment in public goods and the efficacy of benefit-cost analysis and discount rates based on social-rate-of-return techniques (social time preference and social opportunity cost). A further question is the valuation of public goods where these are exchanged or integrated with privately owned improvements or disposed of by state or municipal agencies.

10. Conclusion

Infrastructure research over the past 30 years has provided a much greater understanding of infrastructure as an asset class and the important contribution that it makes to economic and social development. Over the past decade, the direction of research has shifted to greater emphasis on the way services are delivered; the efficiency of public institutions in planning, prioritising, coordinating and implementing infrastructure projects; procurement methods; and private participation in service delivery and management. The immediate problem is the need to meet the infrastructure supply gap and, in low- and medium-income countries, identify new ways to finance the infrastructure of the future.

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