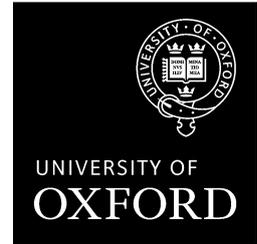


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Investing in Africa's Infrastructure: Financing and Policy Options

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Investing in Africa's infrastructure: financing and policy options

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1. Introduction

Africa is judged to have a severe shortage of infrastructure. The World Bank estimates annual needs at \$93bn and the financing shortfall at between \$31 and \$40bn.³ The underlying rationale for the notion of an infrastructure shortage is that it would unlock large gains in African factor productivity. There is probably more potential for resource extraction than any other region, and the African labour force is increasing and urbanizing more rapidly than any other region. However, these opportunities cannot be fully seized without the provision of infrastructure. Yet increasing the finance for infrastructure faces acute difficulties. Domestic financing is constrained because Africa's fragile democracies are hungry for consumption. International public finance is constrained by the fiscal woes of OECD governments. International private finance is deterred because African infrastructure is encumbered by an array of political and organizational impediments that raise perceived risk to unacceptable levels. To break the impasse, each of these will need to be tackled. African electorates must be convinced that deferring gains in consumption would yield large benefits. Donors must restructure aid budgets so as to gear up other sources of finance. Governance reform of infrastructure projects must make them acceptable assets for patient international capital such as pension funds.

This paper reviews the literature on the need for African infrastructure, and what it would take to address it. Section 2 sets out the evidence for a current infrastructure shortage. However, this

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³ World Bank's Africa Infrastructure Country Diagnostic (AICD), (World Bank 2010).

shortage is the result of past decisions, and Section 3 explains how it has come about. Section 4 discusses how the remarkable expansion of resource extraction in Africa during the past decade is transforming the opportunities for financing infrastructure, and why seizing these opportunities is not straightforward. Section 5 addresses four ways in which finance for infrastructure could be scaled up and their implications for capacities and governance. Section 6 concludes.

2. Africa's infrastructure challenge

Africa faces a critical shortfall in public infrastructure. An estimated 600 million people still have no electricity connection, over 80 percent of the road network remains unpaved and only 56 percent of the population have access to an improved water source (IEA 2013, Foster and Briceño-Garmendia, 2010 and Banerjee et al, 2008). Furthermore the infrastructure shortfalls in African countries typically lag behind their peers across the developing world. The differences are particularly large for paved roads, telephone main lines, and power generation. For all three, Africa has been expanding stocks much more slowly than other developing regions; so unless something changes, the gap will continue to widen (Yepes, Pierce and Foster, 2008).

According to the Teravaninthorn and Raballand (2009), the African road stock is contracting. The World Bank (WDI, 2014) data shows paved roads for sub-Saharan Africa represent just 15 percent of total road networks in 2011, down from 18 percent in 2003. Electricity consumption is not much better. Consumption levels - of 530kwh per person per year for 2009 - has been largely stagnant for the previous decade, and down slightly from 560kwh in 1997. Rail continues to be a significant challenge for the continent; with over 80 percent of the 69,000km network in a dilapidated, non-operational state in 2009. Even when lines are running, transit time can be excessive; the 3,000km trip from Kolwezi, DRC to Durban takes 38 days, an effective speed of 4km/hr according to Foster and Briceño-Garmendia (2010).

Infrastructure is of critical importance to economic output and human development. It complements a wide variety of private investments and types of economic activity. Furthermore, the provision of infrastructure services is typically an important contributor to welfare provision and therefore human development outcomes. According to World Bank estimates, successfully

closing the infrastructure efficiency gap could yield social dividends of \$17 billion a year (World Bank 2010).

The infrastructure deficit in Africa has wide-reaching consequences beyond the implications for economic growth. Limited infrastructure means Africa will fail to meet the Millennium Development Goals for water and sanitation. The Africa Infrastructure Country Diagnostic (2009) estimates a persistent annual infrastructure investment need of around \$93billion. This represents more than double the current levels of investment across the continent.

There exist a wide variety of definitions of infrastructure. They typically refer to large capital intensive natural monopolies, such as highways, other transportation facilities, water and sewerage, power utilities and communications (Gramlich 1994). Social infrastructure, such as schools, hospitals, prisons and public housing are sometimes included in this categorisation. Typically in Africa these types of infrastructure have been publicly financed, owned and operated, but some are held privately, and in other cases the absence of their provision leads to smaller-scale private solutions (such as on-site power generation where grid connections are inadequate).

Quantifying the importance of infrastructure investment

Researchers have traditionally relied on two distinct methodological approaches to evaluate the importance of infrastructure investments. The first, cost-benefit analysis, takes a project level view attempting to compute all the costs and benefits and their implied rate of return. Additionally assessments may attempt to quantify the external effects of the project although these are notoriously challenging to capture. The alternative takes a macro view of public investment within the aggregate production function. Here, following Arrow and Kurz (1970) infrastructure enters the aggregate production function and is considered to be a complement to other input factors- labour and private capital. There exists a large body of empirical work exploring the link between the stocks of public capital or infrastructure and economic performance (see for example Aschaur 1989, Gramlich 1994).

More recent approaches have moved beyond these two methodologies to construct more rigorous evaluation of the wider effects and benefits of infrastructure. They seek to estimate the impact of infrastructure investment using historical series and econometric techniques. These

methodological innovations utilise various sources of data, including trade statistics, firm or household-level survey data or regional economic data. Here economists can often exploit time and spatial variation, or exogenous placement of infrastructure to identify causal effects of projects on the wider economy.

For transportation infrastructure, studies have found that an infrastructure deficit can carry a heavy cost, while the social returns to new investments can be potentially very high. Limao and Venables (2001) show that poor infrastructure significantly reduces trade flows. Donaldson (2012) finds that colonial railroads in India decreased transport costs, increased trade and raised real income levels. Mu and van de Walle (2007) show that rural roads can increase wages and develop local markets in poor communities in Vietnam.

Storeygard (2013) examines the role of road infrastructure and transportation costs on economic activity in Tanzania. Using new data on spatial patterns of economic activity derived from satellite imagery of night-time lights, he estimates the effect of an exogenous increase in transport costs induced by a rise in world oil prices. The results show that an oil price increase of the magnitude experienced between 2002 and 2008 induces cities close to a major port to become 6 percent larger than otherwise identical cities one standard deviation farther away.

Likewise, Baum-Snow and Turner (2012) estimate that Chinese transport infrastructure has a strong influence on the shape of the rapid urbanization process across the country. They find that railroad construction has supported the decentralization of production from traditional economic centres, while road construction has supported the decentralization of population. The pattern of road building within cities, namely the construction of ring-roads, has supported the decentralization of both population and production. Casaburi et al (2013), using road-level regression discontinuity design in Sierra Leone, study the impact of improvements in rural road infrastructure on crop prices in rural markets. They show that the improved roads reduced market prices of local crops.

While the social return on road investments likely exceeds world interest rates, mobilizing investment effectively can be challenging. The countries that need investment the most face the biggest barriers. For example the unit cost of new road infrastructure can be very high. Collier et al (forthcoming) find that higher unit costs are negatively correlated with infrastructure

provision, and that poor infrastructure provision occurs in the places that may need it most- those affected by conflict or corrupt governance.

Road investments can have strong economic persistence. Michaels and Rauch, (2013), show that in Europe there is a significant legacy of Roman infrastructure investments for modern agglomeration and urbanisation. This approach has also been applied in Africa to measure the effects of other types of transport infrastructure.

A study of colonial railroads in Africa by Jedwab and Moradi (2012) provides evidence suggesting that railroad cities have persisted, even after the railroad has fallen out of use. Furthermore their study finds evidence suggesting the railroad cities are wealthier than non-railroad cities, suggesting the agglomeration triggered by railroad connectivity is persistent and leads to accumulation of other factors, thus have a long term effect on economic growth.

A similar study of railroad construction in colonial Kenya (Jedwab, Kerby and Moradi, 2014) uses data at a fine spatial level. Here the authors show that railroads causally determined settler location, which in turn decided the location of the major cities at independence. The persistence of these urban centres, outlasting both the settlers and the railroads, served as a mechanism to coordinate investments in the post-independence period. Their work underscores the importance of choices of infrastructure investment as solutions to coordination problems with persistent effects on spatial development.

Recent empirical estimates by Lowe (2014) seek to understand the impacts of African rail privatisations. The author finds preliminary evidence on improved outcomes of interest such as economic activity, proxied by night-time lights. However there is some evidence to suggest a negative effect on subjective measures such as perceived living standards and political support. This raises a puzzle where local narratives seemingly diverge from tangible outcomes. Meanwhile it suggests tentative evidence that late-1990s privatisations have been a step in the right direction.

For power, Dinkelman (2011) measures the effect of the massive roll-out of the electricity grid in rural South Africa on employment –and, most notably, female employment and labour market participation. She finds that via time-saving contribution to the household, access to grid power

frees up female's time for increased employment- as much as 9 hours per week more in districts with an average improvement in power access.

Kosec (2013) examines the effect of private sector participation (PSP) in the water sector across Africa. The author employs micro-level panel data to measure the decreased in diarrhoea prevalence among urban-dwelling under-five children by 35%. The study identifies causality through exploiting the time variation in private water market share controlled by African countries' former colonizer. A placebo analysis reveals that PSP does not affect symptoms of respiratory illness in the same children, nor does it affect a rural control group unaffected by PSP. Where each year one in ten child deaths result from diarrhoea, the author argues that PSP can be an important policy instrument for improving human development outcomes.

In an earlier study, Galiani et al (2005) examine the effect of privatising water provision across thirty percent of Argentina's municipalities. Since privatisation was not randomly assigned they rely upon a difference in difference approach to compare privatised municipalities with their non-privatised counterparts. While diff-in-diff cannot eliminate selection on unobserved characteristics, it does allow the authors to control for time-invariant effects. Their estimates find a striking 8 percent fall in child mortality in privatised areas, with a twenty six percent decline in the poorest areas.

Water infrastructure services are also important for agriculture. Duflo and Pande (2007) find that the benefits of building a dam, as a major form of public infrastructure investment in India, accrue to downstream districts in the form of increase agricultural reduction and reduced rural poverty.

Various authors have examined the effects of ICT and in particular the market effects of improved mobile phone connectivity. Both Jensen (2007) and Aker (2010) estimate the impact of communications infrastructure for lowering search costs and reducing information frictions. They find reduced price dispersion from mobile phones, and more so if connected by road.

The effects of infrastructure can be complex, including direct channels of welfare effects versus long-term agglomeration effects. Infrastructure, as a complement to both other infrastructure and private economic activity can provide a platform for diversification, or as a driver for agglomeration and urbanization, all of which are effects that can be hard to capture under cost-

benefit analysis or focus on the macro picture. The long run effects can be stark and persistent. Furthermore, in developing countries with significant shortfalls in the stock of public capital, understanding the relationship between infrastructure investment and growth, and the social rates of return on different types of infrastructure investment is of critical importance to policy making. Evidence suggests that privatisation can yield benefits but is no panacea. Furthermore, high unit costs and deferred or dispersed returns on investment create daunting hurdle rates for new projects.

3. Reasons for the deficit

Africa's infrastructure shortfall has a number of contributing factors. Historically it has suffered from under-investment and deterioration of previous infrastructure stock such as colonial railroads. While overall stocks at independence were roughly comparable with other developing countries, they have since fallen increasingly behind. According to the World Bank, Africa had levels comparable to South and East Asia in terms of roads in the 1960s, for telephones in the 1970s and for power in the 1980s. The comparison with South Asia, which has similar per capita incomes, is particularly striking. In 1970, sub-Saharan Africa had almost three times the generating capacity per million people as South Asia. In 2000, South Asia had left sub-Saharan Africa far behind—with almost twice the generation capacity per million people. Also in 1970, sub-Saharan Africa had twice the landline telephone density of South Asia, but by 2000, the two regions were even (World Bank 2010).

The colonial legacy of infrastructure, which was focused on resource extraction, has exacerbated the challenge. Countries have had the wrong kind of infrastructure in the wrong places. Indeed, new work by Bonfatti and Poelkke (2014) suggests that infrastructure investments motivated by resource extraction such as mine-to-coast infrastructure has decreased cross-border trade and regional interconnectivity. Furthermore political instability and conflict has led to the pillage or dilapidation of public assets. Following conflicts affecting the Democratic Republic of the Congo, the World Bank estimates about fifty percent of infrastructure assets need rehabilitation (World Bank 2010).

Africa is characterised by low overall population density, low urbanization and geographically dispersed economic activity. These characteristics reduce the potential returns to investment,

either through lower utilisation levels, or larger distances to traverse. For example, Africa has a much lower spatial density of roads than any other region of the world: only 204 km of roads per 1,000 km² of land area, with less than one-quarter paved, while the world average is 944 km/1,000 km², with over half paved (Gwilliam, 2011). Population dispersal has been exacerbated by political fragmentation: notably, many countries are landlocked. Crossing borders is costly and reduces the size of locally accessible markets. It also limits the opportunities to connect important economic centres.

While these underlying historical factors all contribute to the challenge, domestic political economy often holds back countries from rectifying their investment deficits. African transportation networks are characterised by high freight tariffs. Research shows however that rather than being driven by higher costs, it is the high profit margin and limited competition that mark out the continent compared to others (Teravaninthorn and Raballand, 2009). The limited competition is exacerbated by a highly regulated market. Furthermore, construction costs remain high compared to the rest of the developing world, and unit costs are particularly high in fragile or post-conflict states (for example see estimates for road costs in Collier et al. forthcoming). However the failure of infrastructure can be attributed to failures of operation and maintenance, as much as to insufficient investment.

Financing the deficit will require over \$90 billion per year, while domestic resources available fall a long way short. It is estimated government revenues contributed around \$60 billion per year to infrastructure investment, with \$22 billion per year made available via Overseas Development Assistance (IMF, 2014). The remainder will have to come from private financing, either in return for resource exports – so-called barter deals or ‘Resources for Infrastructure’ – or from private financing models to build profitable projects.

The nature of the infrastructure challenge varies markedly between African country groups (Briceno-Garmedia, Smits and Foster, 2008). In fragile states for example, infrastructure spending needs exceed thirty five percent of GDP, and attract little external finance. While the challenge is lower in non-fragile states, the World Bank (2010) estimates they must allocate, on average about 23 percent of their GDP to build and sustain basic infrastructure. Resource-rich countries are, in principle, better placed to meet their infrastructure needs, though in practice they have not tended to do so (IMF 2013; Bhattacharyya and Collier 2014). Resource-rich

countries could meet their infrastructure spending needs for only around 12 percent of GDP (World Bank 2010). Capturing the value of resource extraction, via tax and royalty payments, could in principle provide a key source of financing, but many challenges this depends upon revenues being captured through taxation, and then spent appropriately.

The political economy of infrastructure provision has become the main impediment. At the international level, in the mid-1990s donors switched aid budgets from infrastructure to social spending on health and education. This was motivated partly by an exaggerated belief that international private finance would meet the need. Additionally, there was a perceived need to regain popular support for aid following criticism from the political left that it was used to enforce socially damaging structural adjustment policies and dams, and criticism from the political right that it fuelled corruption.

At the domestic level, there has been a bias against maintenance, so that existing infrastructure has eroded. This was due partly to the greater opportunities for corruption presented by construction contracts, and partly to the bias in aid towards new construction (Briceno-Garmendia et al., 2008). Service provision has been dominated by public monopolies either inherited from colonial times, or established in the heady atmosphere of post-independence state-led development. Once established, these entities acquired strong vested interests which have been defended through patronage. As with other African public services, they have failed to develop an ethic of service to the national interest⁴. The public monopolies have grossly underused infrastructure: for example, Nigeria has cumulatively spent around \$16bn to purchase generating equipment, to little effect (Collier, 2012). In consequence firms and households invested in self-provision with massive sacrifices of scale economies: for example, most firms have private generators (Reinikka and Svensson, 2002). Occasionally, new technology has enabled commercial provision to bypass the public monopolies, the most spectacular instance being the mobile phone which, by virtue of being classified as a distinct product, evaded the telecoms monopoly. The exceptionally rapid take-up of mobile phones was driven by the prior failure of public landline provision. Similarly, the associated development of e-banking in East

⁴ See Collier (forthcoming – **publication details to follow**) the Harold Wincott memorial lecture 2014, “Africa: New Opportunities, Old Impediments”, 8th October, Blavatnik School of Government, Oxford.

Africa was aided by the inadequacies of official payments mechanisms. There are hopes that solar power will become an equivalent technology for electricity generation, enabling cheap off-grid provision. However, to date, solar has needed complementary inputs such as maintenance and finance the inadequacies of which have precluded mass adoption (Collier and Venables, 2012).

Public monopoly provision is also handicapped by the politicization of pricing, resulting in subsidies that are only affordable if supply is acutely inadequate. Seemingly, there is an obvious political deal to be struck in which citizens accept higher prices in return for expanded provision. However, such deals face a time-consistency problem. Ministers of finance have authority over financing, while ministers of energy have authority over pricing. A minister of energy will share some of the kudos for expanded provision but face criticism for raising prices. Since expanding provision takes time, if the two decisions are announced as a package, the minister of energy will face immediate criticism and may not survive to reap a share of praise. If, however, investment in expansion is undertaken before prices are increased, the minister of energy has no incentive to comply with such an undertaking. Seeing this, ministers of finance will not authorize investment. Nigeria and Guinea have been examples of this standoff.

4. The Natural Resource Opportunity

The resource boom of the past decade created an unprecedented opportunity to rectify this deficit in infrastructure. Directly, some infrastructure investment became necessary to enable the exploitation of newly profitable resource discoveries. Indirectly, the increased public revenues made infrastructure more affordable. However, each of these has proved difficult.

Infrastructure for resource extraction

The price boom sharply increased the incentive for prospecting. For straightforward commercial reasons this was concentrated in those regions which had previously had little search. As of 2000, the value of known sub-soil assets per square kilometre of sub-Saharan Africa was only \$22,700, or around one seventh of that in the OECD.⁵ This massive difference is unlikely to have reflected fundamentally less promising geology: over two such large parts of the Earth's surface the most reasonable presumption is that the random allocation of localized value would generate

⁵ Data from Wealth of Nations, World Bank, 2010.

similar averages. Rather, it reflected the fact that there had been much less opportunity to prospect in Africa. For the quarter-century prior to the boom resource prices had been depressed and prior to that much of Africa had been politically risky as a result of recent decolonization and coups; the deterrence effect of weak governance is estimated to have been quite large for resource exploration over the past half century (Cust and Harding, 2014). The decade of the resource boom was the first time during which price incentives were aligned with satisfactory governance. Following the fall of the Berlin Wall much of Africa had transitioned to democratic political governance, while the conjunction of sustained IMF programs and Jubilee debt relief had transformed macroeconomic governance. As resource extraction companies recognized this opportunity, investment in search was ramped up, and this has yielded many commercially viable discoveries. Given the size of the continent, it was inevitable that many of these discoveries would be far from the coast, and indeed far from urban centres. Their exploitation therefore required large investments in infrastructure for transport and power. For example, the massive and high-quality iron ore deposits at Simandou in Guinea required investment in a new rail line. Further, the shortest rail route to the coast involved a line through Liberia. This generated problems, to be discussed below, and so the government of Guinea required a new rail line of over 600km and a new port. In combination the cost of this new infrastructure substantially exceeds \$10bn, and is approximately double the capital costs of the mine itself. Despite this enormous cost the deposit is so valuable that the returns on the total investment remain high. Currently, Rio Tinto and the Government of Guinea are seeking to put together a consortium that could finance the project. Simandou illustrates both the opportunity for resource extraction to induce infrastructure investment and the difficulties involved.

First, Simandou requires an irreversible investment that is so large as to be wholly disproportionate to the size of the economy – more than double GDP. The combination of irreversibility and uniqueness renders the investment subject to potential hold-up by the sovereign polity. The loss of sovereign reputation inflicted by repudiation of contract may be regarded by a future government, and hence by prospective investors, as less costly than the gain generated, so that undertakings are liable to be time-inconsistent. For many years this indeed deterred investment in the processing of Guinea's bauxite because even the billion dollar

investment required would have been disproportionate to GDP.⁶ This hold-up problem is not confined to the extraction of minerals. Oil extraction in Chad required an investment of \$4.2bn. Because the Government of Chad was subject to criticism from NGOs in respect of its legitimacy and its potential use of the revenues, oil companies were reluctant to risk their reputations. The World Bank undertook the reputational risk by getting the government to commit to a specific use of revenues, with a substantial part being devoted to social spending enforced by a governance structure. This was sufficient protection for oil companies to go ahead with the investment. However, once the investment was made, the government invoked its sovereign right to withdraw from the undertaking and switched expenditures to armaments. It backed its new policy with the threat to transfer the investment to Chinese companies unless the initial owner continued extraction. The undertaking was seen to be time-inconsistent and was resolved by acquiescence on the part of the investor and the World Bank. The hold-up problem can also arise in power generation where the sole purchaser is a public entity: we take this up in Section 5.

Second, because the African land mass is divided into 50 different sovereign polities, the most efficient infrastructure investment will often be trans-national. The resource problem extends beyond the extraction of ore and two further examples illustrate the generic issue. Deep sea gas has recently been discovered off the coasts of both Mozambique and Tanzania. For the enormous costs of extraction to be covered, a substantial proportion of the gas will need to be sold in international markets, notably East Asia. This requires conversion into LNG which itself requires massive investment in trains.⁷ It might well be most economic for this investment to be shared between the two countries. The largest single opportunity for electricity generation in Africa is Inga, which could harness the River Congo in the Democratic Republic of Congo. However, this would generate far more power than the DRC could use, and the only substantial market within transmission distance is South Africa. To reach this market the electricity would need to be transmitted through Zambia, Zimbabwe and Botswana. Both private investors and home governments are wary of such involvement of other sovereign polities because of the enhanced potential for hold-up.

⁶ Personal communication from Paul O'Neill, a former CEO of ALCOA.

⁷ A train in this context is the technical term for a gas liquefaction plant.

Third, there is an intrinsic tension between the interest of the government in regulating the infrastructure built for resource extraction and the interest of the investor. Prospecting for resources is inherently a sequential process: not everything is discovered at once. The circumstances in which private investment in the infrastructure for extraction is viable arise only because some valuable resource has been discovered, but this increases the prospect that further resources will be found in neighbouring locations. If the company which makes the first discovery is permitted to invest in a transport connection that it owns and controls, it has a strategic advantage in the bidding for rights to all neighbouring prospects. Only it would be able to use the transport connection at marginal cost; other companies would be willing to pay for usage rights anything less than the cost of building their own dedicated infrastructure and would therefore be outbid. Unrestricted rights over the infrastructure would thus be tantamount to acquiring the rights to all further prospecting in the neighbourhood at a heavy discount. This is indeed the situation in Guinea in respect of bauxite extraction via the railway line to Boke. In its negotiations over Simandou, the Government of Guinea determined to learn from this mistake of a previous government and insisted that the railway line should be multi-user. In the limit, the government can require a complete separation in ownership between the rail company and the resource extraction company. Evidently, such a separation creates the potential for a further hold-up problem. This became apparent in Mozambique where the company that owned the railway built to transport coal came into conflict with the coal mining company. The conventional solution is to regulate the price that can be charged by the railway. However, this is made considerably more difficult because regulation requires an irreducible degree of discretion, which is problematic in the context of potential corruption. In turn, this complicates the task of raising finance for the rail investment. The challenge of multi-user infrastructure is compounded if the government requires that it also be multi-function – able to serve uses other than resource extraction. We return to this in Section 5.

Infrastructure financed by resource revenues

The indirect effects of resource extraction on infrastructure are potentially even more positive than the direct effects. The public revenues generated by extraction can finance new infrastructure and there is a powerful reason for them to be used for such a purpose: a substantial proportion of resource revenues should be used for asset accumulation (Halland et al., 2014).

The reasons for this are partly the prospect of physical depletion and partly the prospect of technological obsolescence.

Resource extraction depletes a natural asset. Viewed from the perspective of permanent income, this depletion should be offset by the accumulation of other assets to the extent required for a sustainable increase in consumption. An elementary inference from the permanent income framework is that the shorter is the duration of depletion, the higher is the savings rate from resource revenues that is required. Many of the recent high-value resource discoveries in Africa are liable to be relatively short-lived. For example, almost all the really large oilfields have probably been discovered decades ago; those discovered during the past decade are consequently mostly small. Hence, physical exhaustion is often a serious prospect: Cameroon, an early African oil economy, is already approaching it. However, even where physical exhaustion is very distant, resource rents are vulnerable to technological innovation. New technology might cause a collapse in demand, as happened with nitrates due to the discovery of synthetics in 1920, or it may open new sources of abundant supply. For example, Zambia is heavily dependent upon copper. While it has a large endowment, the global demand for copper will collapse once an alternative to copper wire is developed for the transmission of electricity, and global supply will expand once new technologies are developed for extracting abundant copper from the seabed. While technological innovation threatens all industries, resource extraction is distinctive because what is at risk is the rent that accrues from it. If a manufacturing activity declines to extinction, capital can redeploy into other activities where it can continue to earn a normal return. But if resource extraction becomes unviable, the rents on the activity are lost.

The implication is that over the next two decades African governments should substantially increase their savings rates. In Section 5 we discuss why, in African conditions, it would be appropriate to use much of this new savings for infrastructure rather than other assets. Here, we consider the prior issue of whether having a high savings rate from resource revenues is politically viable.

During the resource booms of 1973-86 few African governments used revenues to accumulate assets. Nigeria is the totemic case. The heady increase in oil revenues consequent upon the price hike in 1974 triggered a large increase in public consumption exemplified by a public sector wage increase of 75 percent in the following year. While there was also a 'big push' effort to

increase expenditure on infrastructure, in the absence of public organizational capacity, this resulted in exceptional levels of waste and corruption. For example, Nigerian agents bought so much cement on world markets that Lagos port was clogged for three years by what became known as the ‘Cement Armada’. Cameroon and Zambia provide important examples of completed cycles of resource depletion. In Cameroon, Gauthier and Zeufack (2011), estimate that sustained asset accumulation was negligible. In Zambia, by 2002 known viable copper reserves had been exhausted, the industry was loss-making, and the international owner, Anglo-American, pulled out. As in Cameroon, the resource had been depleted without offsetting asset accumulation. Within Africa the historic exception to this pattern of low savings from resource extraction is Botswana. The astute first president promoted patient use of diamond revenues through a national narrative that became widely known: ‘we’re poor and so we must carry a heavy load’.

During the boom of the past decade, African governments were well aware of this history. The sentiment ‘we won’t make the mistakes of Nigeria’ was widespread. However, whereas the previous resource boom was generally managed by autocracies, most African polities are now democratic. What matters is no longer what governments understand, but what citizens understand, and what they trust governments to do. Ghana is generally rated as at the forefront of both democratization and economic improvement in the region, but the policy response to its discovery of oil in 2007 has not been encouraging. A close and intense political contest triggered competitive commitments to public consumption and wage increases, resulting in an overall decline in the public savings rate. By 2014, after only three years of oil revenues, the government had to call in the IMF. Similarly, in Zambia, also a closely contested democracy, by 2014 the copper boom had been sufficiently fiscally destabilizing to require IMF involvement. In Nigeria, the population resisted, through mass strikes, an attempt in 2012 to redirect the use of oil revenues from a scam-prone petrol subsidy to the development budget. Underlying this resistance was a suspicion of government so deep that it could not credibly commit to spend revenue in ways that would only benefit the future. In effect, most governments lack commitment technologies.

5. Options for financing infrastructure, and the role of natural resource extraction

We now consider four ways in which new finance can be raised for African infrastructure, each being related to natural resources.

The almost-free lunch

The most straightforward way in which resource extraction can meet Africa's infrastructure needs is if the infrastructure that has to be built in order to facilitate extraction is designed and regulated so as to be multi-function. This is distinct from being multi-user which is about the competitive access of resource extraction companies to each other's infrastructure.

For example, a railway whose primary use is for the transportation of ore to the coast can become either a quasi-wall across the country traversed only by ultra-long ore trains, or a transport corridor that opens up the interior for commercial agriculture. The resource extraction company itself has little direct interest in making such a facility multi-function. Running such a railway would constitute a non-core business, and would risk reducing the efficiency of extraction which depends upon synchronizing the arrival of trains with the arrival of ships. Further, there are few rents in commercial agriculture so that such users would be unable to pay much more than marginal costs. Similar considerations apply to the ports, power generation and water supply needed for resource extraction.

However, while the resource company has little to gain from multi-function infrastructure, the society has much to gain. While it may take many years for the benefits of a transport corridor to be realized, they can be considerable. For example, Lusaka, the capital city of Zambia, was initially merely a coaling station on the railway line from the coast to the copper belt.

These divergent interests can be resolved if the government requires as part of the extraction rights that the infrastructure be designed to be multi-function and priced for non-resource users at marginal cost. The company will then factor in the increased costs generated by the requirement in its bid for the rights. Since the cost to the company will usually be much less than the gain to the society, the small reduction in government revenue will be a cheap price for getting a lot of public infrastructure. This is just becoming recognized as an appropriate policy by African governments (Collier, 2011). For example, after initial opposition in the context of the Simandou

project, Rio Tinto adopted the global principle that infrastructure should normally be multi-function.

Resources as collateral

Africa is highly unusual in its urgent need for urban infrastructure. Africa is the least urbanized region, and its rural population is now rapidly shifting to cities. Further, Africa's total population is still rising rapidly. In conjunction, population shift and growth are expected to triple Africa's urban population by 2050: two thirds of Africa's future cities are to be built. It is far cheaper for this infrastructure to be built in advance of settlement rather than retrofitted in arrears, yet to date public investment has not kept pace with urbanization, hence the standard phenomenon of sprawling shanty towns. African governments therefore need urgently to ramp up their expenditures on urban infrastructure.

Urban infrastructure is distinctive in that its cost can potentially be recovered by socializing the consequent appreciation in land values. Since the infrastructure can only benefit those who live or work near to it, the benefit is reflected in higher land values. If the land does not appreciate sufficiently to cover the cost then the infrastructure was not worth installing. The appreciation can be socialized either by taxing it, or more directly by the government taking ownership of a proportion of the land. China is the exemplar of this self-financing strategy for urban infrastructure, some Indian states have now adopted it, and in Africa it is being followed by Ethiopia.

While such infrastructure is ultimately self-financing, it poses a challenge to cash flow: infrastructure must be built before the value of land can increase. Nor is the prospect of land appreciation itself likely to be satisfactory collateral for an international lender. The appreciation of the land value is contingent upon a loan being spent on well-implemented infrastructure. Further, the land appreciation generates domestic currency whereas loans to Africa are liable to be in foreign currency. The future revenues from natural resource extraction provide a much safer form of collateral and so loan rates can be lower.

To take a current example, Tanzania is one of the least urbanized countries in the world. Dar es Salaam, its main city, is set to grow from 5 million to around 15 million by 2050. To pre-empt settlement, much of the infrastructure for this extra ten million people needs to be built during

the coming decade on land currently used for farming. The government cannot finance this scale of infrastructure from its existing resources. However, in 2012 Tanzania discovered offshore gas. While it will not start to generate revenues until at least 2022, by 2016 the international companies involved will decide whether to make the large investments necessary to bring it to market. Once this decision is taken, and with it the associated contracts for LNG sales, the government would be in a position to borrow using the prospective gas revenues as collateral. Such a use need not pre-empt the future use of gas revenues, since the land belongs to the state subject to compensation for existing usage rights. The debt could thus be repaid from the appreciation of the requisitioned farmland.

Infrastructure as an offset to resource depletion

Almost all African countries are chronically short of social and economic infrastructure. Some of the services generated by investment in this infrastructure could in principle be recovered by charging users and we discuss this in the next sub-section. But much of the services generated by valuable infrastructure could not be appropriated. For example, the cost of enforcing tolls on rural roads would most likely exceed the revenues collected, while charging for water has sometimes proved to be politically unacceptable. There are isolated examples of tolls on new major roads, but even in such cases public opposition has proved to be much stronger than anticipated. For social infrastructure, such as health clinics and schools, attempts during the 1990s at cost recovery have generally been judged to be mistakes due to the strong discouragement of usage among poorer households.

However, while citizens seem to expect such infrastructure to be financed by government taxation, the share of GDP captured through taxation is usually less than 20 percent and so too low for this to be viable. Supposing that the social rate of return on African infrastructure lies in the range 5-20 percent, with only a fifth of this captured by taxation, the financial return is therefore only around 1-4 percent. This is far below the borrowing costs faced by any African government: a typical real rate in the sovereign bond markets would currently be around 6 percent. The IMF has recently developed a tool to help governments to evaluate whether debt finance of infrastructure is sustainable (Berg, Portillo, Yang and Zanna 2013). The tool takes into account the linkage between investment and growth and makes assumptions as the rate of return

on public capital. One reason why Africa is so short of infrastructure is that commercial borrowing would usually be unviable.

However, were the infrastructure to be financed out of savings from resource revenues, the pertinent comparison would not be between this financial return and the cost of borrowing, but between the social return and the return on foreign financial assets. Given that world risk-free real interest rates for depositors are currently close to zero, nearly all the real interest rate that African governments pay on their commercial borrowing is a risk premium: there is a large wedge between their borrowing and lending rates. Hence, infrastructure yielding 5-20 percent is far superior to foreign financial assets offering negligible yield.

Some African governments are now adopting this strategy. In 2010 Guinea received a \$700m windfall as part of the Simandou negotiations. The finance minister ring-fenced \$200m of this into a fund to be spent on infrastructure. However, it has also become fashionable for resource revenues to be earmarked to a Sovereign Wealth Fund, influenced by the Norwegian model in which assets are held abroad: African countries have become the fastest growing region for such Funds. An offshore Fund is reasonable for Norway, since it already has more invested domestic capital per member of the labour force than any country in the world, and the government has also already paid down its domestic debt to zero. However, there are two important weaknesses with such a model for Africa. First, as discussed above, the return on foreign financial assets is likely to be far below that on infrastructure. Secondly, the establishment of a Fund can create the illusion that resource revenues are being saved when in fact the opposite is happening. For example, Ghana has paid around \$200m into an offshore Heritage Fund, while over the same period raising almost \$2bn from sovereign bond issues. Clearly, being a saver while also being a borrower merely incurs the costs of the substantial wedge between the borrowing and savings rates facing African governments.

The Chinese business practice in Africa of linking resource extraction directly to the provision of infrastructure and finance in a single deal simulates the approach of using the revenues from resource rents to finance infrastructure. Future resource extraction becomes the collateral for the advance provision of infrastructure. During the past decade such Chinese deals have rapidly increased although data remain limited. They have been estimated at around US\$0.5billion per year in 2001-2003, US\$1.5billion by 2004-05, and at least US\$7 billion by 2006. (Foster,

Butterfield, Chine and Pushak, 2009). The finance was mainly through resource-backed loans from the Export-Import Bank of China (Cust and Zhang 2014). These Chinese packages have three potential advantages over contractual separation.⁸ They can be negotiated and implemented quickly, and in particular within an electoral cycle which is often the horizon for African governments; the control of collateral reduces default risk and so borrowing costs; while the packaging of infrastructure and resource extraction provides a valuable commitment technology. Otherwise, even if a finance minister has got prior cabinet approval to earmark resource revenues for infrastructure, they may be outvoted by spending interests once revenues arrive. However, they also have important weaknesses. Being packages they are opaque, so it is difficult to determine whether they are good value. Since China is the only entity offering them they are not disciplined by like-for-like competition. Hence, they have acquired the reputation for being poor value.

Private finance for infrastructure

As Africa continues to grow, helped by resource extraction, the demand for infrastructure services is increasing. FDI to Africa, for example, has increased by a factor of five since 2000, increasing from \$10 billion to \$50 billion in 2012 (UNCTAD, 2013). This is opening the potential for private investment in utilities. However, to date such projects are rated as highly risky and few have been completed (Eberhard et al., 2011). Success depends upon reducing perceived risk. Currently, private finance seeks sovereign guarantees: for example, this was the solution proposed by Tijane Thiam, the African-born CEO of Prudential, who was commissioned by the G20 in 2011 to devise ways of scaling up private financing. However, in view of the limited borrowing capacity of African sovereigns, it is important not to pre-empt it with projects that could be commercially viable as free-standing entities. Indeed, properly structured, such projects can be less risky than sovereign debt because, while they lack the backing of the general tax base, they gain a dedicated source of revenue that cannot be pre-empted for other uses. For example, when the Government of Cote d'Ivoire defaulted on its sovereign debt during the civil war, the debt of the Azito Project, the first major private power project in Africa, continued to be serviced.

⁸ Indeed, the Chinese packages recall an earlier literature on interlinkages in rural factor markets in poor countries (Braverman and Stiglitz, 1982).

In part private risks can be reduced by expansion of donor-provided risk capital and political risk insurance. Currently, the World Bank requires its risk capital arm, the International Finance Corporation to cross-subsidize its concessional aid program, IDA. Yet for aid to gear up private finance for infrastructure it would be more appropriate for IDA funds to be used to cross-subsidize first-loss equity stakes held by IFC. Similarly, until recently the Multilateral Investment Guarantee Agency of the World Bank had only a small African portfolio. Yet due to the considerable soft power of its parent group, MIGA has been able to recover on all but two of its 750 projects, so that it is more akin to a commitment technology than an insurance agency. A strategic way for aid to gear up private infrastructure finance would be to subsidize the political risk insurance of projects. Donors are now recognizing that for aid to maintain significance it will need to be redirected to gearing up private finance for infrastructure rather than the full financing model of the past.

Risks can also be pre-empted by redesigning the governance of projects. Conceptually, a project can be split into three phases: negotiation, building, and operating. Currently, the pipeline of bankable projects is limited, suggesting a failure at the first stage. Many negotiations drag on for years: each project treated as idiosyncratic, and time-inconsistencies are not addressed upfront. There are few private dedicated teams with the combination of technical and political expertise necessary to catalyze projects because it is difficult for them to appropriate a share of the gains. There is a good case for aid agencies to subsidize such teams. The British aid agency, DFID, now does this through AfriCo, and the new Africa50 fund of the AfDB. But the approach could be scaled up through IFC and its bilateral counterparts. The traditional mode of operation of IFC and its bilateral counterparts has usually been passively to wait for private sector proposals to be submitted, rather than to catalyze them. There is also scope for greater standardization to reduce delays and address time-consistencies at the onset of negotiations.

The build stage requires large, irreversible investments facing high risks. It therefore requires high-return, equity capital, but unless this capital has an exit strategy upon completion the resulting cost of infrastructure services financed by private equity will be far above world levels. Hence, a critical step is to provide a credible exit strategy for high-risk capital once the utility is operating.

Once operating, African infrastructure needs to be classified by international investors as a utility rather than as a frontier investment and so made suitable for pension funds. This implies that a reputable international operator has to be attracted. In turn, foreign operators and government both need reassurance that they will not be subject to holdup by the other party. Operators could get some reassurance by being allowed to sell directly to firms. For example the need for sales to a public electricity grid could be eliminated by contracts which use it only for transmission, matching input with off-take. Resource extraction companies could sometimes serve as anchor clients for private infrastructure operators. However, an anchor client potentially creates a new risk of holdup. For example, in Mozambique on World Bank advice mining and rail were designed as independent private activities, but the investors in coal mining complain of inadequate capacity installed by the rail company on which they are dependent. More generally, investor and government reassurance requires credible regulation. But regulation requires discretion, and in the high-corruption environment of the African public sector it is therefore distrusted, posing a new risk of holdup. For private finance of infrastructure to meet Africa's needs, regulation would therefore need to be transformed so that regulators come to be seen as independent of government while subject to the conventions and norms of an international profession.

Implications for government decision processes

If government and private finance is forthcoming to scale-up African infrastructure, the technical capacities for public investment will need to be augmented, and the political authority over infrastructure redesigned.

Enhanced capacities are needed to design, select, implement and evaluate public projects. Each has recently been measured by the IMF in a Public Investment Management Index (PIMI) (Dabla-Norris et al, 2011). This confirms that investment efficiency in sub-Saharan Africa lags behind other emerging markets and developing countries. However, there is considerable variation among the subcomponents and so potentially scope for governments to learn from each other and perhaps even to combine capacities. For example, were all the countries of the West African Monetary Union able to reach the best attained by each of them, they would rate among the best in the developing world. Rwanda and Botswana have already built valuable capacities, the former in cost-benefit and the latter in project implementation. Additionally, donor-provided

technical assistance is now substantial. For example Estache (2010) estimates that support for infrastructure capacities now accounts for sixty percent of the grant budget of the African Development Bank.

To address the failures of the past, political commitment technologies need to be built. Specifically, project selection and implementation need protection from the influence of political patronage and prestige, a high rate of saving out of resource revenues needs to be maintained, the proceeds of sovereign bond issues need to be ring-fenced from consumption, and maintenance budgets need to be protected. The practices of China have made the former more difficult: often ready-designed Chinese infrastructure projects such as airports and stadiums are pitched directly to the president, bypassing conventional financial scrutiny. Locking in to spending on infrastructure and maintenance has often fallen foul of IMF rules on integrated budgets, the rationale for the avoidance of earmarking being that marginal equivalences can be maintained between all components of expenditure. However, this ignored the severe time consistency problems which African finance ministries often face. Commitment devices such as road funds, which earmark some road-usage generated revenues for maintenance, while potentially distorting, may in practice be helpful (Gwilliam and Kumar, 2002).

6. Conclusion

The infrastructure shortfall poses a major challenge for Africa. The economic costs of absent or limited infrastructure can be large and persistent, while the benefits are often dispersed, hard to estimate *ex ante*, and hard to recover. However, there is wide agreement that the economic returns can be significant, long-lasting and serve as an important platform for urbanization, diversification and growth.

The imperative therefore is to overcome barriers to source the necessary financing to build, operate and maintain the next generation of infrastructure. Government faces a problem of both securing this financing, and creating the political and regulatory environment to attract and protect the investments. To break the present impasse, each of these challenges will need to be tackled. Domestic financing is constrained because Africa's fragile democracies are hungry for consumption. International public finance is constrained by the fiscal woes of OECD governments. International private finance is deterred because African infrastructure is

encumbered by an array of political and organizational impediments that raise perceived risk to unacceptable levels.

Looking ahead, natural resource wealth presents policy options that can be leveraged to tackle these constraints, with the potential to unlock complementary infrastructure investments and crowd-in additional private capital. Multi-function resource infrastructure is rapidly becoming the preferred approach, but governments require better tools to evaluate and design these schemes. Resources can serve as collateral to secure, and commit to long term infrastructure investment. Packaging infrastructure for resources can overcome time inconsistency, but bring their own challenges of ensuring value and transparency. Private capital flows will necessarily play an important role. Finally, the technical capacities for public investment will need to be augmented, and the political authority over infrastructure redesigned. Underpinning the reform of institutions, African electorates must be convinced that deferring gains in consumption would yield large benefits.

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