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EIB **Papers**

Public and private financing of infrastructure

Policy challenges in mobilizing finance

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Public and private financing of infrastructure

Policy challenges in mobilizing finance

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Preface

Plutarchos Sakellaris
Vice-President

Faced with the double-need of fiscal consolidation on the one hand and infrastructure renewal and upgrading on the other, many EU countries seek to mobilize more private finance for infrastructure. The volume of private-sector finance in infrastructure, the economics of Public-Private Partnerships and the drivers of infrastructure fund investments are key topics addressed in the companion issue (Volume 15, Number 1) to this issue of the *EIB Papers*.

Since the government is, and will remain, a key player in planning, commissioning and financing infrastructure, the 2010 *EIB Conference in Economics and Finance* also dwelled on public-policy issues in mobilizing finance, which are compiled into this issue (Volume 15, Number 2).

Due to its public-good and natural-monopoly characteristics, infrastructure services require government regulation to ensure that private firms supply these services in the right quality and quantity. A first important question therefore is whether the regulation that we have is conducive to channelling private finance to infrastructure and, if not, how to change it. In fact, inadequate regulation might stifle the provision of private finance, bias its structure, and make it unduly expensive.

Second, infrastructure finance concerns more than providing the money for the up-front capital expenditure on infrastructure. Finance is also about who ultimately pays for the infrastructure. Getting the balance right between user charges and support financed by current and future taxpayers is far from obvious, and the optimal balance is unlikely to be the same for all types of infrastructure and all countries. For example, high-income countries have a menu of possible choices between user fees and tax finance from which they may choose the arrangement that offers greatest cash flow security and hence, maximizes the availability of private finance at affordable cost. By contrast, in low-income countries, the sheer poverty of large swaths of the population severely constrains both the overall availability of finance and the funding mix, and equity concerns are a more severe issue than in developed countries.

Finally, to what extent is climate change exacerbating the challenge to finance infrastructure in developing countries, knowing that the latter will be hit harder than developed countries? This question may be seen from two angles, the mitigation and the adaptation angle. The former refers to investing today in infrastructure conducive to lower greenhouse gas emissions tomorrow while the latter is about making infrastructure assets resilient to extreme climate events. While both needs tend to increase the required upfront capital expenditure, they both offer the prospect of significant benefits to society, too. As it turns out, adaptation needs are relatively small compared to the overall development gap. Indeed, what contributes to developing countries' vulnerability to climate change is not so much the lack of climate-resilient infrastructure but the lack of basic infrastructure to begin with.

The contributions to this issue of the *EIB Papers* provide enlightening insights into these (and further) policy questions that will advance our understanding of infrastructure financing issues. I am confident that they will also serve a wider audience in Europe and elsewhere.

Public and private financing of infrastructure

Policy challenges in mobilizing finance

The *2010 EIB Conference in Economics and Finance* – held at EIB headquarters in Luxembourg on November 11 – brought together academics, policy makers and companies to discuss trends and policy issues in infrastructure-financing. It highlighted the relevant facts and figures and the basic economics of infrastructure finance. Moreover, it focused on infrastructure assets and markets, including the impact of the crisis, and it identified the key factors shaping infrastructure finance going forward as well as the public-policy issues involved.

Speakers included:

Rien WAGENVOORT
of the European Investment Bank

Eduardo ENGEL
of Yale University

Georg INDERST
Independent Adviser

Christoph KASERER
of Technische Universität München

Nicolás MERIGO
of Marguerite Adviser S.A.

Dieter HELM
of University of Oxford

James STEWART
of Infrastructure UK

Marianne FAY
of the World Bank

Antonio ESTACHE
of Université Libre de Bruxelles

ABSTRACT

Europe faces major investment in infrastructure in the coming decade in the context of the credit crisis and the broader economic crisis that followed. *The article considers what the core market failures in infrastructure are, focussing on the gap between marginal and average costs, the system nature of infrastructures, and the time inconsistency problem. The difficulty for government in providing credible commitments to investors in respect of the fixed and sunk costs is the classic problem in contract and institutional design. The roles of government and the private sector are defined, and the article proposes that the concept of regulatory asset bases (RABs) developed in privatised-utility models provides a way of cementing in commitment and hence ensuring that regulatory and political risk is appropriately allocated. As a consequence, the financial structure of infrastructure investments can be determined, with debt playing the primary role in respect of the RABs, and equity in respect of the creation of new infrastructure.*

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Infrastructure and infrastructure finance: The role of the government and the private sector in the current world


Dieter Helm

1. Introduction

It is widely acknowledged that major investment is required in European infrastructure. This is partly as a result of the historical investment cycles, with replacement now a priority. It is also due to technical change, changes in demand patterns and the need to decarbonise in the face of the climate change challenge.

To these are added the challenges of integrating networks and competitiveness: Europe lacks integrated electricity and gas networks, and its transport and communication networks are fragmented. The result is higher costs as network capacity margins are required in each country to meet unanticipated demand, scale economies remain unexploited, and transactions costs between the networks are high.

For historical reasons, Europe's infrastructure networks have been developed largely in a piecemeal and bottom-up fashion, with a multitude of standards and technologies. Even in those countries which have centralised nationally (like France and Britain after the Second World War), the systems have a distinctive national flavour in a European context.

Europe's piecemeal approach has also been a feature of the institutional framework for infrastructure development. Though all countries have had some state involvement, the spectrum is a wide one, between the centralised state provision through ministries and state-owned companies, local municipalities and private provision. This spectrum of provision is matched by a spectrum from public to private-finance, and from franchises to asset ownership.

From the late twentieth century, increasingly the ownership as well as the finance of infrastructure assets were transferred to the private sector. Privatisation reduced the role of the state to one primarily of regulation, and investors sought out the security of more stable and predictable rates of return, supported by the ownership of the assets. A "new" model emerged of regulated privately-owned and privately-financed infrastructure utilities.

Yet not all infrastructure assets fit into the utilities class, and alongside the privatisation model, a host of project-specific institutional arrangements were developed. These were given names like "public private partnerships" (PPPs) and "private finance initiatives" (PFIs). Numerous variants emerged as projects tended to be treated on a case-by-case basis.

Much of the impetus for the greater involvement of the private sector came from cash-strapped governments trying to raise monies and reduce their capital expenditures. It was, in effect, an attempt at off-balance sheet financing. But there were efficiency motives, too: the idea was that private provision and private finance would improve efficiency and, where possible, user charges would create better incentives between providers and customers. Though it was widely assumed that the cost of capital would be higher, this extra cost would be offset by lower capital expenditure costs and better design.

These moves towards private provision, private ownership and private finance pre-date the latest economic crisis. In the booming debt and equity markets of the 1990s, capital flows to infrastructure and privatisations were relatively easy to pull off. After the stock market crash in 2000, the loose monetary and fiscal policies – especially the low interest rates – provided a debt-based flow of funds, and gearing levels increased, with infrastructure funds coming into the markets on the back of the acquisition of debt-based assets.

In 2006, real interest rates started to rise back toward their longer-term averages, and the credit crunch reflected the problems of asset valuations which had been driven by debt at close to zero real interest rates. Interest rates were again lowered, and quantitative easing added a new dimension to infrastructure finance, as central banks bought up government bonds (a close substitute for utility debt) and indeed, in the UK's case, the central bank directly purchased utility bonds.

In the recent recession, debt for existing assets became very cheap while finance for new infrastructure did not.

The credit crunch led on to the economic recession. Demand fell – including for infrastructure services. The supply of credit remained constrained although the cost of debt ironically became even cheaper. Utilities provided a relatively safe haven, with the ability to pass through inflation as well. Yet the cost of equity did not fall correspondingly and financial markets made a strong distinction between debt finance for existing assets in regulated utilities, and the finance for new capital expenditure, especially that outside the explicit regulated-utility frameworks. Hence the irony: never had the cost of debt been lower and risk-averse investors so willing to accept very low returns on bonds; and yet the problems of financing new infrastructure assets have gone up significantly, especially where there is a requirement for equity.

This article considers why there is this strong distinction between the cost of debt for existing regulated assets and the cost of debt and equity for new infrastructure. It explains why and how regulation can address the core economic problems which infrastructure brings – the nature of long-term fixed and sunk costs in a context where average and marginal costs sharply diverge and where political and regulatory incentives to expropriate the sunk costs are strong (Section 2). The article then considers the implications for the respective roles of government (Section 3) and the private sector (Section 4). The specific problems of private finance are considered next (Section 5), and a model for extending the concept of regulated asset bases across the wider infrastructure space is set out (Section 6). The immediate and longer-term effects of the credit crunch and the resulting economic crisis on infrastructure provision and finance are then considered (Section 7) and a number of policy implications and conclusions are drawn (Section 8).

2. The infrastructure problem: Public goods, credibility and commitment

Part of the confusion over the design and implementation of infrastructure policy is a lack of clarity about what the problem is to which the various instruments are supposed to provide solutions. There is much discussion about access to and cost of finance, but little by way of explanations as to why these financing problems arise.

Infrastructure poses multiple market failures – and intervention poses multiple government failures. The primary failures are related to public-goods properties, sunk costs, market power and externalities.

Most infrastructure forms part of networks and systems. These systems tend to be public goods: once they are in place, the marginal costs of another consumer tend towards zero. Hence economic welfare is maximised by providing the public good to as many consumers as possible, with marginal incentives which reflect the marginal and not the average costs. This, however, raises the obvious public-goods problem – how to recover the fixed (and sunk) costs without creating distortions to consumption?

A number of "solutions" to this cost recovery problem have been proposed and many have been tried in practice. Amongst these there is an inherent tension between economically efficient mechanisms which relate the fixed costs to the (inverse of) demand elasticities and those which take account of distributional considerations. Fuel and water poverty are significant problems, whilst transport to rural and poorer groups of customers have typically received priority in charging the marginal rather than average cost.

The determination of prices and the allocation of the fixed costs inevitably involve governments. This is in addition to the point that the optimal scale and design of a system needs to be determined at the system level. It cannot be the aggregation of a series of disaggregated market choices. Hence the choice and provision of the system itself have a core political element – with inevitable consequences for the level and allocation of risk in the context of government failures.

The most important context in which this political and regulatory dimension arises is in respect of the fixed and sunk costs. It follows from the above that a very large gap between the average and marginal costs exposes investors to the problem that their *ex ante* investments may be subject to *ex post* expropriation as there will be a political and regulatory incentive to drive prices to marginal costs in the full knowledge that owners will operate the assets up to the point where only their marginal costs are covered. Where the assets are long lived, the exposure of these fixed and sunk costs is particularly important. In response, investors will seek long-term contracts and/or fast depreciation to recover these costs. As we shall see below, these long-term contracts are at the heart of the regulatory design of infrastructure policy. The problem is how to design credible political and regulatory commitments to the recovery of the sunk costs – in other words how to overcome the inherent *time inconsistency problem*. During much of the twentieth century, the inability to credibly commit on the part of governments undermined investment incentives so seriously, that nationalisation was required with the state doing the investing which the private sector was reluctant to deliver.

Governments are tempted to drive prices to marginal costs knowing that owners will operate as long as their marginal costs are covered.

Historically, one solution has been to recognise that the provision of much infrastructure has monopoly or market power elements. The investor can in principle therefore rely on their monopoly to exploit customers so as to recover the sunk costs. Road and bridge tolls played this part in the early development of roads, for example.

Monopoly, however, brings two problems: first, it may not last; and second, it leads to political and regulatory intervention. With long-lasting assets, investors would need long-lasting market power to match their sunk costs. The problem with monopoly is, however, that it provides the seed of its own destruction – what Schumpeter famously called "creative destruction" of entry and technological change induced by the presence of monopoly rents. For most network systems, cherry-picking of customers is an attractive option. Entrants choose to service only those parts of the market where marginal costs are lowest, and to cream off correspondingly high-value customers. This, in turn, drives the incumbent to charge greater proportions of their fixed costs to those customers less attractive to entrants. Where network competition is deliberately encouraged, this can cut quickly into broader distributional considerations. Provision of rural postal and telecommunications services fits into this category. At the limit, duplicating networks helps core attractive customers get better deals, but raises the costs of the incumbent networks.

Market power may not last for a further reason: technical progress may cut away the market. In almost all major network systems this is a real threat. In electricity, smart grids and meters threaten existing assets. In communications, copper wires face threats from new transmission mechanisms, including wireless ones. For nuclear and wind technologies, over the next decade or two, both may face new cheaper rivals. The longer the lives of the assets, the greater is the risk of stranding. Long-term contracts and regulatory regimes are again parts of the solutions.

Externalities are pervasive in infrastructure. These fall into two broad categories – environmental and social. Environmental externalities are multiple – in terms of greenhouse gases, other forms of air pollution, water pollution and runoff, noise and land use and biodiversity. For example, a new runway or airport will raise greenhouse gas emissions, increase local air pollution, result in significant water runoff, create significant noise affecting local people and their house prices, and take up land which can often include areas with considerable biodiversity value, such as marshes and open spaces.

In theory, the "correct" solution is to price each and every externality. In practice, this is impractical and politically impossible. The result is that decisions are based on politics and planning, and very much open to political and regulatory failures.

Social aspects of infrastructure arise not only in the allocation of the fixed costs between customer groups discussed above, but also in respect of wider concerns about inclusiveness and access to essential services. Infrastructure is a core aspect of the provision of basic social goods which are essential to participate in society. Infrastructure lies behind the provision of health, education, heating, lighting, transport and communications. No civilised country can be indifferent to these dimensions. Indeed, at the limit, people freeze to death through fuel poverty, and die if they do not have access to hospitals and transport to them. For these reasons, it is inevitable that governments will want to influence the design, provision and pricing of infrastructure.

3. The role of government

The role of the government is to make main infrastructure choices, facilitate planning and licensing, and credibly commit to the efficient sunk costs.

Given the market failures, it is inevitable that the role of government lies at the heart of infrastructure policy, and that its finance depends on how that role is designed and implemented. Government failures in turn raise the costs of provision and finance, and in particular affect the cost of capital and the optimal mix of debt and equity.

The role of government is: to provide for the over-arching choice of networks and infrastructure; to facilitate planning and licensing; and to provide a credible commitment to the efficient sunk costs of the investment, whilst ensuring that market power is not exploited.

3.1 Decisions about infrastructure

Deciding about the overall shape of infrastructure is for most governments a fraught process. It does not occur in an efficient political vacuum, but rather, given the size and scale of infrastructure decisions, it is almost always set within wider budgetary constraints. With governments faced with significant constraints on spending, and with little practical differentiation between capital and current spending, most governments will be tempted to reduce capital expenditure (CAPEX) to protect operating expenditure (OPEX), and to respond to short-term macroeconomic constraints.

In part this is a response to the inadequacy of government accounts and the failure to distinguish between consumption and investment. Most government accounts are in cash terms – there have been few serious attempts to create national balance sheets, reflecting asset values and, in particular, depreciation. GDP growth in particular, a primary aim of most governments, takes little account of the state of infrastructure assets, and indeed, spending on consumption rather than on meeting depreciation tends to increase GDP in the short run. As a result, major projects are almost always subject to stop-go interventions.

The "correct" way to think of the government's position in respect of infrastructure is to consider the national balance sheet in current cost terms (Helm 2010a). Arguably, the job of government is to be indifferent between generations and to maintain an infrastructure through time capable of meeting the needs of the economy and society. It is a general set of public goods. It therefore makes little sense to depreciate the assets. Rather, an infrastructure renewals charge is the appropriate way to maintain the operational value of the assets intact. It is operational in the sense that the precise mix of assets is likely to change over time as technology changes and as wealth varies. For example, broadband and smart grids now play a prominent role, whereas once fixed telecommunications and conventional electricity networks were sufficient.

An infrastructure renewal charge is a way to maintain the operational value of the assets intact for the next generation of users.

Once assets have to be maintained intact – in effect asset lives are treated as infinite and infrastructure maintenance and renewal replaces depreciation – national accounts need to make provision for the necessary infrastructure spending. This "charge" is determined not by the short-term macroeconomic requirements, but by the condition that the assets must be maintained in at least as good a state. The implication is radical: consumption is the residual item, not investment, and when macroeconomic constraints bite, then it is consumption that has to adjust. In the current economic crisis, this points away from attempts to boost demand through consumption, and towards more investment.

These considerations set the current estimates of the infrastructure spending requirements within Europe (and indeed the US) into context. For the last two decades (with some notable exceptions like Germany after reunification), assets have been allowed to deteriorate. They have, in effect, been depreciated. Furthermore, the combination of a "new" problem – climate change – and new technologies – like broadband and the application of information technology (IT) to transport and energy networks – have together necessitated a major change in the composition of infrastructure. The energy and transport systems in Europe are predominantly based upon fossil fuels at a time when policy is to radically decarbonise, rendering much of the existing assets redundant, and whole new infrastructures have emerged as system public goods.

Climate change can be considered as a classic failure to take account of depreciation: the atmosphere as an asset has been degraded without compensating investments. Biodiversity and the pollution of fresh and marine water environments provide additional examples.

Government's role is therefore to provide not just the choices over infrastructures and infrastructure systems – to decide how much broadband, smart grids, electric trains and roads should be provided – but also to ensure that existing assets are maintained at least operationally intact. The latter requirement is wholly absent across European national accounting, and the former is seriously impaired as a result of the latter. Decisions about infrastructure and infrastructure systems become driven by short-term macroeconomic considerations.

3.2 Planning and licensing

The next task is to facilitate infrastructure investment by providing for planning permissions and licences. Almost all infrastructure requires the acquisition of land and imposes significant externalities on local populations. New roads tend to go through countryside and houses, airports impose additional noise and pollution, and electricity transmission lines blight the landscape. Wind farms, nuclear power stations and major buildings like hospitals and schools impose significant costs. Almost all have also knock-on consequences for other networks and infrastructures.

Gaining the permissions to build and the licences to operate is necessarily a political matter. Only political frameworks can allocate such rights (and damage others' interests). Property right allocation is never a matter purely of economic efficiency, and indeed attempts to make such decisions technocratic tend to lack legitimacy and hence, open up decisions to *ex post* reappraisal.

There have been a number of attempts to make planning "independent" – notably Britain's Infrastructure Planning Commission. Like the Monetary Policy Committee's decisions (and the European Central Bank's) on interest rates, and the Competition Commission's decisions (and the European Commission's) on mergers, the idea is to remove politicians' assumed short-termism and responsiveness to capture by narrow interests, and instead replace this with independent experts who decide what is in the public interest.

The objections are numerous and overwhelming. The idea of a purely publicly-interested technocrat adjudicating on economic efficiency is a fantasy of economic theory and textbooks: given a social welfare function, the technocrat chooses the efficient outcome. Yet there are two overwhelming problems: first, there is no clear and unambiguous social welfare function; and second, "experts" are human and may be prone to having interests and being vulnerable to capture, too. The difference between the two approaches – planning within a political context, and planning by technical experts – is that the former has significantly greater legitimacy. The latter can inform the former, but not replace it, if investors are to have faith in the credibility of the decision and, crucially, its robustness against *ex post* revisions. As we shall see, this matters greatly for the determination of the cost of capital and hence, the efficiency of private finance.

3.3 Credible commitments and sunk costs

Investors demand that the government – on behalf of future customers – commit to paying the sunk costs.

The third role of government is to credibly commit future customers and taxpayers to paying for the fixed and sunk costs of infrastructure investments. The time inconsistency problem identified above bedevils infrastructure investment. Future customers want the services provided by future infrastructure. Investors know that once the costs are sunk, they can be expropriated *ex post*. They therefore demand that future customers commit to paying the sunk costs which they, the investors, provide.

But a contract between future customers and current investors in the infrastructure space almost always involves government because government implicitly or explicitly determines the price, because government is the only agent capable of acting on behalf of future customers, and because future customers are also voters and therefore have an incentive to lobby politicians to renege on the sunk costs.

These difficulties tend, surprisingly, to be recognised in the detail rather than the generality. As a result, in the literature, too, little attention has been paid to how to organise infrastructure contracts in a credible way, and in particular to how government should optimally contract and what institutions are necessary to ensure that contracts are enforced. The framework for PFI, PPP and utility regulation are all attempts to resolve the time inconsistency problem, as are models for more direct governmental procurement.[1]

Below we consider how well these mechanisms work and how the concepts of regulated assets and regulatory asset bases might improve on the mechanisms for commitments. The point to establish here is that failure to credibly commit has a direct financial consequence – the cost of capital is determined by the degree to which risk has been efficiently allocated. Credibility is a political and regulatory risk, not a business problem.[2] Hence, the allocation of that risk to the private sector is, in effect, the allocation of exogenous risk to private investors. Since it is exogenous – investors cannot manage it – the relative cost is likely to be high, and higher than if it remains in the public sector, where in principle that risk is endogenous.

1 For a range of examples and the implications for commitment, see Hogan and Sturzenegger (2010).
2 On its relation to price caps, see Helm (2010b).

In practice, whether the political and regulatory risk is endogenous – whether the public sector can manage it – is debateable, and it depends upon which bits of the public sector it is imposed upon. For example, local government may have little control over central government, and particular public bodies like hospitals and transport authorities may similarly have to treat the credibility risk as exogenous.[3]

The reason this matters is that political and regulatory risk is *equity risk*, and risk allocation is all about settling the equity risk appropriately. If equity risk is placed upon private investors to whom it is exogenous, then it will raise the equity cost of capital. Put simply, the greater the risk that *ex post* political and regulatory interventions will undermine the recovery of the sunk costs – the drive towards marginal cost pricing – the higher the private equity cost of capital.[4]

The greater the risk that regulatory interventions undermine the recovery of the sunk costs, the higher the cost of private equity capital.

This higher cost of capital in effect telescopes future returns back towards the present. It is similar to a high depreciation charge. Investors want their money back sooner rather than later, the greater the chances of *ex post* intervention.

The standard response is that investors can diversify this risk – which the Capital Asset Pricing Model (CAPM) will reflect in the beta coefficient as the volatility to the market of the project, not the inherent risk in the project itself. Putting aside the obvious reply that this is not what project appraisers tend to do in practice, the broader issue is whether political and regulatory risk can in fact be easily diversified. It is not obvious who the beneficiaries of an *ex post* intervention in a time-inconsistent way would be.

The practical way in which these questions have been addressed is through institutional design – through the legal framework and through the development of arms' length regulatory bodies.

Legal protections for investors are obviously extremely important, and in countries with a legal tradition based upon the protection of property rights, the courts are the natural way in which time inconsistency is addressed. In the US, this is particularly apparent. It is also a developing trend in European legislation, where the rights-based framework has increasingly been used to defend private property rights against expropriation by public bodies and governments.

In other countries (like Britain), the public interest tends to dominate the primacy of property rights – and where piecemeal pragmatism lends discretion to public officials. Here the focus is on mechanisms outside the courts to fetter the discretion to *ex post* intervention. A broad-based public interest test for intervention is typically a greater risk from a time inconsistency perspective: conditions and circumstances change, and the pliability of the public-interest test allows this to be reflected in decisions about pricing and cost recovery.

In these sorts of countries where pragmatism about the public interest dominates over courts and legal constraints, the emphasis has been on creating independent institutions as intermediaries between the government and the investors. Unlike planning – where decisions are made about the systems and specific projects and licences granted – the sunk cost issue arises from the capital expenditure, not the granting of permission to carry out the project. The intermediary is the guarantor that the government will honour its commitment and regulators will have due regard to investor

3 In the case of the London Underground, for example, it is far from obvious that the political and regulatory risk has been reduced by the recent transfer of the private-sector company Tube Lines to the public-sector company Transport for London. Neither company had much control over HM Treasury nor, hence over the determination of the capital budget for the upgrade of the London Underground or indeed the related project Crossrail.

4 On the role of risk in capital structure, see De Fraja and Stones (2004), Dewatripont and Tirole (1994) and more generally, Hart (1995).

protection. In the utility sector, a host of new regulatory bodies has been created, partially with this purpose in mind. Such measures – not only in the UK, but also across Europe through Directives requiring independent regulators – have not, however, generally been extended to PFI and PPP contracts and, as we shall see below, this has had a number of impacts. It has tended to result in higher costs of capital, but also the use of other mechanisms to give investors security, including claims on the assets and further contracts on maintenance and ancillary revenue streams.

4. The role of the private sector

Faced with the political dimensions of infrastructure systems and projects, an obvious question to ask is whether the private sector has *any* role to play. For much of the twentieth century in Europe, the answer has been "very little", and largely as a contractor to projects, rather than as an investor in projects. Governments could not commit to making timely decisions, providing for planning decisions without the desire to maintain the flexibility to change and alter the decisions *ex post*, and above all commit to the sunk costs. The preferred model was state-owned companies and departmental investments. The great post-Second World War nationalised industries played this role in Europe, alongside notionally private national champions who were in many regards implicit agents of the state.

This internalisation within the public sector was not without merit: it put the political and regulatory risk where there was at least some scope to manage it. Taxpayers and customers shared the risks, and governments could typically borrow at lower rates than the private sector.[5] Yet it became gradually apparent that the failure to disaggregate the various types of risk, and the failure to take account of the incentive structure of the public sector could lead to sub-optimal outcomes.

4.1 Private production

The role of the private sector has gradually increased: from carrying out the physical investment…

The easy bit was to focus on public versus private production – the differences between private and public asset operations (OPEX) and carrying out the physical investment (CAPEX). Public incentives arguably encouraged operating cost bias towards labour (reflecting upon influences on governments) and a tendency to over-invest (notably in areas like electricity transmission and power stations' capacity margins).[6] In other areas, resistance to reflecting changes in demand and technology were witnessed in a reluctance to prune rail networks as car transport grew. The idea was that in the public sector there would be a tendency to "predict and provide" in a context in which there were strong incentives to over-predict and hence over-provide.

The important point here is that the perceived problem for which the private sector was deemed to be the solution was over- and not under-investment. The corollary is that as the role of the private sector has grown, the result is a tendency towards under-investment. Some would argue that – as predicted at the privatisation of many core infrastructures – that is what has happened.[7]

Though the constraints of public finances have now, in effect, curtailed this concern, the response is that it is not the job of the private sector to decide on the appropriate level of infrastructure investment. This, as argued above, is for government. It is government that should determine the bundle of public

5 In the current context, with negative real interest rates, this lower borrowing cost cannot be ignored.
6 The classic framework for looking at incentives and regulation is Averch and Johnson (1962). For a recent survey of the relation between efficiency and privatisation, see Cavaliere and Scabrosetti (2008).
7 Examples include the debates about the privatisation of British Airports Authority and electricity privatisation in Britain.

infrastructure goods for the economy. Thus, the current state of Europe's infrastructure is as much a consequence of the failure of governments to set the frameworks and decide about the public goods as it is a perceived failure of the private sector to invest.

If the private sector's role is to carry out decisions ultimately made by governments on behalf of customers and taxpayers, then it is ultimately all about contracting. The private sector can operate assets and build assets. Construction risk and operational risks are risks which can be endogenised to the private management.

The advantages of the private sector in operating and building is that their incentives are simpler (profits) as opposed to the complexity of the public sector (maximise social welfare) and that the private sector is less open to lobbying and capture by vested interests.

The private sector brings this simplicity of objectives to bear through a competitive bidding market. Rival companies compete for contracts. Provided that the outputs are clearly defined and provided that there is no corruption (implicit or explicit), costs of both operation and build should be more efficient.

The provisos are, however, important. Corruption tends to arise where the public and private sectors interact and large construction projects in Europe have a long history of associated corruption scandals. Here the issue is the design of the competitive bidding process and the legal framework of fines and penalties for corruption.

4.2 Private asset ownership

Contracting out operations and build are incremental steps: they are all about defining limited-period contracts, and leave aside the problems of finance to which we return in the next section. A further more radical step is the transfer of the ownership of infrastructure assets to the private sector – either for existing assets through privatisations or through the retention in the private sector of new assets which are built.

…to outright ownership and operation of existing and new infrastructure assets.

Privatisation transferred the assets as well as the licences in respect of OPEX and CAPEX to the private sector (see Helm and Tindall 2009). The asset transfers were attractive to governments concerned with general government finance, but they also provided a security against which future investment is made. In setting prices, regulators were typically required to pay attention to the "financing of functions" and this in turn meant not only a return to CAPEX and the appropriate provision for OPEX, but also a return on the existing assets. In the process, and more by accident than design, the concept of a "regulated asset base" (RAB) was developed, and this in turn led to a mechanism by which the creation of new assets (CAPEX) could migrate into old assets once completed and then transferred into the RAB.[8] The crucial point here is that the RAB represented the sunk costs – and the RAB mechanism thereby became a means to addressing the time inconsistency problem. It was not that the assets needed to be owned by the private sector to facilitate private building of new assets: it was rather that the ownership of old assets was the collateral against new CAPEX and the mechanism for recovering the sunk costs. Giving a return on RAB assets meant that pure *ex post* marginal cost pricing could not be applied and thus limited time inconsistency expropriation of sunk costs.[9]

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8 It was a modern restatement of the pervasive concept of a "rate base" required in rate-of-return regulation and developed extensively in US post-Second World War regulation. To provide a calculation of the actual returns, the question "on what?" had to be answered.

9 See Helm (2009a and b) for a more comprehensive exposition of the RAB concept.

4.3 PFI and ownership

Discussion of PFI projects has tended to focus on the finance bit, to which we turn in Section 5 below. However, the important dimension from the perspective of time inconsistency is the assets themselves and how the revenue is generated to remunerate the sunk costs. In this regard, PFI projects vary greatly. A project can be built and then transferred at a variety of subsequent dates. There can be a fixed contract period (for example, the 30-year contracts for the London Underground) or a transfer on completion. In some cases, the PFI contractor gets to build and then operate the asset, with charges for the asset's use covering the build and the operations costs. In effect, the user charges cover all the costs of the contractor – and at the limit these are equivalent to mini-utilities for single assets like hospitals and schools.

In PFI projects, there is typically a fixed period for the contract and then a transfer to the public sector.

More typically, there is a fixed period for the contract and then a transfer to the public sector. The period can be designed to fit with the depreciation in life of the asset, so that the investor recovers the full capital costs through depreciation in charges against users. This is, however, likely to be equivalent to the public sector's current cost approach discussed above. If, for example, the government wants to provide a service of say, education, and it needs schools to achieve this, then the current cost approach is to provide for infrastructure renewal through user charges (in this case to the taxpayer). As a result, there is a distinction between paying the contractor to build the school and the subsequent treatment of the building. Buying the completed project as a capital asset at completion does, however, run into a government accounting issue: whether the cost can be spread over the life of the asset or must be taken as a cash payment in a specific year. This is, however, a consequence of inappropriate accounting rules, not of efficient contract design.

5. Private finance

All finance is ultimately private: governments derive all their income from individuals – either through intermediaries such as companies (ultimately owned by private individuals) or directly through taxes on individuals. For infrastructure assets, the revenues come from taxpayers and customers. The question is not, therefore, whether individuals or governments should finance infrastructure: the question is whether individuals should do it directly, through their intermediaries like pension funds, or through the intermediary of government.

The conventional argument for government finance of infrastructure has been that the government can borrow at lower rates than private individuals. Why? The answer conventionally given is that the government is lower risk for two reasons: because it has the biggest portfolio and, hence the CAPM-type diversification of risk favours big entities like government; and because it is debt rather than equity.

This argument is superficially attractive. Why, for example, finance a new fleet of nuclear power stations at a private sector cost of capital to large energy companies of, say, 10 percent real when the government can borrow at, say, 2 percent real? Or, indeed, in the current context, at negative real interest rates? It is extremely unlikely that for capital-intensive projects the CAPEX efficiency savings could be equal to 8 percent in this example, especially when spread over a very long period.

Furthermore, a low cost of capital leads to a low discount rate, which in turn puts greater value on the future over the present and therefore introduces a degree of intergenerational equity. Private investors, the argument runs, tend to be myopic, whereas society should be indifferent up to the point at which consumption takes place.[10]

10 For a broader consideration of these intergenerational effects of discounting, see Guo *et al*. (2006).

The confusion at the heart of this pro-public-sector finance argument is in the second part – between debt and equity. The reason governments can borrow at lower rates is twofold: first, that they have a monopoly on force – they can compel taxpayers to contribute through legislation and ultimately, force; and second, that taxpayers absorb the equity risk.

Government debt looks much cheaper than private equity because the government has a monopoly on force and taxpayers absorb the equity risk.

But equity risk never goes away. Thus, the true cost of capital to the public sector is the cost of debt plus the implicit cost of equity which is absorbed (and disguised) by taxpayers. The comparison between the 2 percent and the 10 percent in the example above is therefore bogus.

What, then, is the equity risk absorbed in the public sector by taxpayers? It comprises at least three elements: the risk of bankruptcy; the risk of the *ex post* CAPEX costs versus the *ex ante* competitive rate; and the political and regulatory risks of reneging on the sunk costs and hence, of time-inconsistent behaviour.

5.1 Bankruptcy

Investors in equity run the risk that the company goes bust and thus, that they lose their money as debt holders have a prior claim. Taxpayers run the risk that government defaults on its debt and that it raises taxes. There is less of a direct link to the government's investment projects, and the costs are spread over all taxpayers. In some countries – like Greece and Portugal in the recent financial crisis – the risk of government defaults is greater than those of individuals and lending to utilities can be at lower costs than to government. In the end, governments can, directly or indirectly, print the money, and renege in that way. Owning the asset is a safer bet: whatever macroeconomic policy is pursued, the pipes and wires and buildings will still be there and have an intrinsic value, as long as their services are demanded.

For the private sector, bankruptcy is a greater threat. Here the ownership of the assets matters, and in particular if the assets are directly tied to the projects that are being financed. If investors in infrastructure CAPEX continue to own the asset once built, even for a limited period of time, there is then some collateral in the event of bankruptcy. Ownership therefore matters if bankruptcy is a potential problem. On balance, however, the government has an advantage over private finance regarding the effect of potential bankruptcy on the cost of capital.

5.2 The CAPEX risk

CAPEX risk pervades infrastructure asset creation. These are typically large projects, requiring complex project management. They tend to have unique features, and they tend to need to be integrated into networks and systems, so their costs depend on coordination. Rebuilding a railway line (like the West Coast Mainline) may need to be coordinated with continuing to operate the system. New offshore electricity transmission assets need to be joined up with wind farm development and onshore systems.

The difference between private and public finance in the CAPEX risk management arises because of the different incentives on public and private-sector project managers that come from private investors. Public-sector managers face a complex objective function and are subject to political and lobby pressures. They are also more likely to be influenced by union interests. These influences extend to the choice of suppliers, the supply chain and to the openness to *ex post* re-design and budget changes.

There are a number of public-sector examples of the different incentive structures. Perhaps the most dramatic in post-war Europe has been the Advanced Gas Reactor (AGR) nuclear programme in Britain.

The initial investment decisions were distorted by a "buy British" reactor choice. Then each design was altered. Then budget pressures came to bear. The result was a very significant cost over-run.[11]

Yet this example illustrates that there is nothing inevitable in public-sector CAPEX inefficiencies. The French nuclear programme has a very different history, and reflects a different approach to public-sector decision making and project direction.

5.3 The sunk-cost risk

Apart from bankruptcy and CAPEX risks, the cost-of-capital difference reflects the extent to which the private sector bears political and regulatory risk.

The third aspect in explaining the cost of capital differences between private and public finance lies with political and regulatory risk, and specifically with the allocation of political and regulatory risk. The simple argument elucidated above is that risk should be allocated to those best able to manage it and hence, that political and regulatory risk should be allocated to the public rather than private sectors.

The obvious way to do this in private finance is through rate-of-return type regulation. Costs are passed through to customers, and investors are entitled to a fair return on their assets, provided the CAPEX is efficiently carried out. This indeed has been the approach in the US for much of the period since the Second World War, notably in electricity utilities. Backed up by a legal system which focuses on individual property rights, it solved the sunk cost problem. As a result, the cost of capital to US utilities tended to be very low, approximating the return on bonds.

Yet this is simply a reclassification: the equity risk in relation to the sunk costs has not gone away. It has simply been transferred to customers. The equity risk in respect of CAPEX remains as long as there is an efficiency test. Bankruptcy is close to impossible, since there is a rate-of-return guarantee.

This opens up a further cost-of-capital consideration: who has the best incentives to minimise the deadweight welfare costs of political and regulatory risk? The answer turns out to be complex. First, the deadweight loss is not simply the prospect that there may be *ex post* intervention. Flexibility may be a good thing: committing to a project over a long period covers times over which there can be unanticipated changes in demand, cost conditions and technology. For example, a government might commit to a private programme of offshore wind development (say through the Renewables Directive) and then discover that the costs are higher than anticipated, new technologies become available, and fossil fuels turn out to be much cheaper than anticipated. In such circumstances, it would be inefficient not to change its mind.

So flexibility can be valuable, but the sorts of fixed-price, fixed-period contracts which typify PFI-type initiatives, tend to limit its scope. What matters, then, is not flexibility in general, but flexibility in particular: the exercise of discretion *ex post* to expropriate rather than to adapt to changed demand, cost and technological conditions. This turns out to be about contract design – and about separating-out and allocating the different types of equity risks.

6. Regulation, the RAB and private finance

Having identified the roles of the state and the private sector, and having considered how to allocate the equity risk between taxpayers, customers and shareholders, how, then, might the regulatory

11 See Helm (2004), chapters 2 and 5, for the history.

framework be designed to enable private finance to be efficiently provided and hence, to facilitate the large-scale infrastructure investment now required?

The key issue is the sunk costs, and the RAB provides a mechanism for first identifying the sunk costs and then giving a commitment to ensure that these sunk costs are remunerated.

In the standard utility model, the RAB comprises the initial value of the assets privatised and then completed CAPEX which has not been paid for out of current customers' bills. In effect, the completed project is "bought" by the RAB at the agreed efficient price. Once inside the RAB, there is no additional requirement on management to do anything to maintain what is a financial number (the agreed "purchase" price). The residual risk is that the regulator will renege on the payments, change the number or not force customers to pay. This political and regulatory risk is the only equity risk left. Hence, the utility can, in principle, finance the RAB entirely from debt, with the equity risk transferred from the investor to the political and regulatory domain.

The Regulated Asset Base (RAB) comprises the initial value of the privatised assets plus the CAPEX not yet recovered out of bill revenues.

This approach has some obvious advantages. It places the equity risk with those best able to manage it, and in thereby facilitating debt finance, the cost of capital for the RAB to the investors is the cost of debt. In practice, this is a small premium over the risk-free rate, and given that the RAB is technically owned by investors, they have the collateral of these assets, which provides additional investor protection.

The credibility of the commitment to the sunk costs is further reinforced by the design of the regulatory institutional framework. "Independent" regulators, created by statute, have a duty to "ensure that the functions are financed", which in practice means that the regulator must make sure there is sufficient revenue to cover the OPEX and CAPEX, and a return on the RAB.

In order to ensure continuity of service provision, there is also typically a ring fence created around the regulated and licensed utility. This ring fence is financial and physical: there must be monies to finance the business, and there must be assets to deliver the services. In the event of failure, the licensed entity can be placed under "special administration", and then sold on. Since the RAB must be financed, the ring fence essentially protects the value of the RAB, and therefore investors can be assured that they should be able to gain the value of the RAB when the licence is sold on (though they may face losses in respect of OPEX and CAPEX failures).

This model has the potential for a much wider application across the infrastructures. It is, in effect, a contractual guarantee to the sunk costs, and it provides an equity exit for investors. This is represented by refinancing. The CAPEX itself is typically financed by equity and project finance, and this reflects the fact that there is equity risk in doing the CAPEX. When it is completed, this CAPEX equity risk is extinguished. The project did or did not come in below budget. At completion this equity gain or loss is crystallised.

An important regulatory dimension, at this juncture, is to make sure that investors get their cost of capital, but not ongoing excess returns. Up to completion, the possibility of excess returns is core to the incentives to out-perform on the costs side. After completion, managers cannot outperform because there is nothing they can do to alter the number that goes into the RAB. They should receive only the marginal cost of debt, since there is no equity risk.[12]

12 A residual risk is the one between price setting intervals and inflation. It can be mitigated through index-linking the debt (see Brearley and Franks 2009).

A further lesson from the experience of British utility regulation is that if a Weighted Average Cost of Capital (WACC) is applied across both the OPEX and CAPEX, and the RAB, then the result will be to give too low a return to the CAPEX (and OPEX) and too high a return to the RAB. The result will be to blunt the incentives on CAPEX – because the equity risk is not properly rewarded – and to encourage financial arbitrage on the RABs. If the marginal cost of debt is, say 3 percent real, the marginal cost of equity, say 10 percent real, and the WACC is set at, say 5 percent (allowing for gearing over 50 percent), then there is an incentive to exploit the margin between the cost of equity and debt in respect of the RAB. Indeed, this is precisely what has happened: leverage has been applied to gear up the utilities, with the capitalised value of the difference going to shareholders. Customers have therefore not only absorbed the equity risk of the RAB (through the cost pass-through) but also paid for that equity risk to be transferred from shareholders to themselves.

Owners of utility assets have, as a result, made an unwarranted (and typically very large) excess return through financial engineering. But they have also been under-rewarded on the CAPEX. This has not mattered much to date, since the companies have been in transition to higher gearing and have not had to raise fresh equity. This is now changing, and recent rights issues have demonstrated the (dis) incentive implied by the difference between the cost of capital in the CAPEX and the WACC.

The above RAB model is, of course, idealised. In practice, there are a number of uncertainties and imperfections. The relation between the duty to finance functions and the RAB has not been made completely explicit and it has not been tested in the courts. In many infrastructure cases, there is no certainty that customers will pay where there is demand risk. There is also uncertainty about whether the incentives are robust. Governments have engaged in explicit windfall taxes on utilities, in *ex post* claw-backs, and there have been a number of examples of implicit interventions, changing the obligations where higher returns have emerged. Notoriously in the water industry, companies in one period were encouraged to "voluntarily" share profits with customers.

A Green Infrastructure Bank (GIB) would act as an intermediary between the completion of climate-related CAPEX and guaranteed sunk cost recovery.

Nevertheless, the model is pregnant with possibilities for extensions across the infrastructure space, particularly in respect of climate change infrastructure measures, like energy efficiency and renewables. One possible mechanism is for the creation of a national green RAB (gRAB), through a Green Infrastructure Bank (GIB)[13]. The idea would be for a new institution to act as intermediary between the completion of CAPEX and the guarantee of sunk cost recovery. Take the example of a wind farm development. At the CAPEX stage, this is largely equity risk, and equity and project finance. When completed, the returns to the wind farm are determined by the returns allowed to such green projects through renewables support programmes, and the operating efficiency of the wind turbines. The latter can be contracted out – to an equity player, since it is an equity risk. But the rest is largely a sunk-cost issue, and for the project developer a question of exit. There is nothing the developer can do about the renewables support regime – it is pure political and regulatory risk. The assets, too, are what they are: the project developer cannot significantly change them.

Thus, a GIB could "buy" the completed wind farm, net of the operating and maintenance contracts and the power purchase contracts for the electricity sales to suppliers, put a RAB structure around the completed and purchased assets, and then sell them on to pension, life and other investors interested in longer term low-risk bond-type investments.[14] The GIB thereby commits the government to the political and regulatory risk, and thus the sunk costs are protected from *ex post* expropriation.

13 See on the GIB, Green Investment Bank Commission (2010).

14 For a discussion of the role of pension funds in infrastructure investment, see Inderst (2009).

There are obvious problems with this extension of the RAB to wider infrastructure provision. Foremost amongst these is the guarantee to the gRAB which the government would be making through the GIB. Yet this is less an obstacle than it might seem. The British government is committed to a Renewables Obligation (RO) and to the Renewables Obligation Certificates (ROCs) regime. All the RAB guarantee does is guarantee that the government means what it says – that it will honour investors' faith in the continuity of its existing renewables support scheme. The government has the possibility to change this support regime in the future, but the guarantee means it cannot do this retrospectively. That is, the government must guarantee to grandfather.

This might seem a strong demand, but consider the consequence of not doing so. Uncertainty about the future of the RO/ROCs scheme transfers regulatory and political risk to wind farm owners after completion. That raises the cost of capital. Apply say, a 3 to 5-percent premium across, say GBP 100 billion of investment in offshore wind, and the implications for the total cost of these investments outweigh almost any other variable.

The model can be extended across the infrastructure space beyond the green zone and across Europe. There could reasonably be a transport RAB, incorporating road projects (there already is a rail RAB). Housing projects, schools and hospitals could follow a similar path – with again an infrastructure bank playing the role of the intermediary.

There are two further policy considerations: the financing of the infrastructure bank itself and its capital requirements; and the relation of the guarantees to public finances.

The intermediary role in theory requires no capital. The infrastructure bank is an intermediary, bringing pension funds together with the sellers of completed CAPEX. In practice, the transactions may involve timing issues and elements of bundling, and the infrastructure bank may need to hold assets for short periods on its balance sheet. But it would not involve itself in equity finance or leverage and hence would not resemble an investment bank or indeed a direct investor. This is not a project finance role. In times of major fiscal constraints, the fact that an infrastructure bank would need little or no capital is a distinct advantage.

As an intermediary, the GIB would require little own capital.

That advantage may, however, be tempered by the treatment of the guarantees in respect of the RAB in public finances. Were national accounts to include a balance sheet, with assets and liabilities properly represented, then the infrastructure finance would be incorporated. The large-scale infrastructure debts would be aggregated into national liabilities, to be placed against the infrastructure assets.

This, however, is not the case. There is no national balance sheet. Instead, a somewhat arbitrary principle is applied to distinguish what is and what is not "on the government's books". This is the distinction between debt and equity which is backed by customer bills and that which is remunerated from taxpayers. Thus, if water bills are ultimately paid by water customers, this is outside the government's fiscal accounts, but if trains are subsidised from taxpayers, this bit is inside.

The tricky question arises in respect of the guarantee. Ultimately, this is a responsibility of government: it is government that has to ensure that, for example, electricity customers pay for wind-generated electricity. There is then a residual taxpayer risk – it may be that customers cannot pay (there are already many millions in fuel poverty), or that voters do not support politicians who commit to forcing customers to pay. But this is inherent in the existing arrangements, too: and, as noted above, if it is not credible, there is a deadweight welfare loss from the cost-of-capital premium that investors demand in compensation for taking an equity risk they cannot manage.

It is also not unique to these non-utility infrastructure investments. The duty to finance functions is ultimately a government guarantee, too: investors who find that the regulator is unable or unwilling to force customers to pay would have recourse to the government, since the agents of the state (the regulator) would have failed to fulfil their legal duties.

7. The impact of the credit crunch and the changed macroeconomic circumstances

In most respects, the issues discussed above are independent of the economic crisis which followed from the credit crisis. Utilities have gone on investing, the utilities' share prices have remained robust and, if anything, core asset-backed infrastructure has provided a safer haven for investors.

7.1 Macro-policy impacts

Reinforcing this stability, the macroeconomic response to the credit crisis has been to lower interest rates to levels well below their long-run real rates. Given inflation, real interest rates in Europe and the US are negative. Further macroeconomic stimuli via Quantitative Easing have also benefited infrastructure and utilities. As noted above, central banks have even bought up utility debt, notably in Britain. Finally, in terms of fiscal stimuli, a number of countries have encouraged infrastructure spending as part of a wider "public works" programme, given that infrastructure tends to support domestic jobs rather than imports. Across Europe, "green growth" has been advocated as a way out of the crisis and to create new industries.

Much of this has been political rhetoric rather than delivered policy and much of the rationale (especially in respect of green growth) has been weak. The actual impact of the economic crisis has been altogether more complex, in changing a number of the market fundamentals.

The economic crisis has lowered current aggregate demand and expected future demand substantially.

The first impact has been to lower demand and to change the future expectations of demand. If the recession reduced GDP by about 6 percent, and then resulted in a year of very low growth, and if the underlying expectation has been for 2 to 3 percent growth *per annum*, then GDP after two years would be at least 10 percent lower than what was predicted for this period back in 2005 or 2006. This is an enormous demand shock to investors in infrastructure (and anything else).

The impact of this demand shock on infrastructure finance depends on the discount rate and the cost of capital. If this number is low – say for RAB-based completed infrastructure – then investors expect returns over a longer period and this is just a sharp cycle. But consider *new* CAPEX aimed at returns in the short run, with a high cost of capital and hence a rapid pay-back period. A house builder might fall into this category. The effects are very much more substantial.

In one respect the economic crisis is good news for stretched infrastructure. If there is a backlog of investment required – in other words, if capacity is fully utilised – then a fall in demand buys time. There is a bigger capacity margin than anticipated and hence, a breathing space in which to meet the infrastructure challenge.

7.2 The demand shock

The demand shock does, however, have more profound consequences. Households are faced with adjusting their own balance sheets and their current and future incomes are lower. They may not be able to pay the bills for all the infrastructure which governments have deemed desirable. The low-carbon transition is particularly at risk: households may not be able to provide the revenue streams to pay for the renewables and energy efficiency measures. Investors know this and so they perceive higher political and regulatory risk, and this in turn raises their cost of capital.

Government might resort to the backstop of taxpayers to finance the required infrastructure. But taxpayers are also consumers: if consumers cannot pay the bills, then they will not have the surplus to pay the taxes. Thus, the policy implication is that infrastructure investment is ultimately limited by the ability to pay, and this in turn has been adversely affected by the economic crisis. In consequence, the only way to go beyond existing ability to pay is to lower living standards, cream off the resulting additional savings and turn these into investments in infrastructure assets. It is an approach that has been tried elsewhere – notably in China where the savings rates are much higher. But it is unlikely to work in Western democracies.

7.3 Government capital spending

Public spending on core infrastructure is being reduced across Europe.

The other demand impact is on governments' fiscal positions. These are widely under stress, and a number of countries are committed to substantially reducing public expenditures. Inevitably, it is easier to cut capital rather than current expenditures and indeed, the evidence from past fiscal consolidations is that this is precisely what happens. Public spending on roads, railways, schools, hospitals and other core infrastructure is being reduced across Europe.

The implication is that infrastructure will continue its trend from the public to the private sector. There will be little alternative, short of simply not investing. Thus, the public sector option – the twentieth century route discussed above of state infrastructure provision – is practically not available. Instead, privatisation is likely to be pushed further, for example into roads, hospitals and schools.

This puts the emphasis heavily on solving the credibility problem so that the private sector has assurance over the sunk costs. A necessary condition is therefore to urgently address the RAB-type models discussed above and to consider new institutions – like intermediary infrastructure banks – which may play a significant role in gaining credibility.

7.4 Finance

For core utilities and for RABs, there appears to be little impact from the economic crisis. Indeed, it might even be benign. But this is less convincing when it comes to project finance and the cost of equity for CAPEX development. Here there is evidence of capital constraints and higher costs. The support services and construction companies involved in these types of activities have found the going (much) harder.

In part, this re-rating of risk has been a return to what might be regarded as more typical financial markets after the boom years. In part too, it reflects a more critical analysis of the project risks. Yet even here the economic crisis has had complex implications. The costs of labour and materials have fallen relative to the boom. Construction costs should therefore have come down, and project completions should be easier to fit into timetables as the economy has more flexibility within it due to spare capacity and softer labour markets.

In this context, an important element of the re-rating of risks has been the exit value of projects. The overall demand impacts and the reduced household budgets from expected levels make the selling-on of the assets on completion harder. In house building, the effects have been dramatic as house prices have softened. Any infrastructure facing demand risk on completion is particularly exposed – and this is risk the investors can do little about. The policy implication is therefore to concentrate on these exit terms – and hence the RAB concept above and the role of an infrastructure bank are particularly important.

8. Policy implications and conclusions

The challenge is to match the need for a major expansion in infrastructure investment across Europe with the constraints of a post-crisis economy. The green agenda has added to the investment demands, but without providing a sufficiently credible policy framework which can deliver at reasonable costs.

At the heart of the infrastructure problem is the relation between the public and private sectors. Governments are intimately involved in infrastructure provision. They decide on the systems and the frameworks, and they control the planning. The private sector typically does the work (the CAPEX) and all finance is ultimately private. Private finance is either via the intermediary of government or direct.

Infrastructure is riddled with government and market failures. A core economic characteristic is that infrastructure involves the creation of long-lived assets with high sunk costs. Once completed, the difference between the marginal and average costs is typically very large. Indeed, the marginal costs are often effectively zero. For investors, this creates a problem: politicians and regulators might be tempted *ex post* to drive prices to marginal costs, having promised *ex ante* to honour the sunk (average) costs. The solution is a contract or bargain between government and private investors. The latter will do the investing for the benefit of future customers only if the government credibly commits to making sure they get their sunk costs back.

It is this problem of credible commitment that lies at the heart of infrastructure policy. As the privatisation process got underway at the end of the last century, the concept of RABs developed to provide a mechanism for a credible commitment, backed up by new regulatory institutions.

The crisis has compounded the need for new RABs and new intermediary institutions able to offer an exit strategy for new infrastructure CAPEX.

This concept can and should be extended to infrastructure more generally – and across Europe, but it requires the creation of new RABs and new intermediary institutions. An infrastructure bank buying completed CAPEX projects, putting a guarantee around them to create RAB assets, and then selling them on to pension funds in a debt-financed package, provides one way forward – at the national level and perhaps even at the European level.

The urgency of providing an exit strategy for new infrastructure CAPEX has been compounded by the economic crisis. The impacts have been ambivalent. For completed CAPEX in formal RABs the impacts have probably been benign. These are relatively safe assets, protected by the duty to finance functions. Quantitative Easing has even involved the state buying RAB-backed utility bonds. In contrast, for CAPEX itself, the impacts have been largely negative, especially where there is demand risk for the services the infrastructure is intended to provide. Providing a broader RAB-based exit through an infrastructure bank is an obvious way to greatly alleviate the position.

Whether these suggested measures are adopted will have a major impact on the delivery of the infrastructure ambitions of European governments. The fate of the green agenda is in particular at stake. Fortunately there are solutions. The question is whether they will be adopted fast enough to meet the targets.

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ABSTRACT

The challenges of infrastructure finance need to be considered in the context of long-term infrastructure planning. *This article outlines the UK's new integrated approach to infrastructure planning to meet large investment needs against the backdrop of fiscal consolidation. The UK National Infrastructure Plan for the first time sets out a broad, integrated, cross-sectoral vision and plan for the substantial infrastructure investment required to underpin the UK's economic growth. This plan will act as a common reference point for the public and private sectors to achieve more effective infrastructure development. It will be updated on an annual basis.*

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The UK National Infrastructure Plan 2010

James Stewart

1. Introduction

For the economy to flourish, people, goods and information must move freely. Businesses across all regions and industries need the right conditions to grow. Reliable infrastructure: energy, water, transport, digital communications and waste disposal networks and facilities, are essential to achieve this. Economic infrastructure drives competitiveness and supports economic growth by increasing private and public sector productivity, reducing business costs, diversifying means of production and creating jobs.[1]

There is a clear correlation between investment in infrastructure and long-term growth. The OECD found that, between 1970 and 2005, investment in UK roads, rail and electricity generating capacity had a stronger positive effect on the level of GDP *per capita*, and on short-term growth, than other types of capital investment (Égert *et al.* 2009). Failing to make the right choices risks slower economic growth and ultimately puts the UK's international competitiveness in jeopardy.

2. The challenge

Over the last 200 years, the UK has developed mature and extensive infrastructure networks. These are some of the largest and most intensely used in Europe. There has been a strong history of investment but the levels of investment have fluctuated markedly over time. The move of the water, energy and communications sectors to regulated private ownership during the 1980s provided the basis for renewal of major parts of those networks. For example, GBP 85bn have been invested in water infrastructure alone since privatisation (Water UK 2010). However, according to the World Economic Forum, in 2010 the UK is ranked just 33rd for the quality of its infrastructure and 12th for overall competitiveness, compared to 9th in 2005 (WEF 2010). The UK must get smarter with its infrastructure investment in both the private and public sectors to maintain its competitiveness internationally.

In 2010, we face an unprecedented series of challenges. Stretching carbon reduction targets and the need to ensure long-term energy security require a revolution in our energy generation mix. We need digital communication networks that transmit information at high speed to all parts of the UK. We need to maintain our transport, water and waste systems in the face of growing demand and the impact of climate change and of other threats and hazards. We need a clear analysis of the increasing interdependencies between networks and of the resulting opportunities for innovation. We need to maintain and grow the national intellectual capital for the UK to be a winner in the global knowledge economy.

All this must be delivered against an inherited legacy of overstretched UK public finances and with many countries embarking on programmes of a similar scale, competing for a finite pool of investment funds.

The immediate challenge is to rebuild the economy, creating the conditions for enterprise to flourish based on an expansion of the private sector. The infrastructure investment programme will help rebalance the economy across all regions and give industries the right conditions in which to grow, as well as itself providing a stimulus to short-term growth.

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1 OECD (2009) highlights that investment in physical infrastructure increases long-term economic output more than other kinds of physical investment.

3. The Plan

The National Infrastructure Plan 2010 sets out a broad vision of the infrastructure investment required to underpin the UK's growth (HM Treasury 2010a). And, just as the UK made bold choices in the past, we need to embrace the options opened up by new technology – for example, in the roll out of super fast broadband, in offshore wind arrays and in high-speed rail.

The role of a Government in this work is clear. It is to specify what infrastructure we need, identify the key barriers to achieving investment and mobilise the resources, both public and private, to make it happen.

The UK Government plans that over the next five years (2010/11–2014/15), some GBP 200bn will be invested in economic infrastructure – a step change from the past.[2] The majority of investment will be in transport and energy, with investment in the energy sector almost doubling between 2010/11 and 2014/2015. Looking forwards, trends all point towards a need for a step change in both the level and type of investment. There are a number of drivers that will have a long-term impact on the infrastructure need across all sectors, including ageing and obsolete assets, strong global competition, growing demand through increasing population and living standards, and growing interdependencies between infrastructure networks.

4. The Spending Review

For the first time, the UK Government has agreed capital allocations across the public sector based on a multi-year plan for overall infrastructure investment.

The UK Government has adopted a new approach in the recent Spending Review (HM Treasury 2010b). For the first time, the Government has agreed capital allocations across the whole of the public sector over a four-year period, against the background of a coherent, long-term plan for overall (private and public) investment in the UK's infrastructure.

As part of the Spending Review process, the Government looked at a range of capital projects to identify those with the highest economic value and has assessed spending pressures from the previous government's contractual commitments. In light of this, the Spending Review has increased the capital envelope by GBP 2.3bn a year by 2014-15 relative to the Budget plan in order to ensure that capital projects of high long-term economic value are funded.

The Spending Review includes plans to:

- Invest in a low-carbon economy – including a commitment to provide a UK-wide Green Investment Bank, up to GBP 1bn for one of the first commercial-scale carbon capture and storage demonstration projects, and the provision of grants to increase the uptake of electric vehicles;
- Provide the best super fast broadband in Europe by 2015 – with the government providing GBP 530m of investment over the Spending Review period;
- Invest GBP 30bn in transport including
    - Funding for the construction of a new rail line across London (Crossrail)
    - Investment in a high-speed rail network
    - GBP 10bn for maintenance and investment in key road and local transport schemes across the country; and
    - GBP 14bn of funding to support Network Rail maintenance and investment.

2 Infrastructure UK estimate based on aggregating individual planned investments that have been publicly declared in both the public and private sectors.

- Ensure that the UK remains a world leader in science and research by investing in new facilities of national importance including GBP 220m in the UK Centre for Medical Research and Innovation and GBP 200m to support manufacturing and business development over the Spending Review period.

5. Enabling investment

To meet the growing requirements for spending on infrastructure, there is a need to use limited public funds wisely and unlock every possible source of private-sector investment.

There is also a clear need to attract private-sector investment and reduce the cost of capital for projects and programmes. This means creating the optimum environment for investment and ensuring that efficient and effective funding models are in place. All countries are operating in an intensely competitive global market for infrastructure funding and, therefore, need to take steps to remain competitive.

The plan includes actions that will encourage greater private-sector investment. This includes more efficient use of public funding in the sense of projects that give the most benefit (building on the Spending Review), improving private-sector investment models, actions to encourage new sources of private capital and actions to address regulatory barriers that stand in the way of greater private-sector investment. Improved regulation already brings in much vital investment but we need to ensure that the system is able to plan for the long-term challenges we face. The plan also sets out the intent to take an in-depth look at the potential for wider use of the regulatory asset base model in lowering the cost of capital.

The plan includes actions that will encourage greater private-sector investment.

6. Improving delivery

Today, the UK is one of the most expensive countries in which to build infrastructure. For example, civil engineering works cost some sixty percent more than in Germany. To address this issue, we need to improve the UK planning system, bring down construction costs, improve the quality of data to inform decision taking, and initiate programmes to look at cross-sectoral independencies, resilience and engineering innovation.

Infrastructure UK are investigating how to reduce the cost of delivery of civil engineering works for major infrastructure projects under the chairmanship of Terry Hill (Chairman of Transport Markets, Arup). This investigation is being led by Infrastructure UK in collaboration with wider government, the Institution of Civil Engineers, and industry. Initial evidence indicates a range of reasons for higher costs of UK infrastructure. In particular, there are issues in the commissioning, early project formulation and pre-construction phases. In these early phases, policy-related factors, for example the UK planning and consents regime, and regulatory standards, impact on the whole infrastructure sector, including public and private-sector investments. The final report will be published by the end of 2010.

7. Next steps

The National Infrastructure Plan 2010 sets out in more detail the key decisions and actions needed by both Government and the private sector to develop world class 21st century infrastructure. Over the next year, Infrastructure UK will take forward the work programme in the plan. The next iteration of the plan will be published by the end of 2011.

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ABSTRACT

Developing countries are faced with a substantial and persistent infrastructure deficit. *Climate change complicates this challenge, affecting the way we design and manage infrastructure (defined here as transport, power, water and sanitation) and increasing costs. But all is not negative: Climate change affects both the economic and financial analysis of infrastructure projects in a way that could help achieve long-pursued but elusive goals, such as better maintenance and greener, more efficient design. Further, climate finance could bring additional financing, although that will require increasing the scale of available resources and addressing the fact that climate finance tends to provide ex post financing, ill-suited to a sector characterized by a need for substantial ex ante funding.*

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The views presented here are those of the authors only and do not represent those of the institutions they are affiliated with (The World Bank for Fay and Iimi, Cired for Perissin-Fabert).

Financing greener and climate-resilient infrastructure in developing countries – challenges and opportunities


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1. Introduction

This study examines how climate change is affecting the way we design, manage and finance infrastructure (defined here as transport, power, water and sanitation). Unlike much of the literature on climate change and infrastructure, it examines issues from the point of view of infrastructure. That is, over and above the familiar question how infrastructure affects climate change, the study raises the question of how climate change affects infrastructure provision and financing. Climate change is shown to complicate the infrastructure agenda. But all is not negative: Climate change affects both the economic and financial analysis of infrastructure projects in a way that could help achieve long-pursued but elusive goals, such as better maintenance and greener, more efficient design. While some of the analysis applies to all countries, we focus specifically on developing countries that are characterized by a substantial and persistent infrastructure deficit.

Unlike much of the work on climate change, we do not neatly separate the discussions of adaptation to and mitigation of (or measures to reduce) climate change, although where needed we flag the different challenges they pose.

The next section discusses the impact climate change is likely to have on the demand for and design of infrastructure, noting that tackling climate change requires profound and immediate changes in the way infrastructure is planned, designed, managed and maintained. We note the importance of improved or at least modified cost-benefit analysis to incorporate the substantial uncertainty introduced by climate change. Section 3 looks at the implications of climate change for climate finance. While climate change will undoubtedly increase the cost of infrastructure, this impact is modest relative to the current infrastructure deficit. Climate finance is becoming available and could be used to reduce the financing gap, although efforts are needed to increase the flows and to address the fact that climate finance tends to be *ex post* financing that cannot help the substantial *ex ante* financing needs characteristic of infrastructure. Section 4 concludes.

2. Win some, lose some – what happens when we include climate change concerns

Infrastructure services directly contribute 42 percent of global greenhouse gases, and this share is likely to increase massively in the coming century under a business-as-usual scenario.[1] Infrastructure services are also very vulnerable to changing climatic conditions. Indeed, large storms paralyze economies usually by interrupting transport and/or bringing down electricity transmission. Droughts affect not only drinking and irrigation water supply but also power supply.[2] Heat waves result in melting pavements and strained power supply. In other words, infrastructure services are both culprits and victims of climate change.

So tackling climate change and its consequences requires profound and immediate transformations in how infrastructure is planned, designed, managed and maintained. Profound, because business-as-usual approaches will condemn us to unmanageable levels of climate change and to unreliable and

1 Based on sum of shares of GHGs contributions by power, transport, and waste and wastewater (IPCC 2007). It does not include residential and commercial buildings (8 percent) or industry (19 percent) although these emissions would likely not be possible without the underlying energy infrastructure. Under a business-as-usual scenario, total energy consumption is set to triple by the end of the century.

2 Note that this is not only valid for hydroelectricity but also for thermal and nuclear power plants that require water for cooling.

expensive infrastructure services. Immediate, because infrastructure is long-lived and triggers substantial inertia in socio-economic systems. The choices made now in what is built, where and how, determine future options and vulnerabilities. The complication, however, is that action is needed in a context of profound uncertainty about future vulnerabilities and costs.

This section first discusses how the planning and design of infrastructure needs to change as a result of the new uncertainties introduced by climate change. It then reviews how adaptation concerns affect the management of infrastructure, increasing the returns to good maintenance and possibly modifying the optimal ratio of capital to current expenditure. The section concludes with a review of how climate change concerns could tilt the balance in favour of greener infrastructure in a way that local benefits (such as reduced pollution and congestion) have not always been able to motivate. In both the adaptation and mitigation discussions we note that climate change will likely increase infrastructure spending needs, though by less than usually argued.

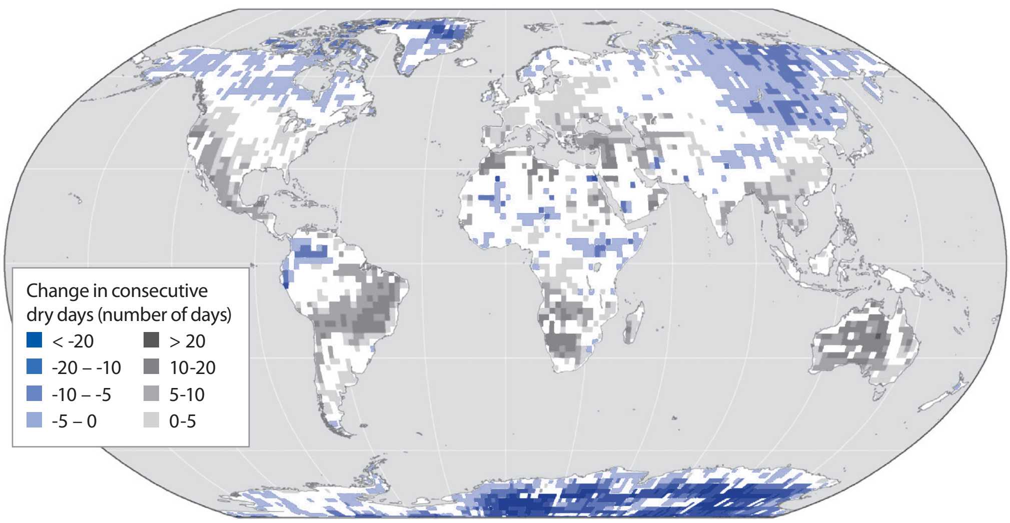
2.1 Climate change complicates the planning and design of infrastructure

Climate change introduces new uncertainties, greatly complicating investment decisions.

Climate change introduces three new sources of uncertainty that greatly complicate infrastructure design and management. These are uncertainties about climatic conditions, about carbon prices and about technologies able to tackle both a changing climate and higher carbon prices.

Climate uncertainty. There is general agreement that sea levels will rise, temperatures will continue rising and the world globally will become a wetter place with more frequent extreme weather events (IPCC 2007). However, the extent of likely change is highly uncertain, as are the timing and location of specific impacts. Map 1 illustrates the point, showing that for much of the world, models do not agree as to whether the climate will become drier or wetter. Further, the reliability of global and regional climate models decreases significantly when results of global models are downscaled to obtain projections at a smaller geographic scale.

Map 1. The future is uncertain – for much of the world models disagree about whether drought occurrence will increase or decrease



Source: World Bank 2009 based on data from The World Climate Research Program CMIP3 Multi-model Database (http://www-pcmdi.llnl.gov/ipcc/about_ipcc.php).

Note: The map shows the median change (based on eight climate models using SRES A1B) in annual values in 2030 – 2049, compared with 1980–1999. A "dry" day is defined as one with precipitation less than 1 millimetre whereas a "rainy" day has more than 1 millimetre. White areas show areas of high model disagreement (fewer than two-thirds of the models agree on the sign of change).

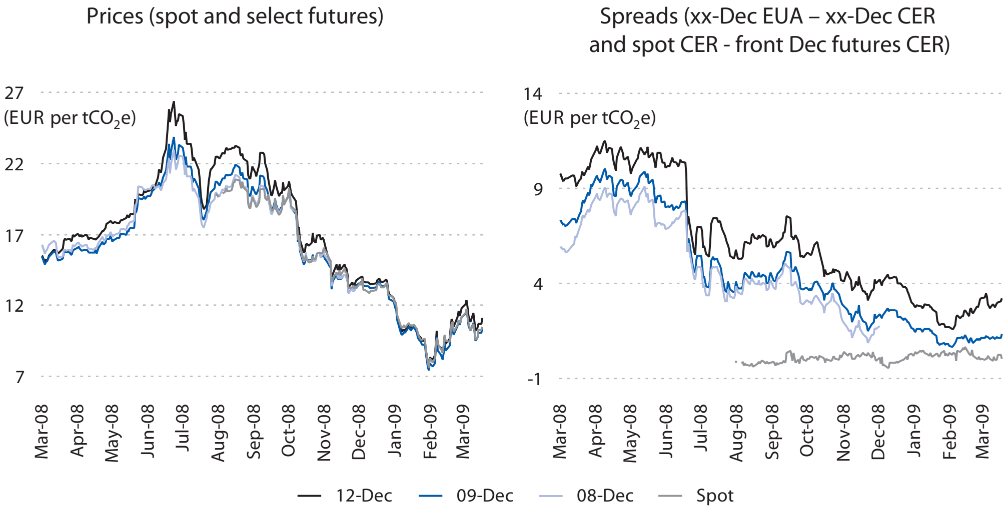
Increased climate uncertainty greatly complicates infrastructure design. In Kazakhstan, for example, truck transportation has already been restricted during the summer when the asphalt is softest due to extreme heat (Nakat 2008). Higher road standards may be necessary. However, it still depends on how the climate will change. In Ho Chi Minh City, more regular and extreme floods are expected because of increasing monsoonal rainfalls combined with tidal influences. The area inundated could increase by 3 to 7 percentage points (World Bank 2010a). More flood control measures, such as flood embankments, sea walls and pumped drainage, may be necessary. But to what extent these measures will be necessary is dependent on the future extent of climate change. Further, a misreading of future trends could result in building infrastructure that actually worsens vulnerability – as indeed has already happened in Ho Chi Minh City, where the construction of dikes resulted in worsened flooding in areas adjacent to the dikes.

Carbon price uncertainty. While it is very likely that carbon will be priced at some point in the future, it is highly uncertain when this will happen, or what the price will be. Carbon markets have been highly volatile with prices between USD 9 to USD 43 per tCO2 (*i.e.* tons of carbon dioxide equivalent) because of the global financial crisis and lack of clarity as to what will happen when the Kyoto Protocol commitment period expires in 2012 (Figure 1). The published literature is far from providing a commonly accepted benchmark of the social cost of carbon. The last report by the Intergovernmental Panel on Climate Change (IPCC) estimates the social cost of carbon at USD 3 to USD 95 per tCO2 (IPCC 2007). Tol (2005), surveying more than 100 estimates, shows that the distribution of estimates has a long tail: the median is USD 3.8 per tCO2, the mean USD 25 and the 95th percentile USD 95**.** The UK government recommends a social cost of carbon of USD 28 per tCO2 for public decisions, with a range from USD 14 to USD 57 (Watkiss 2005) similar to the United States' central value of USD 21 per tCO2 and range of USD 5 to USD 65 (US Department of Energy 2010, Appendix 15A). A committee tasked by the French Government to look into the question recommended USD 60 per tCO2 in 2010, rising to USD 135/tCO2 in 2030 (Quinet 2008).

There is so far no commonly accepted benchmark for the social cost of carbon, and estimates are in a wide range of USD 3-95.

The combination of historical volatility and uncertainty about future prices has led investors to urge decision makers to act swiftly in implementing policies that put a clear and effective price on carbon to allow businesses and investors to reassess investment values and redirect their investments (Institutional Investors Group on Climate Change 2009).

Figure 1. Secondary Certified Emission Reductions (CER) in the carbon market



Source: Capoor and Ambrosi (2009)

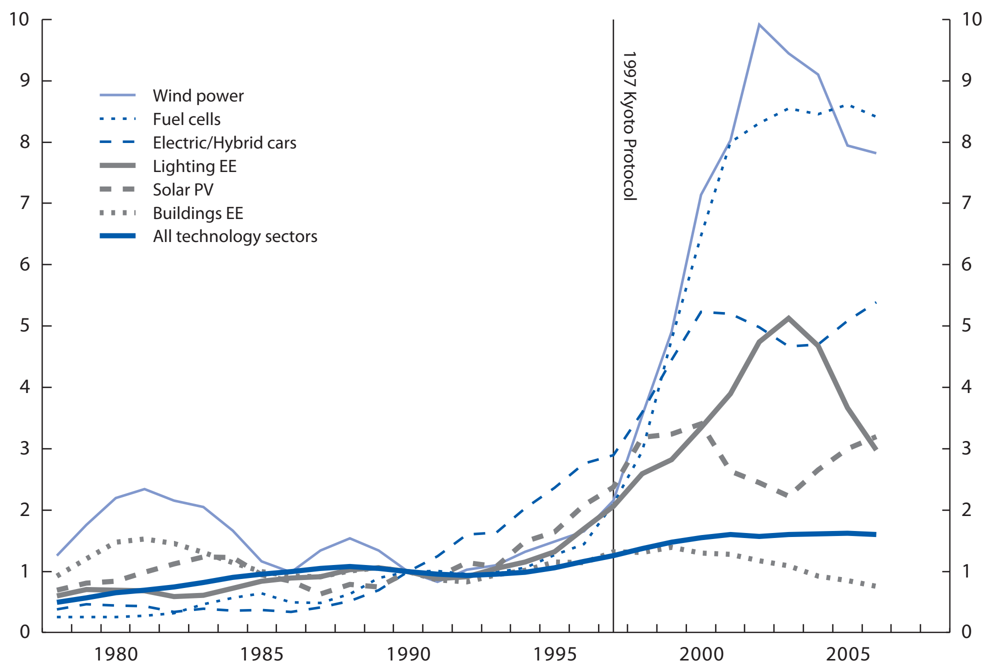
Technology uncertainty. Technology optimists argue that little adaptation and mitigation efforts are needed now, since better technology will make it easier and cheaper to adapt and mitigate later on. Technology pessimists would instead argue for substantial efforts now since new technologies may be far away. Uncertainty about technology also makes it difficult to decide what to build. For example, why invest massively in public transport or high-speed rail if inexpensive electric or hydrogen cars are around the corner? Should a city take a bet on electric cars and start building the associated infrastructure? What if electric cars remain very costly? But technological progress itself depends to a certain extent on estimates of future carbon prices, which motivates investments in R&D.

A number of new technologies have been developed in recent years. Patent applications for climate-related technologies increased since the late 1990s (Figure 2). Some energy-efficient or climate-resilient technologies are ready to use while others remain to be developed. There are also not-yet-proven advanced technologies, such as carbon capture and storage, fuel cell cars and second-generation biofuels. Which technology to bet on also depends on the uncertain future evolution of costs. While costs are generally expected to drop with higher scale of production, this has not always happened. Wind energy costs declined by 80 percent over the past 20 years largely due to economies of scale (World Bank 2009) but the price of the Toyota Prius – the best-selling hybrid car – barely changed over the last ten years (although fuel efficiency improved by about 20 percent).

Depending on technology availability, the sector distribution of climate change mitigation can look completely different.

Mitigation scenarios can look completely different depending on views on technology availability. This is particularly true for the transport sector. The IEA projects transport to contribute with a 30-percent reduction in transport-related emissions to the 50-50 scenario (50 percent reduction in emissions by 2050). By contrast, the Pacific Northwest National Laboratory (PNNL), an equally reputable energy modelling institution, projects a 47-percent increase in transport emissions in the same overall 50-50 scenario (Table 1). The main reason for this divergence of views is that the PNNL is more pessimistic about technology diffusion of advanced vehicle technologies, such as plug-in hybrids and electric vehicles.

Figure 2. Trend of number of patent applications for mitigation technologies (Index 1990 = 1)



Source: OECD (2010)

Table 1. Sector contributions to a 50 percent reduction of energy-related 2005 emissions by 2050

	Estimated percentage of carbon that must be removed by sector	
Sector	IEA	MiniCam
Power	-71	-87
Building	-41	-50
Transport	**-30**	**47**
Industry	-21	-71
Total	-50	-50

Source: World Bank (2009)
Note: MiniCam is the model of the Pacific Northwest National Laboratory.

Uncertainty about impacts, prices and technology would not be so problematic if infrastructure could be quickly adjusted to respond to new information. However, infrastructure exhibits significant inertia: infrastructure investment creates long-lived capital stocks which cannot be removed overnight and therefore induce lock-in effects in terms of technology used and GHG emissions during their lifespan (*e.g.* 40-50 years for power plants; up to 75 years or more for road and rail networks or power distribution networks). Further, infrastructure investments are "lumpy", implying a concentration in time of aggregate investment in major networks of long-lived capital. As a result, the window of opportunity during which to influence what is built is quite narrow (Shalizi and Lecocq 2009): developing countries (particularly fast-growing ones such as China and India) will install the bulk of their infrastructure in the coming decade.

Substantial inertia in infrastructure and associated socio-economic systems complicates the management of uncertainty.

China offers a striking quantitative illustration of the magnitude of the issue. Although its emissions are currently on par with those of the US, its "committed emissions" (computed on the basis of its existing installed infrastructure and the world average of infrastructure lifetime) already account for 37 percent of global emission commitments (Davis *et al.* 2010). This is due to the massive and very recent expansion in its infrastructure and the fact that coal accounts for most of its power generation capacity.

Infrastructure choices generate further downstream socio-economic inertia. The US interstate highway program launched during the 1960s caused particular patterns of settlement (sprawl) to emerge, making it very difficult to develop cost-effective public transportation (Shalizi and Lecoq 2009). Network effects create incentives to densify existing grids (Economides 1996). The comparative value of having a fuel car rather than an electric car increases when everybody has a fuel car and a dense network of fuel stations is already set up. Then, the dominant technology tends to crowd out the market at the expense of newer technologies. Further, oil refineries, auto manufactures, and power generator producers usually exhibit internal economies of scale and are accompanied by a number of downstream industries (Shalizi and Lecocq 2009; Davis *et al.* 2010).

Many of the likely climate impacts will not look new for engineers, policy makers and project designers. In choosing how high to build the clearance below a bridge, how securely the decks must be attached to the substructure to withstand high winds, how often its surface ought to be repaved, whether riprap or extensive gabions are needed to protect abutments from scour, decision makers consult building and maintenance standards that provide guidance on these choices in relation to climate, hydrological, geological, and usage data. Probabilities and risks are always weighed against costs, and locally appropriate choices are made based on the combination of physical factors with risk tolerance and budget constraints. So why can't investments continue to be made as they have always been?

The fundamental problem is the deep uncertainty about climate change and future technology. Past climate data have, until now, provided reasonable summary statistics to guide infrastructure investment decisions, based on probabilities and averages. Infrastructure design and planning, insurance pricing, and many other decisions have long assumed stationarity in climate events. However, with climate change, "stationarity is dead" (Milly *et al.*, p. 573). Decision-making based on past averages and probability distributions for various climate phenomena are no longer valid. And new underlying probability distributions are unknown. Given recent extreme events, such as floods, heat waves and massive snow, we may not have yet figured out whether they were realizations of the past probability distribution or whether the whole underlying probability distribution has shifted.

New ways of thinking to facilitate robust decision-making are required to limit the possible adverse impacts of deep uncertainty on infrastructure (see discussion in Sub-section 2.4 below). Communication between infrastructure planners and climate specialists must be promoted to determine the full range of relevant climate information that could affect a specific project and then get planners the relevant data. Further, local decision makers will need to decide what variables are most important for them. In some instances this will be quite obvious – land-locked countries do not need to consider sea-level rise, and changes in freeze/thaw cycles are not a concern in low-elevation, low-latitude areas. In others, it will not be so clear, so an initial general understanding of possible climate impacts might be needed to determine which variables need to be monitored.

2.2 Improved infrastructure management is a key part of any adaptation strategy

A key consequence of climate change will be an increase in both intra-annual and inter-annual variability in temperature and precipitation as well as greater frequency of extreme weather events. The greater intra-annual variability means that, even though total annual rainfall in a location may be unchanged, under an altered climate regime, rainfall is likely to occur in more concentrated downpours so that many regions will experience both more floods and more droughts. Thus, infrastructure and operational procedures will need to be adapted to deal not just with drier *or* wetter conditions, but with both. This will very likely mean an increase in costs. For even if it were no more or less costly to build, maintain, and operate transport infrastructure in either a dry climate or a wet climate, it is more costly to build, maintain, and operate assets to withstand both.

Estimates of the infrastructure adaptation gap are relatively modest…

Yet, World Bank estimates of the investments required for developing countries to adapt their infrastructure to a changing climate are relatively modest at USD 14-30 billion a year (Table 2). The cost of adaptation only includes the incremental cost of constructing as well as operating and maintaining the baseline level of infrastructure under new climatic conditions (Annex). Estimates from other studies range from USD 2 billion to USD 63 billion, with infrastructure generally one of the largest sources of total adaptation costs.

Table 2. Average annual incremental adaptation cost by 2050

	Total	Infrastructure	
Source	USD billion	USD billion	Percent of total
UNFCCC (2007)	28-67	2-41	
Parry *et al.* (2009)		16-63	
World Bank (2010b)			
NCAR scenario	90	30	33
CSIRO scenario	78	14	17

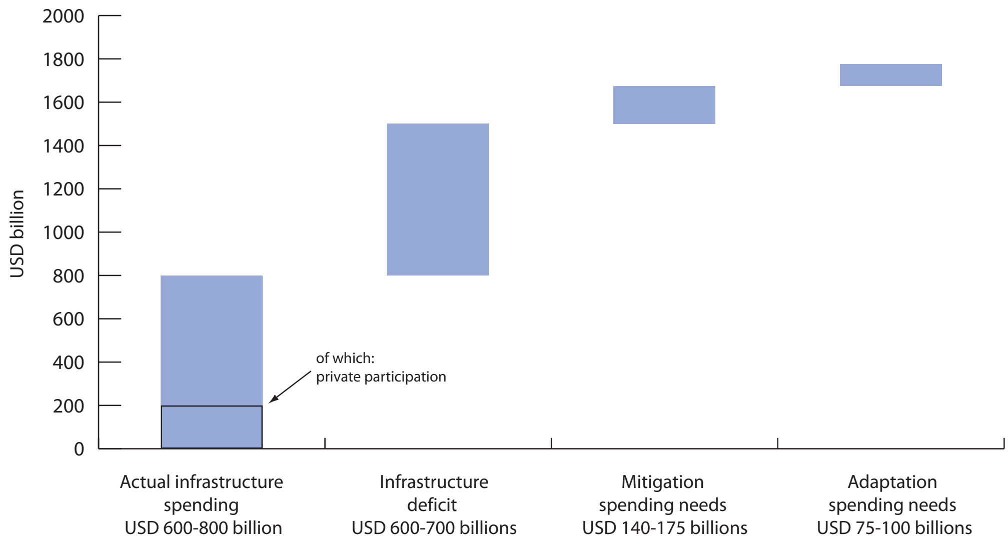
Notes: Estimates by Parry *et al.* (2009) include housing and infrastructure. Estimate by World Bank (2010b): Delta-p estimate only. See Annex for a discussion of the methodologies used by the various studies.

The methodologies used to estimate adaptation costs estimate the incremental cost of adapting to climate change rather than the cost of reducing vulnerability. The latter would require addressing the significant infrastructure deficits that exist in most developing countries. This approach is theoretically correct given the fact that adaptation costs are usually being calculated to estimate the assistance that high-income countries should provide given their responsibility for a disproportionate share of past emissions.

But in most developing countries vulnerability arises mostly from a lack of infrastructure or from poorly maintained assets. Developing countries are generally estimated to need some USD 1.2-1.5 billion in annual infrastructure investment to close the development gap – of which only about half is actually invested every year. This is supported by the result of country level studies conducted across Africa that show that most countries are investing only 30 to 60 percent of what would be needed to close the development gap (Briceno-Garmendia *et al.* 2008). Thus, adaptation costs pale in comparison to the USD 600-700 billion in additional annual investment in infrastructure that would be needed to close the development gap (Figure 3 and Table 3).

…but resilience to climate change requires addressing the development gap.

Figure 3. The adaptation and mitigation gaps, while important, are a fraction of the overall infrastructure "development" gap



Source: Own elaboration based on data from Fay *et al.* (2010) and World Bank (2009)
Note: Total infrastructure investment needs are estimated at USD 1.2-1.5 billion per annum, of which only about half is actually invested.

Table 3. Comparison between annual development and adaptation deficits (USD billion)

Source	**Parry *et al.* (2009)**		**World Bank (2010c)**	
Region	Infrastructure deficits	Adaptation costs	Baseline spending	Adaptation costs
Asia	218	11–44	956	18
Latin America and the Caribbean	37	2–7	283	4
Africa	62	3–12	130	3
Others			531	5
Total	**316**	**16–63**	**1900**	**30**

Notes: Parry *et al.* (2009): includes housing and infrastructure and calculates the infrastructure deficit as the investment needed to address the Millenium Development Goals. World Bank (2010c): Based on the National Center for Atmospheric Research (NCAR) climate scenario; estimates include health, education, power and wire, road, urban, water and sewage, and other transport infrastructure; baseline spending is estimated as amounts of investments needed to address the overall development deficit.

But in addition of adressing the development deficits, reducing vulnerability will require better maintainance infrastructure assets. Returns to maintenance are well known to be very high, with assets decaying at a much faster rate when improperly maintained. Climate change will only increase the importance of good maintenance. Poorly maintained roads are very vulnerable to climate change, particularly increased precipitation, as water infiltrates through cracks and joints, resulting in pavement faulting and increases in the roughness of roads. A detailed study of the road sector in Ethiopia found that much of what was needed to adapt to the changing climate was in fact better maintenance (COWI 2010). Unsurprisingly, the study found that aggressively improving maintenance of roads would pay off even with the current climate as potential benefits from better maintained culverts, bridges and riverside roads are estimated to be already greater than costs (Table 4).

Table 4. Cost of climate-related incidents in 2009 and climate change adaptation in Ethiopia (USD thousand, constant 2009 prices)

	Culverts	Bridges	Roads	Drainage ditches
Expected road user costs in 2010 due to climate-related incidents	3.2	9.8	5.3	0.003
Annual adaptation cost	0.1–0.3	4.3–14.0	0.1–0.4	0.02–0.2

Source: COWI (2010)
Notes: "Roads" refers to roads located next to river banks. Cost is per km.

While proper maintenance contributes to climate-proofing existing infrastructure, the most vulnerable populations are those without any access to basic infrastructure.

Lack of proper maintenance of rail assets is already affecting rail operations in developing countries. In Africa, nearly half of the assets of railways are estimated to be in urgent need of rehabilitation (Briceno-Garmendia *et al*. 2008). In Azerbaijan, 62 percent of the track on the East-West corridor is operating under speed restrictions. Nearly two thirds of the mainline locomotives are well beyond their design service lives and in need of urgent replacement. Accordingly, Azerbaijan Railway cannot operate at full capacity (World Bank 2008). Climate change may add to these difficulties, because increased intensity of precipitation may damage rail beds and more frequent heat waves may strain tracks. But increasing resilience will require addressing the development deficits.

In many developing countries, proper airport infrastructure and facilities are also missing. This tends to result in poor regulatory aviation oversight and compliance with international safety and security standards (World Bank 2010d). One third of developing countries have not yet satisfied the international standards and practices for aircraft operations and maintenance (Table 5). And many flight cancelations are attributable to weather conditions.[3] Without adressing the infrastructure deficit, it will be impossible for the air transport sector to accommodate more severe weather conditions in the future.

In the electricity sector, many developing countries are wasting a significant amount of energy in technical and non-technical losses (Figure 4). In addition to reducing emissions, improving efficiency would make it easier to expand services and tackle the challenge of providing electricity to the 1.5 billion people who still do not have access. It might also help reduce climate vulnerability. In Albania, which derives more than 95 percent of its energy from hydroelectricity and is likely to experience reduced precipitation as a result of climate change, significant efforts to improve energy efficiency in production and consumption are now being made as part of efforts to adapt to climate change (ESMAP 2009).

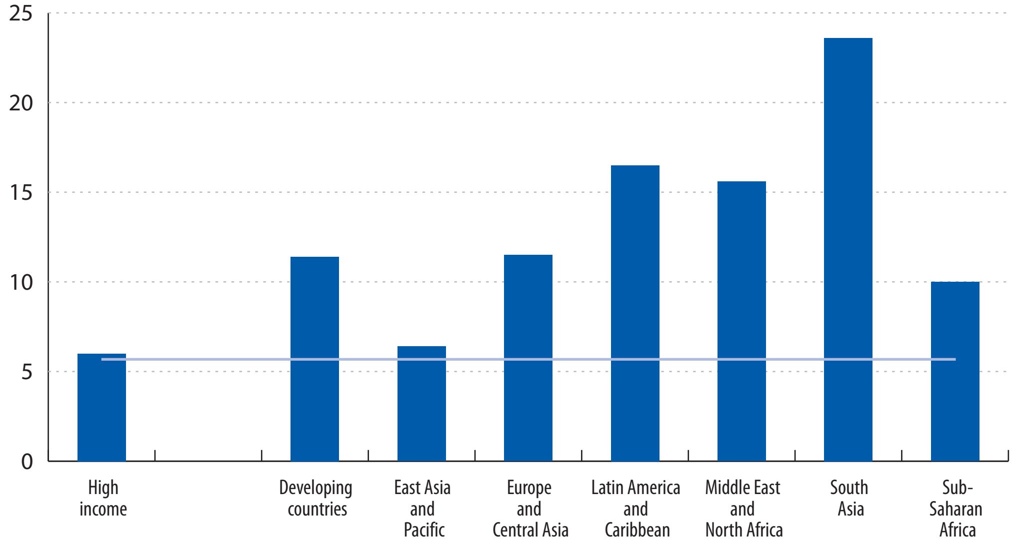
3 According to the Research and Innovative Technology Administration, Bureau of Transportation Statistics, about 40 percent of flights cancelled were attributed to weather in the United States.

Table 5. US civil aviation safety assessment 2008

	Number of countries assessed	Percent of countries meeting ICAO standards
High-income countries	45	96
Developing countries	62	68
Upper middle-income countries	27	89
Lower middle-income countries	27	59
Low-income countries	8	25

Source: US Federal Aviation Administration

Figure 4. Electricity transmission and distribution losses, latest available year (percent of total)



Source: World Development Indicators (accessed November 2010)

2.3 Mitigation benefits further tilt the balance in favour of greener infrastructure

Mitigation costs in developing countries could reach USD 139-175 billion a year by 2030 with associated financing needs of USD 264-563 billion (Table 6). The difference between upfront costs and financing needs is due to the fact that many efforts concern energy efficiency or renewable-energy projects that have higher upfront costs, but eventually pay for themselves or have lower operation costs.

Annual financing needs for mitigation in developing countries could reach USD 264-563bn by 2030, more than half of it concerning infrastructure.

Table 6. Annual net cost and financing needs to limit warming to 2°C in 2030

	Net cost	Financing need		
		Total	Infrastructure	
	USD billion	USD billion	USD billion	Percent
IEA		565	324	57.3
IIASA		264		
MiniCam	139			
McKinsey & Co.	175	563		
PNNL		384		

Source: World Bank (2009) and IEA (2009)

Yet not all is negative. Factoring in the benefits of mitigation could significantly alter the economics of investment in infrastructure in favour of greener investments. These usually carry a host of local co-benefits, such as improved environmental health or a reduction in congestion and local pollution, which are often not fully taken into account in project appraisal. This internalization could encourage policy makers to allocate more resources to greener and cleaner investment.

Taking the case of transport, externalities such as congestion and local pollution are estimated at 11 cents per mile (Table 7). This is approximately the same amount as the fuel cost spent on a standard passenger car in the United States, meaning that the monetary cost of driving a car is only half its social cost. In total, these external costs amount to 10-11 percent of GDP in OECD member countries (Banister 1998 cited in OECD 2002b). The potential benefits from removing these externalities therefore cannot be ignored when implementing policy interventions.

Table 7. Estimated external costs in the United States

	US Cent/gallon	US Cents/mile
Central values of marginal external costs		
Greenhouse warming	6	0.3
Oil dependency	12	0.6
Local pollution	42	2.0
Congestion, cents/mile	105	5.0
Accidents	63	3.0
Total	**228**	**10.9**

Source: Parry *et al.* (2007)
Note: It is assumed that vehicle fuel economy is 30 miles per gallon and gasoline price is USD 3 per gallon.

In transport, greenhouse gas abatement requires infrastructure improvements but demand side measures might be needed, too.

Policy interventions to reduce emissions can carry significant local co-benefits. For instance, traffic congestion clearly increases emissions as cars tend to emit more CO2 when traffic speeds are too low (Davis and Diegel 2004; Anas and Timilsina 2009). But congestion and idling also increase local pollutants and noise. Optimization of traffic signals can not only alleviate congestion and save travel time but also reduce CO2 emissions. In Tokyo, for instance, an improvement of the intersection of rail tracks and trunk roads resulted in a doubling of traffic speed, thereby reducing emissions by 12,000 tons of CO2 per year (OECD 2002a). Complementary measures might be needed, however, so that people do not respond to reduced congestion by driving more.[4] Fuel taxation, road user pricing, parking policies, congestion charges and high vehicle-related charges help discourage people from using cars, resulting in both lower traffic congestion and emissions.

And while public transportation helps reduce emissions, it also results in reduced road traffic injury and fatality. Speed limits and car inspection regulations also help with both safety and emissions. In Rio de Janeiro, the state light-vehicle inspection and maintenance program is expected to reduce carbon monoxide by 16-44 percent and hydrocarbon by 9-37 percent as a co-benefit (Ribeiro and Abreu 2008).

Potential health benefits from local pollution prevention policies that help reduce emissions, such as diesel particulate filter regulation, are also significant. Particulate exposure affects the pulmonary

4 In Niort, France, a traffic signal synchronization project improved the average speeds. But at the same time, the traffic volume also increased by 7 percent. People seem to have been induced to travel more because of the increased speeds. As a result, emissions rose by 6 percent (OECD 2002a).

function in children and asthmatics and causes mortality (Schwartz 1994). Individuals in lower middle-income and low-income countries are exposed to 50 percent higher particulate matter air pollution than people in high-income countries. For instance, converting diesel to CNG buses is one of the common measures to control pollution from vehicles. In Mumbai this could reduce particulates by 662 tons of PM10 per year while also reducing CO2 emissions (Takeuchi *et al*. 2007).

Another positive side-effect of the pressure to mitigate is the increased emphasis on energy efficiency. Energy modellers expect energy efficiency to account for a significant share of emission reduction relative to the business-as-usual scenario and evidence abounds that the potential is very large (World Bank 2009). Furthermore, it is cost effective: a dollar invested in energy efficiency is estimated to avoid more than two dollars in investment in energy supply capacity (World Bank 2009). This is particularly true for buildings, which consume about 40 percent of the world's final energy, and manufacturing. Pricing is critical to motivate energy consumers to use energy more wisely. If energy consumption is properly priced, the energy efficiency markets, such as energy supply companies (ESCO) can be part of the solution. In Brazil, the National Electrical Energy Conservation Program aims to retrofit government buildings and save 140 GWh of energy per year (UNEP 2010).

2.4 Better cost-benefit analysis is needed to help with both adaptation and mitigation concerns

New externalities and increased uncertainty call for revisiting cost-benefit analysis.

New externalities and increased uncertainty call for revisiting cost-benefit analysis (CBA) approaches. To perform sound project appraisals, the full spectrum of the consequences of investment decisions has to be examined. Still, as desirable as expanded CBA may be, they are constrained in practice by data availability, reliability, cost of collection, and accuracy. Decision makers may therefore be confronted with a trade-off between accuracy and relevance for action.

With this *caveat* in mind, it may be desirable to expand CBA to better take into account the following broader set of factors.

- **Indirect and induced effects**. Shalizi and Lecocq (2009), drawing on the input/output literature, give a new definition to these concepts. "Indirect effects" refer to effects that occur outside the boundary of the project but within its system. They are not taken into account in traditional project appraisal but can be related to the project because they belong to the same system. Example: an indirect effect of the US interstate highway network was to foster the building of new roads since it was the easiest way to plug in new transport infrastructure with the existing transport grid. "Induced effects" are those that occur beyond the boundary of the project's system and later in time. The sprawling pattern of US cities which does not belong to the road transport system can then be analyzed as an "induced effect" of building an efficient interstate highway network. Tracking those effects may be critical to assess projects' CO2 emissions and very relevant for mitigation concerns.
- **Externalities or intangibles**. The transport literature is already familiar with the pricing of certain externalities such as congestion (through the opportunity cost of time). Though they are still controversial, methodologies to price eco-system services are already available (Costanza *et al.* 1987, Chevassus 2009). And as discussed earlier, there are also attempts to integrate a social cost of carbon in project appraisals to rebalance the competition between high and low carbon investments (*e.g.* AFD 2008, Awerbuch and Yang 2007).
- **Integrating uncertainty: real option value** (Scandizzo and Paolantonio 2010)**.** Real options do not measure the values of the investments already made, but the contingent values that these investments would have if they were to be undertaken under alternative degrees of uncertainty. Within that framework, the extended form of the Net Present Value (NPV) calculation could be written in the following simplified form: ENPV = E[B] – E[C] + [OVc – Ovd]; where OVc denotes the "option values

created" and OVd the "option values destroyed" by the project. Then, when OVc-OVd > 0, the option value framework discloses additional benefits which increase the rate of return of some projects that would have failed traditional NPV tests. This improves the accuracy and relevance of the economic analysis of projects. It can help make the case for climate adaptation projects, for instance, which rarely pass traditional CBA because of their present excess costs (compared to business-as-usual projects), whereas they may get profitable when the option values they create are taken into account.

Yet, as accurate as an expanded CBA could be, a simple one-size-fits-all framework cannot encompass all the relevant dimensions of investment decisions. In some cases, monetary valuation (aggregation into only one commensurate dimension) of some decisive effects becomes meaningless because it is too reductive. Then CBA may be just one component of the decision process while narrative arguments can complement quantitative analysis. These arguments would be usefully based on the following techniques.

- **Multi-criteria analysis.** This approach aims at capturing a broader scope of dimensions of the decision (especially the moral dimension of decisions and human behaviour). Such framework acknowledges that decisions are fundamentally driven by political or normative choices, as reflected in the weight attributed to each criterion of the decision.
- **Technological-scenario analysis** along a decision tree. This consists of an *ex ante* mental experiment which describes sequences of investments. The framework assumes that one can attribute evolving subjective probabilities to alternative technical options all along the sequence of investments (*i.e.* along the branches of the decision tree). In a context of uncertainty, let us assume that all technical options are equally probable before the first round of investment. Then, after the first investment in, say, an interstate highway network, probabilities attached to alternative technical options for the second round of investment may have changed and become unequal among possible options. From now on, new investments in local road extension plugged into the interstate highway network, or densification of the existing network, are more probable than the construction of a parallel railway system. The new bias in favour of this type on transport infrastructure arises from a number of reasons: (i) path dependency; (ii) network effects; (iii) knowledge lock-in; and (iv) institutional lock-in.

Infrastructure delivering even in the face of extreme yet uncertain climate events may be preferable to one with maximum net benefits in the baseline scenario.

- **Robust decision-making** (RDM). In the framework proposed by Lempert (2000), decisions are not based on optimizing for the most likely future but on optimizing given an unknown future, assessing vulnerabilities of different strategies. The aim is not to select the only "optimal" strategy, but the one best suited to generate a consensus among stakeholders and/or to minimize the impacts of a bad surprise. Thus, RDM does not help decision makers predict what will happen but to design better choices and improve the ability to cope with low-probability, undesirable events. In fact, the RDM approach offers a hedge, which consists of both reducing policy vulnerability and increasing policy flexibility if the unexpected occurs. RDM prepares decision makers to face the remaining uncertainty and help them to make inevitable trade-offs between the costs of coverage and levels of acceptable risks. RDM is particularly adequate to guide long-lived capital investments when decision makers are confronted with both deep uncertainty and a rich set of controversial options.

3. Implications for the design and use of climate finance

Even if adaptation and mitigation costs are a fraction of overall infrastructure investment needs, they do add to the stresses of an already underfinanced sector. Climate finance could help although remains too modest. This section reviews the limitation of current adaptation and mitigation finance and looks at possible solutions. A first step is to "get prices right", or at least move in that direction, by eliminating distorting subsidies. A second involves looking at means to develop public-finance schemes to increase available finance. In the absence of carbon prices or firm commitment to reduce emissions, the challenge remains substantial.

3.1 The limitations of current adaptation and mitigation finance

Currently available resources are a fraction of the adaptation and mitigation gaps.

Current flows of mitigation and adaptation finance pale in comparison to needs (World Bank 2009). As discussed earlier, overall mitigation financing needs in developing countries are estimated at USD 265-565 billion per year. At the same time USD 75-100 billion are needed for adaptation. In contrast, the various funds available amount to a fraction of these needs. The Global Environment Facility (GEF) established in 1991 commits about USD 250 million per year largely in the form of grants to developing (non-Annex I) countries who are parties to the UNFCCC, in support of energy efficiency, renewable energy, new clean energy technology, and sustainable transport projects. The Clean Technology Fund (CTF) established in 2008 also provides grants, concessional loans and partial risk guarantees to help countries scale up clean technology initiatives. Including private and public co-financing, the CTF allowed for some USD 37 billion in green investments over the last two years. It demonstrated that the combination of funding instruments can leverage substantial resources, as in the case of Mexico City (World Bank 2010b).

The funding gap remains huge even if other official and nongovernmental financial resources are taken into account. Private capital will not shift from regular projects to climate projects unless the latter are viewed as lower-risk options. Indeed, redirecting private finance is fundamentally an issue of lowering the risk premium on carbon-saving investments. This reduction depends upon: (i) the credibility of some form of carbon pricing in the future (carbon markets, carbon tax, social cost of carbon, shadow cost of regulatory standards); and (ii) the deployment of national mitigation efforts that facilitate the effectiveness and acceptability of measures leading to this carbon value.

In addition to their inadequate amounts, both adaptation and mitigation funding suffer from drawbacks that reduce their ability to effectively contribute to infrastructure finance. Adaptation projects are constantly confronted with the problem of additionality. If the goal of the financing is to reduce vulnerability, the financing might wisely be used to remediate a development deficit (*e.g.* clean up the road culverts and maintain the roads more regularly) rather than a net incremental project (enlarge the culverts).

In fact, many developing countries reject conditionality on adaptation funding, invoking the (very valid) need to use adaptation funding as a new source of development assistance. Indeed, limiting adaptation funds to the financing of incremental costs due to adaptation to climate change bears the risk of providing only a small share of total cost, insufficient to leverage other funding sources, and of making it impossible to implement most-needed development projects. Drawing an interesting parallel between the EU enlargement funds and adaptation finance through the notion of additionality, Przyluski and Hallegatte (2010) suggest that adaptation funds should finance more than the incremental cost, as was done for EU projects in accession countries. The authors propose to set the level of funding at the level necessary to trigger other funding sources to reduce the development.

As to mitigation finance, it suffers from four main limitations – despite commendable achievements, such as creating a large market with a single price for carbon and catalyzing and implementing Clean Development Mechanism (CDM) projects:[5]

5 See de Gouvello and Zelenko (2010) for a discussion.

Carbon finance tends to be project based and ex post.

- It is only a limited means to overcome the upfront-financing barrier faced by many low-carbon projects since it provides *ex post* funding only once emission reductions are effectively observed;
- It is project based, making it largely irrelevant for sectors such as transport which require sector-wide combinations of demand and supply-side measures to truly affect emissions.[6]
- It only provides incentives to generate carbon offsets; consequently, emission reductions achieved in non-Annex 1 countries can only compensate for insufficient reduction efforts in Annex 1 countries (*i.e.* the buyers of carbon offsets);
- Future demand for CDM carbon offsets by Annex 1 countries will decrease as these countries limit the share of emission reduction that can be achieved through offsets (already the case for the EU emission trading system).

From an immediate infrastructure finance point of view, the first two of these four limitations are the most problematic. Many "climate-smart" projects – projects that efficiently incorporate relevant adaptation or mitigation concerns – still suffer from a lack of upfront funding necessary to launch the project. And the impact of the CDM on infrastructure will remain limited as long as it is project-based.

3.2 Mobilizing more available internal resources – getting the price right

The removal of climate-damaging subsidies (implicit or explicit) is an essential first step before attempts are made to tap outside resources. This will not only encourage people to use energy more wisely but also free up scarce fiscal resources. The IEA estimates that fossil-fuel-related consumption subsidies in developing countries amounted to USD 312 billion in 2009, a significant drop from USD 558 billion in 2008, which is mainly due to the decline in fossil-fuel prices. Consumption of oil products and natural gas received subsidies of USD 126 and USD 85 billion, respectively. The rest went to coal. A complete phase-out of these subsidies by 2020 would result in a reduction in global primary-energy demand of 5 percent and a fall in energy-related carbon-dioxide emissions of 5.8 percent, compared with a baseline in which subsidy rates remain unchanged (IEA 2010). Ten countries spent more than USD 10 billion subsidizing fossil fuels; nine countries allocated 5 percent or more of their GDP on such subsidies (Figure 5). These figures underestimate global fossil-fuel subsidies since they do not include producer subsidies that are believed to exist notably in high-income countries.

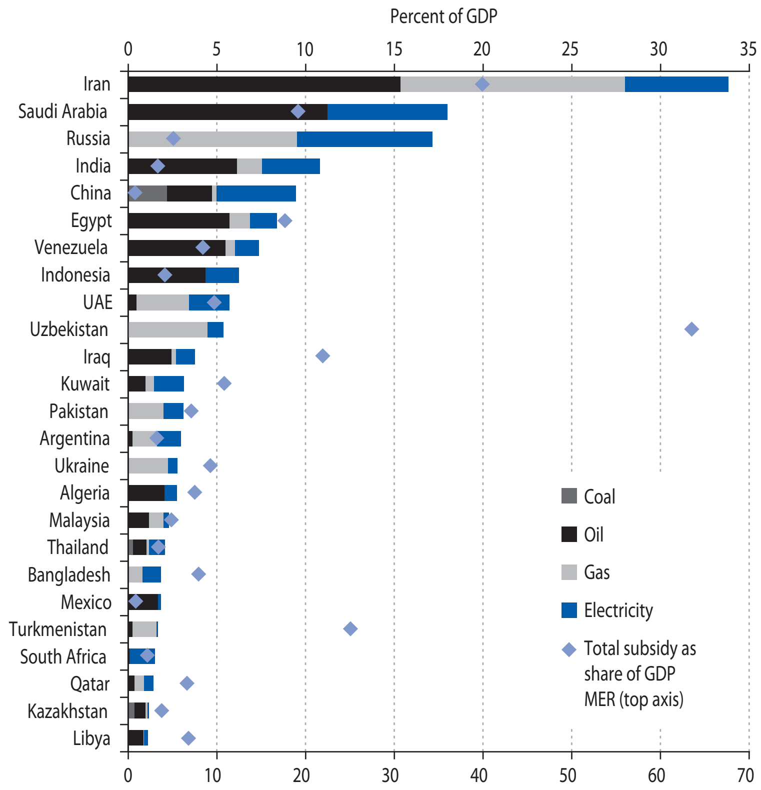
Another internal resource that can finance mitigation and adaptation in infrastructure is user charges. In many developing countries, utility services and roads are explicitly or implicitly subsidized to a greater or lesser extent. In the electricity sector, excess technical losses, non-payment or under-pricing, averages 0.84 percent of GDP in Africa (Briceno-Garmendia *et al.* 2008). Improving technical reliability of the network, strengthened tariff collection and/or rationalization of the prices, could generate substantial financial resources while promoting more efficient consumer behaviour.

Similarly, roads are largely publicly funded, hence *de facto* subsidized by public resources in most countries. In the United States, there are 277 toll roads, bridges and tunnels, totalling about 5,000 miles. But this accounts for only 0.2 percent of total roads or 0.5 percent of federal-aid highways. The share of toll revenue is less than 10 percent of total highway funding resources (NSTIFC 2009). Road pricing – both toll roads and cordon pricing – has proven highly effective to reduce congestion and emissions from traffic in urban areas since the pioneer experience in Singapore (World Bank 1978; OECD 2002a). Recently, more comprehensive road user pricing, such as cordon pricing, has been implemented in

6 Transport only accounted for three out of more than 2,200 registered CDM projects as of mid-2010.

several urban areas. In London and Stockholm, cordon pricing brought about USD 237 million and USD 116 million of congestion charges a year, respectively. These approaches are, however, only suited to high-density areas.

Figure 5. Economic value of fossil fuel consumption subsidies by country and type 2009



Source: IEA (2010)

Note: MER = market exchange rates.

3.3 Reforming external public financing schemes

A reform of external public financing schemes should enhance the attractiveness of 'climate-smart' infrastructure projects…

Most economists share the view that the global economy is not confronted with a problem of capital shortage. Huge amounts of capital are held by sovereign funds, pension funds and more broadly by institutional investors. The available capital could be reoriented toward climate-smart projects if private investors could earn adequate risk-adjusted returns. Indeed, climate change presents both significant risks and significant opportunities for investment portfolios.

The challenge for public action consists in attracting the vast amount of private capital needed to scale up private investment in climate solutions. Public-Finance Mechanisms (PFMs) must be designed to maximize the leverage of additional private finance and to minimize the cost of public action (Ward *et al.* 2009). One assessment of experience with a number of different models of PFMs suggests typical leverage ratios of private investment in the USD 3–15 range for every USD 1 of public money[7] (Maclean *et al.* 2008). A more conservative assessment estimates leverage ratios of 2 to 4 (AGF 2010). Either way, concerted programs of PFMs are key to raise needed private funds.

7 Such estimates are rather conservative in that they do not take into account the whole array of positive externalities generated by the PFMs, which support multiple generations of investments and help create markets that continue to grow after the public funds are expended. Public funds here are taken to include official development aid (ODA) and resources made available through multilateral development banks.

However, the emerging proposals for developing climate finance are at risk of fragmentation. This is a source of inefficiency denounced in the Paris Declaration on Aid Effectiveness and discussed in the Bali action plan. It is also a cause of distrust inhibiting the increase in climate finance.

…and address the 'instrument gap' between climate-smart and traditional development projects.

Assessments and reviews of experience of existing mechanisms are still very few.[8] Table 8 lists all the PFMs used so far to back up climate-smart projects.

Table 8. Examples of public-finance mechanisms provided by different institutions

	Public-finance mechanisms	Direct support	Indirect support	
		International to project	*International to national*	*National to project*
Contribution to investment and operation	**Up-front grant** - Standard technical-assistance grants - 'Smart' grants	GEF grants Other bilateral and multilateral DFIs	ODA	Investment support
	Funding during operation	Offset mechanisms (CDM) World Bank support	Grant linked to continuous delivery (finance *plus* regulatory stability)	- Incremental payment to renewable - Removal of energy subsidies - Carbon tax/cap-and-trade scheme
Facilitating access to finance	**Provision of equity** - Private equity - Venture capital (VC) - Long-term investment	ADB Clean Energy PE fund EIB/EBRD Sovereign Wealth Funds	EIB/EBRD support for VC fund setup costs, and co-investment in funds	Carbon Trust VC fund Transition economy VCs
	Provision of debt and equity - Loans (usually with governance conditions) - Credit lines - Equity (large projects, alongside foreign investors)	IFIs *e.g.* EBRD, IFC	IMF and World Bank loans	
	Risk coverage - Full or partial guarantee - Policy to cover all or specific causes of non performance - Other financial products	MIGA political risk insurance	World Bank/IFC Partial Credit and Partial Risk Guarantees	Export credit agency guarantees

Source: Neuhoff *et al.* (2009)

8 The World Bank is launching a study to address this gap and evaluate its own instruments as well as those that have been used by Regional Development Banks.

The table distinguishes two types of PFMs:

Public-finance mechanisms fall into those removing financial and institutional barriers against climate-smart investment and those commonly used to finance development projects.

- Those which aim at removing the excess financial and institutional barriers against climate-smart investments. Up-front grants and technical-assistance grants during the planning phase address directly the excess cost of such projects, which usually arises from the specific expertise and the more costly technologies they require. Then, CDM projects are explicitly dedicated to climate-smart projects enhancing project revenue during the operation phase when business as usual would have lead to less climate-friendly investments. Lastly, the suppression of distortive subsidies to dirty energies and the implementation of a carbon tax or a carbon market restore the truth on relative energy prices, thereby facilitating low-carbon investments.

- Those which are less focused on climate issues but commonly used to finance development projects. Public loans or public equity can be used to complement private funding of up-front capital (public funds intervene as "lenders of last resort") or to maximize the leverage effect of additional private capital participation in the project. Regarding the risk coverage of building costs or production costs, the public sector can play the role of "insurer of last resort" through well-defined guarantees when private insurers are not ready to cover the risks or require too high premiums.

As inventive as existing PFMs can be, they are not sufficient to leverage the overall amount of capital required to fund climate-smart projects. Therefore, they should be complemented by a more comprehensive and sophisticated financial architecture, which would offer low-cost access to capital and manage to channel enough private funds toward green infrastructure projects.

The scope of public intervention has to be defined consistently with an appropriate risk allocation between the private and public sectors. The private sector will invest to the extent that it expects a competitive risk-adjusted return. The role of the public sector thus should be limited to reducing risks associated with market failures, policy credibility and equity considerations. To go beyond this goal would be inefficient, stretching the financing capacity of governments and causing deadweight loss.

Given the risks of underlying projects and low familiarity with carbon finance, there have been few attempts by financial institutions to monetize forward carbon revenue streams to provide (part of) the investment capital required. The World Bank Group has been exploring structures to convert anticipated carbon revenues into finance flows or piloting innovative structures, such as revolving funds where accruing carbon finance revenues can support the next tranche of investments. Such initiative clearly aims at designing smart PFMs and shaping a financial architecture grounded on an effective carbon value. Further possible PFMs are explored in Box 1.

New proposals include, first, the IMF's "Green Fund" (Bredenkamp and Patillo 2010), which suggests using an initial capital injection by developed countries in the form of reserve assets such as Special Drawing Rights (SDRs). The equity stakes could be scaled in proportion to countries' IMF quota shares that define the respective contribution of countries to the IMF. The equity stakes would thus be disconnected from countries' CO2 emissions since they depend on countries' weights in the world economy.[9]

9 Although, in general, rich countries emit more than poor countries, there is substantial variation among high-income countries and hence, less-than-perfect correlation between *per capita* income and emissions.

Box 1. Examples of possible new PFMs

An intermediary and more sophisticated option is to combine financial devices of uncertainty hedging and public commitment to secure part of the risk. In this case, public intervention focuses on a very restricted part of the risk: the excess risk perceived by private investors relative to other competitive more carbon-intensive projects. Such perception of an excess risk may arise from a lack of credible information on future carbon prices, biased expectations of risk-adjusted returns of carbon-intensive projects or an excessively high rate of pure time preference. Therefore, the high risk premium required prevents private investors from adopting the socially optimal project design. Thus, the government, consistent with an optimal control framework which aims at minimizing the cost of climate policy (the optimum is reached when for each point in time marginal abatement cost equals marginal damage), selects among a pool of projects those which deserve to be funded to reach the optimal aggregate path. Then public action aims at backing those projects by lowering their risk premium to a competitive level through appropriate financial instruments.

Besides the existing PFMs mentioned above, innovative financial instruments such as long-term put option contracts (*i.e.* purchase promise of carbon credit at a defined future date and level of price) issued by governments could be examined (Ismer and Neuhoff 2006). Maintaining the carbon price at or above a certain level needs from their part a credible commitment both towards investors in low-carbon technology and towards foreign governments. Such commitment assumes the achievement of an international agreement on future targets of emission reduction protected from free-riding. In fact, this financial device provides two virtuous incentives. First, towards investors who can rely on credible future carbon prices; second, towards governments, since, to avoid potentially huge public loss, *i.e.*, if the carbon price falls below the strike price of the options, a rational government would better comply with its international commitment in terms of emission reduction. Indeed, only the actual implementation of more stringent policies can make carbon prices follow an increasing trend. Moreover, with sufficient outstanding contracts, the commitment is sufficiently strong, the likelihood of low carbon prices is low and thus, the price of contracts is close to zero, which makes the contracts easily accessible as a risk-hedging device under many circumstances. Indeed, public intervention can be very cheap and even free as long as the government's expectations over the true risk of the projects are right, that is, if the excess risk was not grounded or endogenized by the government's own behaviour and only rested on a lack of information among private investors.

Proposals to increase climate finance include IMF issuance of green bonds…

The basic idea is to give to the transferred SDRs the character of a genuine reserve asset, so that it just consists of an exchange of assets and does not require upfront budgetary cost for contributors. However, to be considered as a reserve, the asset must be perfectly liquid so that a contributor can withdraw all or part of its reserve to face a specific temporary funding need. Rules to ensure that equity in the Green Fund is perfectly liquid remain to be defined. Further, for the operation to be the neutral swap described by the IMF, the dividends offered to shareholders would need to be equivalent to the interests provided by their reserves expressed in SDRs.[10] The SDRs would then be used as the counterpart to the issuance of low-cost "green bonds" sold to private or public investors and hence, to mobilize a multiple of its paid-in-capital. Basically, the Green Fund set up by the IMF is a financial device to reduce the cost of issuing Green Bonds. Its advantage over existing funds depends on whether compared to other institutions, IMF (or SDR) credibility is greater, allowing for issuance of bonds at lower cost.

10 The proposal acknowledges that additional funding would likely need to be mobilized since much of the financing would be provided as grants or concessional loans.

Green-Bond revenues would be used to provide loan resources to mitigation projects, with investors remunerated with the interests on those loans and the dividends that accrue to the shareholders of the Fund. The Green Fund therefore borrows at low price and lends at a higher price to pay back the interests of the bonds as well as the induced transaction costs. It essentially amounts to earmarking a share of IMF lending for climate-smart investments. Note that the IMF proposal does not envisage a role for the IMF in allocating the resources, which would be left to institutions better suited to this role.

…a facility ensuring an annual USD 100bn in AAA bond revenues and an international agreement on the social cost of carbon.

A second proposal is that of the Low Carbon Development Facility proposed by de Gouvello and Zelenko (2010). It assumes that future negotiations can generate an agreement among countries to set up a green fund able to emit USD 100 billion in AAA green bonds per year whose revenue would be used to lend to climate projects globally rated BBB. Given the operation costs and the default and recovery rates attributed to BBB investments, the financial model shows that an initial capital of USD 68 billion would be necessary to sustain the AAA of the green bonds. These USD 68 billion represent the short-term one-shot effort that countries have to agree on to make it work.

Finally, a third alternative consists in relying on a social cost of carbon to measure the value created by projects. Existing climate financing schemes implicitly assume that climate-smart projects will eventually create a valuable asset based on the value of avoided emissions. But in the absence of a global framework to price carbon externality, they face regulatory uncertainty that entails financial risks. In this context, existing initiatives are necessarily of limited scale and unlikely to generate the funding needed to reach ambitious climatic goals.

A global agreement on an estimate of the social cost of carbon would help scale up climate finance. The social cost of carbon is basically a notional value of the carbon externality that may allow disconnecting the price signal effect from an actual carbon price. Contrary to a carbon tax or a carbon market, the social cost of carbon does not imply an up-front budgetary cost for countries and may therefore be more acceptable politically. Specifically, the international agreement would be on the allocation of a certain amount of social-cost-of-carbon units (the values and time profiles of which would be conventionally defined) to different types of climate-smart projects. In practice, such allocation would lower the cost of capital for climate-smart projects because those social-cost-of-carbon units could be converted into international reserve.

4. Conclusion

This article represents a first attempt at looking at how climate change affects the management and provision of infrastructure services in developing countries. It reviews how uncertainty associated with local climate impacts, technology and future carbon prices complicates the design of infrastructure. It also argues that both mitigation and adaptation concerns will increase the costs of infrastructure. Estimates of the additional costs associated with adaptation are modest but this is due to the way they are calculated: as the incremental costs of adapting new infrastructure rather than the costs of improving resilience. The latter would require first and foremost addressing the large infrastructure deficit that characterizes most developing countries. In fact, adaptation and mitigation costs pale in comparison to the unmet infrastructure funding needs.

Climate finance for developing countries, if modest relative to needs, is expected to make a net addition to domestic and concessional resources for infrastructure funding.

All is not negative however. One positive side effect of climate change might be that it helps bring attention to the need to better address environmental issues in infrastructure design at the same time as it increases the value of environmental co-benefits. Further, high-income countries have pledged resources to assist developing countries both in adapting to and in mitigating climate change. It is reasonable to expect that a share of these resources will constitute a net addition to domestic and concessional resources available for infrastructure funding.

Unfortunately, climate finance for developing countries remains modest relative to needs. Adaptation funding needs to increase at the same time as it moves away from a narrow focus on incremental costs. The experience of the EU accession funds, which also had to tackle the question of additionality, offers some useful lessons. Mitigation funds suffer from the absence of agreement that could generate more certainty and stability around a carbon price and around the potential size of the offset markets. Several ideas are offered that could help raise additional funding but these require some commitments by high-income countries.

One issue that is not tackled in this study and requires further research is the extent to which climate change may affect private participation in infrastructure – currently the source of some 15-20 percent of developing-country infrastructure finance. As climate change increases uncertainty, it should increase the cost of capital and hence, make private finance more costly and possibly more difficult to attract, at least in the most affected countries. We can also expect that climate change and the need for new environmental regulations will affect the optimal regulatory regimes that govern PPPs.

Annex. Estimating infrastructure adaptation needs[11]

As Parry *et al*. (2007) explain, the UNFCCC (2007) follows the traditional approach to estimate the adaptation investment needs. It does not take into account incremental operation and maintenance costs generated from the existing levels of infrastructure services. It first estimates the gross fixed infrastructure capital formation in 2030 at USD 22.27 trillion, which would be three times the investment in 2000 and corresponding to an average annual investment growth rate of 5-6 percent. Then the estimate of the proportion of the new investment that is vulnerable to climate change is assumed based on insurance data on losses from weather disasters. Munich Re considers 0.7 percent of total infrastructure as vulnerable while the Association of British Insurers (ABI) assumes 2.7 percent. This leads to estimates of vulnerable new investments of USD 153–600 billion for 2030. As climate-proofing infrastructure is assumed to cost 5 to 20 percent of total vulnerable investments according to the UNFCCC study, this leads to incremental financial cost for adaptation of USD 8–31 billion (with the vulnerability share of Munich Re) or USD 33–130billion (based on the ABI data).

A different approach is taken in the World Bank's Economics of Adaptation to Climate Change (EACC) Study. It projects stocks of major types of infrastructure over 2010 to 2050. The transport infrastructure includes roads, rail and ports. The cost of adaptation is computed as the incremental cost of constructing as well as operating and maintaining the baseline levels of infrastructure services under the climate conditions projected by the climate models of the National Center for Atmospheric Research (NCAR) and the Commonwealth Scientific and Industrial Research Organization (CSIRO).

The study focuses on price and cost changes for fixed quantities of infrastructure (referred to as a delta-P component) but also calculates costs resulting from the impact of climate change on demand for infrastructure services (delta-Q component), including operating and maintenance costs. The parameters of the price and cost change estimates are obtained from dose response engineering studies on the effects of climate change on the construction of new infrastructure. Based on the NCAR model both the additional cost and the maintenance expenditures for all sectors would amount to USD 36.8 billion annually. On the basis of the CSIRO model, it would be USD 28.6 billion annually.

11 This Annex draws on Parry *et al.* (2009) and World Bank (2010c).

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ABSTRACT

This study analyzes the main approaches to infrastructure financing in developing countries and their evolution. *It places the discussion in the context of the importance of infrastructure investment and maintenance needs to achieve growth and broader social objectives. It summarizes the evidence on the efficiency, equity and fiscal consequences of the main public and private financing options commonly used to achieve these goals in these countries. It shows the limits of the role of the private sector as a source of financing of infrastructure and the wide underestimation of public-sector financing support needed to serve the poorest and ensure that services are offered at prices consistent with their ability to pay. It concludes with forward-looking lessons from roughly 20 years of efforts to diversify the sources of infrastructure finance in developing countries.*

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Infrastructure finance in developing countries: An overview

Antonio Estache

1. Introduction

This study offers a policy-oriented overview of the main approaches to infrastructure finance in developing countries since the early 1990s. The main purpose of the analysis is to draw forward-looking lessons from roughly 20 years of efforts to diversify the sources of development infrastructure finance. To set the context, it discusses the importance of infrastructure needs to achieve growth and broader social objectives. It also summarizes the evidence on the evolution of the relative importance of private sources of financing in the sector as well as some of their economic consequences.

The decision to diversify the sources of infrastructure finance in developing countries, and in particular to open up the opportunities to private-sector financing, started to be common among governments and development agencies around the mid-1990s.[1] It was the delayed outcome of a very specific set of historical policy choices that had taken place 10-15 years earlier. Indeed, it was a late response to the cuts in public infrastructure spending that had resulted from efforts to cut fiscal deficits during the 1980s macroeconomic structural adjustment programmes.

Policy makers were slow to realize the consequences of the blind fiscal cuts. The infrastructure "collateral damage" of the efforts to address the deficit problems only started to be deemed undesirable in the early 1990s when policy makers realized that infrastructure bottlenecks were slowing economic growth. Moreover, investment in basic infrastructure was, by then, hardly catching up with population growth. Many governments were caught in a "catch-22" situation in which they knew they needed to spend more on infrastructure to promote growth and, hence, their tax base, yet they could not afford the fiscal costs of the much-needed increase. The short-term fiscal concerns prevailed and investments were not being made.

By the mid-1990s, closing the infrastructure gap started to become part of the political speeches again but it did so with a twist. The twist was that the public sector should not have the monopoly over infrastructure investment. In a continued context of fiscal discipline, but with a growing volume of liquidity available on international financial markets, the case for a potential role of the private sector was increasingly easy to make. In a nutshell, this is the sequence of events that explains the push for an increase in the relative importance of private financing in the sector that has now lasted for the last 15 years or so.

The debate on the realism of the expected take-over of private finance of the sector started then and it still continues to this day. The speeches announcing the stimulus packages prepared to pull the world out of the 2008-2009 crisis were quite revealing about entrenched political convictions. Many bet on the private sector to be a key player in the implementation of these packages.

The conviction that private financing is the way to go, is, however not unanimous and has not been so for a while now. In contrast to the continued political optimism, the public emotions towards the

1 It is hard to forget that this is not the first time in history the private sector was expected to play a major role in infrastructure. During much of the 19th century, key infrastructure developments were actually privately financed. Interestingly enough, many of these original private infrastructure projects already required government subsidies and guarantees. For a brief longer-term historical perspective on infrastructure finance, see Eichengreen (1995).

Popular support for a bigger role of the private sector has given way to anger about an unfair distribution of the benefits from infrastructure reform.

role of the private sector have fluctuated in developing countries.[2] The initial popular support, from the mid-1990s to the early 2000s, for an increased role for the private sector, resulted from the deterioration of infrastructure quality that had prevailed under public management. It was also the outcome of the increasing rationing of access to services by the low-income classes, and increasingly the middle class as well, resulting from investment levels lagging behind population growth and social mobility.

The situation changed by the mid-2000s. The low and the middle classes started to be unhappy again. The perception – and in many instances the evidence as well – of an uneven distribution between users and investors of the gains from infrastructure reforms has progressively fuelled a rejection of a significant role for the private sector in many countries. The Bolivian and Venezuelan re-nationalization experiences are only the most obvious illustrations of this unhappiness. They are, however, symptomatic of a sustained malaise.

The emotional dimensions associated with the distribution of responsibilities between the public and the private sector in the financing of infrastructure need to be taken seriously – more seriously than some of the political speeches seem to care to do. But it is just as crucial to have a cold look at the facts as well. Almost 20 years after the launch of the Argentinean infrastructure reforms that kick-started the opening of a role for private large-scale financing of infrastructure in developing economies, there is enough evidence of the efficiency, equity and fiscal effects of adopting this policy option. This means that reasonably objective lessons on the most realistic financing and management options for the sector are possible from an economic, social and political viewpoint. This is what this article attempts to do.

The main challenge to the discussion of the forward-looking lessons from this evidence, however, comes from the timing of this stock-taking exercise. First, the world has not yet settled down following the financial crisis. Any current assessment is still subject to a lot of uncertainty, limiting some of its forward-looking value. We are all still learning from the multiple diagnostics of the remarkably brutal shock that hit the real and the financial economies of this world in 2008. Second, the analysis is also influenced by the fact that the brutality of the shock has shaken the confidence of economists in their ability to differentiate between faith and facts in their diagnostics. The timing thus defines a context forcing humility and a focus on trying to separate facts from ideology to ensure that the growth and poverty-reduction prospects of the infrastructure finance strategies are not damaged by wishful thinking and hopes. The mistakes of the past have been costly and these costs should be recognized as much as the potential benefits and risks of the policies aimed at increasing private finance in the sector.

The study adopts the following logic to cover all the dimensions that need to be addressed to get a sense of the purpose, the instruments and the implementation challenges of infrastructure development finance. Section 2 provides a brief summary of the relevance of infrastructure for growth and poverty-related dimensions of development. Section 3 discusses the current investment levels in infrastructure, their efficiency as well as estimates of the needs according to development levels of developing countries. Section 4 summarizes the evidence across regions of the extent to which the private sector has taken over the traditional public-sector role of financing infrastructure. Section 5 briefly reviews the wide range of instruments which have been designed to increase opportunities for private-sector involvement in infrastructure as well as the evidence available on how much they managed to deliver. Section 6 offers a more strategic discussion of the financing challenges of development in which the

2 See Martimort and Straub (2009) for an analytical assessment of the sources of popular unhappiness with the effort to rely on private financing of infrastructure.

infrastructure challenge fits. Section 7 discusses emerging challenges facing infrastructure financing in developing countries. Section 8 offers some concluding comments.

2. Infrastructure needs for growth and social goals

The poorer the country, the more infrastructure matters for health, education and economic growth.

Unless governments were dramatically wrong in the design of the 2007-2009 stimulus plans, increasing infrastructure investment is widely perceived as an important way of restoring short to medium-term growth. According to Freedman *et al.* (2009), the expenditure measures adopted by G20 countries include an average annual additional allocation of fiscal resources of 0.40 percent of GDP to infrastructure, to be disbursed in 2009 and 2010, and longer in some countries. Khatiwada (2009) estimates that the share of the stimulus packages allocated to infrastructure was, on average, three times higher in developing and emerging economies than in developed economies, quite consistent with the idea that infrastructure needs are actually much stronger in the poorer countries. In these countries, even more so than in developed countries, the bet on infrastructure was also a bet on job creation, as suggested by the ILO (2009).

But for developing countries, infrastructure investment is a much longer-term concern than a bet on recovery from a crisis. It is indeed common knowledge that developing countries lack access to electricity, water, telecommunication facilities as well as common transport infrastructures such as roads and ports. Better health and education outcomes are the usual policy goals when addressing infrastructure coverage gaps. But tackling these gaps is also associated with the potential role of infrastructure as an engine of long-term economic growth. Indeed, there is a lot of evidence on the opportunity cost of infrastructure investment gaps in terms of growth and productivity. A few surveys have recently summarized the very large literature on the importance of infrastructure for growth.[3] The relevant point of that research is that the poorer the country, the more infrastructure matters!

Before discussing the specific estimates of infrastructure investment needs in developing countries, it may be useful to provide a more intuitive sense of the coverage gaps through a summary of the state of access to infrastructure around the world. The sheer number of people lacking access is more impressive than the cold dollar figures revealing the high costs of the coverage gaps.

2.1 Electricity coverage gaps

According to the International Energy Agency (IEA), about 1.5 billion people lived without electricity in 2008; almost all of them in developing countries. That's about 22 percent of the world population. The information on access rates per region is summarized in Table 1.

It shows that only 58.4 percent of the people living in rural developing areas have access to electricity. The most extreme situation is in Sub-Saharan Africa where about 88 percent of the rural population live without electricity but also 42.5 percent of the urban population. This means that roughly 3 out of 4 people in Sub-Saharan Africa do not have access to electricity. There is nothing romantic about not having access to electricity day after day. About 3 billion people, half of the world's population, have to rely on traditional and harmful biomass for cooking and heating. The smoke from the biomass is associated with pulmonary diseases causing, annually, the death of 1.5 million people, mostly women and children.

3 Straub (2008), for instance, provides a recent lengthy overview of the literature. More recently, Estache and Garsous (2010) conducted a meta-analysis synthesizing analytically the large literature on the elasticity of growth to infrastructure stocks, finding it to vary from 0.15 to 0.35 depending on the model specification.

Lack of access to modern electricity sources is also commonly stated as an impediment to investment in the 'Doing Business' reports of the World Bank.

Table 1. Electricity access rates in 2008

	Population without electricity (millions)	Electrification rate (percent)	Urban electrification rate (percent)	Rural electrification rate (percent)
East Asia	195	90.2	96.2	85.5
Latin America	34.1	92.7	98.7	70.2
Middle East	21	89.1	98.5	70.6
North Africa	2	98.9	99.6	98.2
South Asia	614	60.2	88.4	48.4
Sub-Saharan Africa	587	28.5	57.5	11.9
Developing countries	1,453	72.0	90.0	58.4
Transition economies and OECD	3	99.8	100.0	99.5
World	**1,456**	**78.2**	**93.4**	**63.2**

Source: IEA (2009)

2.2 Water and sanitation coverage gaps

Close to a billion people lack access to safe drinking water, and almost three times as many have no decent sanitation facilities.

The situation in the water sector is just as bad for the poorest. The figures reported in the World Bank Development Indicators (World Bank 2009a) suggest that in 2007, about 925 million people lacked access to safe drinking water. Almost three times as many lacked access to improved sanitation facilities. The World Health Organization argues that the investment gap in the sector contributes to explain the deaths of 1.4 million children every year from diarrhoea caused by unclean water and poor sanitation (Prüss Üstün *et al.* 2008). The Millennium Development Goals (MDGs) call for halving, by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation. The effort needed is, however, distributed quite disproportionately in the developing world. Table 2 shows the geographical distribution of the investment needs. Sub-Saharan Africa is the region with the largest water gap. Moreover, unless investment allowing sound water delivery and management speeds up, the problem is likely to get worse as supplies of freshwater are dropping as a consequence of climate change and over-consumption.

Table 2. Water and sanitation access rates in 2007 (percent of population)

	Access to improved water source	Access to improved sanitation facilities
East Asia	87	66
Eastern Europe and Central Asia	95	89
Latin and Central America	91	78
Middle East and North Africa	89	77
South Asia	87	33
Sub-Saharan Africa	58	31
World	**86**	**60**

Source: World Bank (2009a)

2.3 Telecommunication coverage gaps

While energy and water needs are easily connected to health concerns, the investment needs in the telecommunication sector are more commonly linked to knowledge, education and business opportunities. The latest evidence suggests that telecommunications coverage gaps are still very wide as well. The 2010 International Telecommunications Union report on the measurement of the information society provides useful insights into the investment needs in the sector (ITU 2010). First, it shows that the digital divide is slowly closing. In developing countries, average mobile penetration has reached 57 percent in 2009 more than twice what it was in 2005. Two thirds of the world's cell phone subscriptions are in developing countries – just a little bit less than their share of the world's population – with the highest rate in Africa where 25 percent of the population now has a mobile. However, in contrast to progress in access to basic phone services, the evidence on the access to the main new information and communication technology (ICT) instruments needed to close the educational and knowledge gaps around the world is much less positive. Indeed, the number of Internet users per 100 inhabitants in developing countries was the same in 2008 as it was in Sweden, the world's top performer on ICT, at the end of the 1990s.

While mobile penetration is rising fast, access to the Internet and new information and communication technologies still lags behind.

2.4 Transport coverage gaps

On transport, it is common to read that one billion people have no easy access to all-weather roads but there is a lot more discussion of its repercussions for business. There is indeed quite robust evidence of the importance of transport for trade and growth. In a study of transport costs and trade, Limao and Venables (2000) find that poor transport networks account for 60 percent of transport costs for landlocked countries and only 40 percent for coastal countries since they can rely on the sea to move freight and people. This original research has since been validated by numerous other papers. For instance, Buys *et al.* (2006), find that an investment of USD 20 billion and an annual maintenance expense of USD 1 billion, to conduct a continental network upgrading in Sub-Saharan Africa, would expand overland trade by about USD 250 billion over 15 years.

While these studies show that transport investment matters for growth, they do not lend themselves to easy estimates of relatively precise macroeconomic assessments of investment needs as can be done for access gaps in energy, water or telecoms. The concept of access is more complex for transport. One possible approximation to give a more intuitive sense of this gap – and hence of the investment needs – is to compare the differences across regions in terms of freight mobility. Table 3 summarizes the information reported by the International Road Federation on the relative shares of freight of the various regions of the world.

Table 3. Share of regions in total freight transported in 2007 (percent of total), by transport mode

	Road	Rail	Waterways
East Asia	25	30	62
Europe (East and West)	38	34	11
Latin America	4	<1	<1
Middle East and North Africa	<1	<1	<1
North America	28	35	26
South Asia	2	<1	<1
Sub-Saharan Africa	4	<1	<1
Total	100	100	100

Source: International Road Federation (2009)
Note: Freight transported is measured in million of ton-kms for each mode.

These data show that the distribution of the shares of world freight is extremely skewed in favour of some regions, the most developed. This is the case for each mode. The data also show that the freight movement in South Asia and Sub-Saharan Africa, the poorest regions of the world, is abnormally low. Table 3 finally reveals, somewhat surprisingly, the very low mobility of freight in the Middle East and Latin America.

2.5 Regional dimensions of the coverage gaps

As network externalities extend across borders, many electricity, telecom and transport projects require international coordination.

The discussion of infrastructure gaps so far gives a good first-order approximation of what the priorities need to be in each region and potentially in each country, since the identification of gaps is actually done at the country level. However, the approach hides one of the major dimensions for the sub-sectors characterized by potentially significant network externalities. There are indeed many instances in which investment in electricity, telecoms and transport in one country need to be coordinated with similar investment in other countries.

This is why regional infrastructure projects are central to the regional economic integration of almost all developing regions in the world. In Central America, in all parts of Africa and in some parts of East Asia, major regional power pools are essential to be able to meet the country-specific needs at the lowest possible unit cost for each individual country. Similarly, many of the potential benefits of roads and rail projects can only materialize if the investments are made in projects that allow landlocked countries to become better integrated with other countries. Some of the main growth payoffs to investment in telecommunications will come from large scale multi-country investments in the backbones needed to close the digital divide in Africa. The cost of these telecommunication investment needs tends to dwarf the cost of the purely local investment needs.

This discussion of the needs explains why the African Development Bank, the Asian Development Bank and the Inter-American Development Bank, the three major regional development banks, have all recently introduced major programs to support supranational transport investment programs. These decisions were based on the conviction that there is an opportunity cost in terms of trade and growth associated with the insufficient coverage of transport networks in the poorest regions. The share of supranational projects in the portfolio of these institutions is very likely to increase significantly in the near future.

2.6 The information gaps on infrastructure

The discussion so far has been possible because in recent years, the international community has put in place useful and objective monitoring systems for the basic access rates in the key infrastructure sub-sectors – although it has not addressed the service quality issue yet. The coverage of the monitoring system is not exhaustive. In particular, it does not really have an equivalent standard objective indicator for transport access. But the international community has also developed interesting indicators on the subjective importance of various infrastructure sub-sectors in terms of their importance for the investment climate. These include the "Doing Business" indicators of the World Bank and the sectoral indicators of the World Economic Forum used in its competitiveness report.

The information challenge is overall still very important. The international community has probably not learned as much as it should have. Consider the most politically sensitive sector: water and sanitation. It has been in the limelight for over 20 years, with the Water Decade and its inclusion in the MDGs. Yet, the measures of access continue to be rough approximations based on imperfect household consumption and expenditure surveys. These surveys offer some coverage of energy and transport but it is not systematic. For energy, the global access figures are based on extrapolations – conducted by the International Energy Agency on behalf of the international community – for each region based on evidence for a sample of countries in each region. The telecoms sector is probably the best informed, simply because the technology lends itself to cheaper monitoring. As mentioned earlier, the transport sector lags well behind on the monitoring and information front, even if efforts to address the issue are on the agenda of the international community.

3. Costing the regional and sectoral infrastructure investment needs

This section summarizes a relatively large literature generally not found in academic publications but widely quoted and used among development agencies interested in getting a sense of the resource allocation needs of the infrastructure sector. The discussion starts with an overview of estimations of current investment levels in the sector. It continues with a discussion of the efficiency of the expenditures and concludes with a summary of the estimates of the investment, and operation and maintenance expenditure needs of the sector.

3.1 Assessing the current levels of investment

Before discussing the main sources of financing and their relative importance, it may be useful to get a sense of the total level of investment currently observed in developing countries. As for most efforts to generate estimates in this sector, this turns out to be quite a challenge. Neither the national accounts nor the IMF Government Finance Statistics (GFS) report a disaggregation of total and public investment data detailed enough to allow identifying every infrastructure sub-sector. In national accounts, energy data cover both electricity and gas but also all primary-energy related products such as petroleum. Similarly, the data do not really distinguish between transport and communication. Water expenditures can be hidden in public works or even in health expenditures.

The most common approach is to derive a sense of the actual investments from estimates of physical stocks and, if possible, to correct for the quality of these stocks. There are too many internal notes in international development agencies reporting these somewhat heroic estimates to be able to summarize them here. But they all start with physical data and approximations of the monetary value of those data obtained from an estimate of unit costs or some approximation derived from a growth requirement function along the lines followed by Yepes (2008) or OECD (2006 and 2007).

Infrastructure investment in the developing world is between 3 and 4.5 percent of GDP.

To discuss the current levels of investment in developing countries in a consistent way across regions, we rely again on the rough estimates of current average expenditure levels in the sector generated by Yepes (2008). A problem with his paper relevant here is that it does not distinguish clearly between the investment and the operational and maintenance components. Yepes (2008) simply suggests that the investment component of these expenditures is roughly 40 percent. This means that based on his valuation of the current physical stocks of capital, the actual investment levels, as shares of GDP, are 5 percent, 3.3 percent and roughly 1 percent, respectively, in low-income, lower middle-income and upper middle-income countries. Back in 1994, the World Development Report, which focused on infrastructure, estimated an average investment level of around 4 percent of GDP for the developing world (World Bank 1994). These two global approximations are thus comparable. Based on these orders of magnitude, it seems reasonable to assume that the average investment in infrastructure in the developing world is somewhere between 3 and 4.5 percent of GDP.

These estimates are also quite consistent with the more detailed estimates generated within regions. In Latin America, for instance, public investment in infrastructure was estimated to be just under 1 percent of GDP until the early 1990s (Calderon and Servén 2004). With the liberalization, the private sector invested nearly 1.1 percent of GDP in infrastructure during the 1990s, but in many countries it crowded out public investment, reducing public investment further (Fay and Morrison 2007). The match with the Asia-specific estimates is not as strong as Asia counts important outliers in terms of public infrastructure investment such as China and Vietnam. In that region, the fast-growing middle-income countries (China, Malaysia, Thailand), have somewhat surprising investment-to-GDP levels that are higher still than the expectedly high averages of the lowest-income countries of the world. In China, for instance, investment in infrastructure averaged 6.7 percent of GDP in the 1990s and 9 percent in the period 1998-2002 (Naughton 2004). This level has been sustained ever since. For Sub-Saharan Africa, Foster and Briceno (2009) estimate investment at 6.1 percent of GDP for low-income non-fragile states.

3.2 Improving efficiency to cut the needs

There is a wide margin for efficiency gains in infrastructure service delivery, varying across regions and sub-sectors.

An important debate in the infrastructure literature is to assess the extent to which infrastructure services are delivered efficiently. Many regulatory regimes now used in infrastructure ensure that there is an explicit incentive for operators to improve efficiency and for regulators to monitor this efficiency. Measuring efficiency of regulated industries has in fact become an important consulting business. The concern for efficiency in regulated infrastructure in both developed and developing countries has also led to a large volume of academic research because the topic raises many interesting methodological issues. Estache *et al.* (2006) provide an overview of academic research on the margin for efficiency gains in developing countries in the various infrastructure sub-sectors. They show that the average potential gains tend to be quite high whilst varying significantly across sub-sectors and across regions. Offering a single sector-specific figure does not really make sense. The efficiency gains are case specific and the homework needs to be done to get a reliable answer.

The real support for efforts to assess efficiency often comes from the fiscal side when the public sector is expected to pick up the financing of infrastructure. Foster and Briceno (2009) suggest that in Sub-Saharan Africa, costs to be recovered and subsidized could actually be cut, on average, by an extra 8 percent by improving efficiency and reducing corruption in the sector. This is equivalent to 1.2 percent of GDP. In other terms, subsidies to the financing of the sector could be cut significantly if the sector were better managed, less subject to corruption, and if its users were charged for the cost of getting the services they are getting.

The Sub-Saharan Africa figures are significant. More importantly, they provide a benchmark for gains that need to be achieved by improving the management of policy, regulation and operations of the sector, as discussed later.

3.3 Costing the needs

The discussion of the gaps in the various sectors hints at major expenses to cover the investment needed to close these gaps. The assessment of the costs of the associated investment needs has become a bit of an industry in the last 10 years. Almost every regional development agency has generated its own set of estimates based on country level estimates. These are often based on bottom-up approaches building on project cost estimates conducted by engineers. This is useful at the country level, but it often causes cross-country comparability concerns, which are difficult to address when conducting broad-brushed assessments of investment needs.

To obtain a relatively robust, if rough, cross-regional comparison of the expenditure requirements to cover both investment and associated annual operation and maintenance (O&M) costs, the easiest approach is to rely on a top-down approach. This is what Yepes (2008) has done, updating and expanding an older study (Fay and Yepes 2003). The general total expenditure need levels (investment plus O&M)

are driven by expected demand growth paths and global goals such as the MDGs for basic services. The resulting estimates are reported in Table 4.

Table 4. Annual infrastructure expenditure needs, 2008–15 (at 2005 prices)

The developing world will need total annual infrastructure expenditure of 6.6 percent of GDP through 2015.

	Transport	Telecoms	Electricity	Water & Sanitation	Total
			Percent of GDP		
Region					
East Asia and the Pacific	1.7	0.4	3.2	0.5	5.9
Eastern Europe and Central Asia	3.1	0.5	2.5	0.3	6.5
Latin and Central America	1.5	0.6	2.0	0.4	4.4
Middle East and North Africa	3.0	0.9	4.5	0.8	9.2
South Asia	4.0	1.3	4.3	1.7	11.3
Sub-Saharan Africa	3.0	1.1	2.8	2.0	8.9
Expenditure type					
Operation and Maintenance	1.8	0.4	1.5	0.3	4.1
Investment	0.5	0.4	1.5	0.3	2.7
Total	**2.3**	**0.6**	**3.0**	**0.7**	**6.6**
			Annual amount (USD billion)		
Region					
EAP	121.5	29.0	226.1	33.3	409.9
EECA	88.7	15.3	72.0	7.3	183.3
LCA	50.6	20.5	66.9	11.9	149.9
MENA	25.2	8.1	38.4	6.9	78.5
SA	73.4	23.5	79.3	31.2	207.4
SSA	28.9	10.1	26.4	19.1	84.5
Expenditure type					
Operation and Maintenance	309.6	57.9	248.9	55.8	672.2
Investment	78.8	48.6	260.2	53.9	441.5
Total	**388.3**	**106.5**	**509.1**	**109.7**	**1,113.6**
Share of Total (percent)	34.9	9.6	45.7	9.8	100

Source: Yepes (2008)

Yepes finds that the developing world will require total annual expenditures of about USD 1.1 trillion (6.6 percent of the developing world GDP) through 2015 to satisfy consumer and producer demand for infrastructure services, assuming current GDP growth and demographic trends. As mentioned above, about 40 percent of this amount is assumed to be required for capital expansion of infrastructure (*i.e.* investment) and 60 percent for maintenance of both current and future infrastructure. These estimates include improvements in the level of some current services, particularly in transport. As expected, Table 4 shows an important diversity of needs across regions.

The highest needs as a share of GDP are in low-income countries with 12.5 percent of GDP. For lower middle-income and upper middle-income countries, these needs are respectively 8.2 percent and

2.3 percent of GDP. Electricity and transport represent the highest burden with a share of the total needs of 46 percent for electricity and 35 percent for transport. The average share for water and sanitation is about 10 percent, but it is close to 18 percent for the low-income countries – about 2.2 percent of their average GDP.

These figures may appear to be very high. Yet they probably still underestimate the real needs. The recent diagnostic conducted for Sub-Saharan Africa on behalf of all major donor agencies from a bottom-up approach suggests that the comparable total annual expenditure needs are USD 90 billion, about 7 percent more than what Yepes finds.[4]

What do the figures mean in terms of affordability for the poor population in each region, the main focus of development assistance? This concerns the population earning less than USD 1.25 per day for those in extreme poverty and less than USD 2 per day for those in poverty. In absolute figures, most of the people concerned live in Sub-Saharan Africa and South Asia.

Full cost recovery would require the average citizen of South Asia and Sub-Saharan Africa to spend an impossible 25-35 percent of income on infrastructure services.

To get a sense of the affordability, a very rough approximation consists of dividing the estimated expenditure needs for each region by the corresponding population. The result is summarized in Table 5, which gives the average *per-capita* daily cost recovery effort associated with the expenditure needs estimated by Yepes. Clearly, the cost recovery efforts are the harshest in the poorest regions in which the infrastructure access gaps are also the largest. More specifically, this rough approximation suggests that in Sub-Saharan Africa and South Asia, any attempt at obtaining full cost recovery would demand the average citizen of these regions to spend 25 to 35 percent of their income to pay their share of total infrastructure costs. This is unlikely to happen. It is not only politically unrealistic, it would also raise ethical issues, which are commonly mentioned to justify subsidies to help the poorest cover their share of the infrastructure costs. A common rule of thumb among practitioners is that the poor should not have to spend more than 15 percent of their income on infrastructure. The rest needs to be subsidized.

Table 5. Amounts needed to recover the new infrastructure expenditure needs (in USD per day and per person)

	Transport	Telecoms	Electricity	W&S and WW	Total
East Asia and the Pacific	0.17	0.04	0.32	0.05	0.59
Eastern Europe and Central Asia	0.54	0.09	0.44	0.04	1.13
Latin and Central America	0.25	0.10	0.33	0.06	0.73
Middle East and North Africa	0.23	0.07	0.34	0.06	0.69
South Asia	0.13	0.04	0.14	0.06	0.37
Sub-Saharan Africa	0.10	0.03	0.09	0.07	0.29

Source: Author's calculations based on Yepes (2008) and the population figures reported in World Bank (2009a)
Note: W&S: Water and sanitation; WW: Waste water.

It is important to recognize that Table 5 is only illustrating the problem. For most sectors, the actual tariffs are more complex and often more costly than the above average suggests. Consider, for instance, the case of telecoms. Despite a significant drop in costs in recent years, ICT services, especially fixed

4 Based on the estimates reported in Foster and Briceno (2009) but adjusted to exclude sectors not covered by Yepes such as irrigation and supranational projects.

broadband access, remain out of reach for most people in developing countries. In 2009, the ITU standardized ICT price basket represented on average of 17.5 percent of average income *per capita* in developing countries. It averaged only 1.5 percent in developed countries. The technology access gap is even more obvious in internet access pricing. An entry-level broadband connection costs, on average, as much as 167 percent of income *per capita* in developing countries, compared to only 2 percent in developed countries. A high-speed Internet connection represents 500 percent of average monthly *per-capita* income in Africa, 71 percent in the Arab world and 46 percent in Asia and the Pacific Region. It represents 10 percent of income in the US and 2 percent in Europe.

The optimal financing approach cannot be made independently of an analysis of the population's ability to pay.

In sum, this discussion has summarized two of the main lessons learned by the international community in recent years. The first is the financial importance of the sector. We now have a much better collective sense of how costly infrastructure investment needs really are in the poorest countries. It is however essential to keep in mind that since the investment needs estimates are based on a derived demand analysis, growth targets are unlikely to be met if the investments are not made. This also means that poverty reduction targets will not be met either since these targets are based on the same growth estimates. The second is the recognition that the optimal financing approach cannot be made independently of a sound analysis of the majority of the population's ability to pay. When cost recovery represents too high a share of a consumer's income, the odds of non-payment for a service increase a lot. The commercial risk associated with an investment decision thus also increases very significantly. When this risk becomes too high, the odds of convincing a private operator to take the lead are low, unless explicit commitments are made to subsidize the investment and sometimes consumption as well, and/or to provide guarantees that cut the risk levels. The menu of realistic financing options for Mali cannot be the same as the menu for England or Australia. This is what explains the relatively low levels of private-sector participation in Africa's and South Asia's infrastructure as will be further discussed in the next section.

4. Public *versus* private-sector financing

While the approximations discussed in the previous section may be rough, they are robust to illustrate the large gap between current investment levels and needs across regions. The main purpose of this section is to summarize what we know about the past sources of financing the sector and the lessons that can be drawn for the future distribution of the financing between the various sources.

The simplest classification of these sources would distinguish between public financing and private financing. It is, however, interesting to try isolating the importance of Official Development Aid (ODA) for the sector since infrastructure has been, and continues to be, a major business for development agencies.

The approach followed here is to identify the relative share of the various key players, starting from the information available on commitment figures both for ODA and for private participation in infrastructure (PPI). The public-sector share is then the residual. Actual disbursement flows are not measured by any international organization. For ODA, the commitment data reported on the OECD web site (http://stats.oecd.org/Index.aspx?DatasetCode=CRSNEW) tend to underestimate multilateral committed flows as well as actual flows because not all multilateral sources are collected. For PPI, the information reported on the web site of the unit of the World Bank collecting the data (http://ppi.worldbank.org/) tends to overestimate commitments since it is not uncommon for projects to be cancelled. The World Bank website itself suggests that, on average, about 8 percent of the projects were cancelled between 1990 and 2008.

Private-sector commitments represented between 19 and 25 percent of the total in 2006 and 2007, Official Development Aid between 3 and 4.5 percent.

Looking at 2006 and 2007, which were the top years in terms of PPI since the 1997 East Asia crisis, the private-sector commitments represented roughly between 25 and 19 percent of the total, depending on whether total investment was closer to 3 percent or to 4.5 percent. Following a similar back-of-the-envelope calculation, ODA would have represented between 4.5 and 3 percent of the total infrastructure investment estimated for that period. This adds up to at most 30 percent and at least 22 percent, implying that the financing share of the public sector ranged from 70 to 78 percent of the total. These estimates imply that the private sector has financed the equivalent of, at most, 1 percent of GDP in infrastructure investment. Similarly, it means that ODA has financed at most 0.2 percent of GDP.

These figures are similar to those estimated for the 1990s by the 2005 Global Monitoring Report (World Bank 2005), except for the fact that the share of ODA estimated then was about the double of the estimates reported here, with the difference absorbed by public financing. They were also recently repeated in the 2009 Global Monitoring Report (World Bank 2009*b*). The latter argued that in the 2000-05 period, public funding of infrastructure was at around 70 percent, while private investment was around 22 percent and ODA at 8 percent. It adds that in International Development Association (IDA)-eligible countries, only 10 percent of infrastructure was funded from the private sector in 2007, and the number is likely to fall in the immediate future in light of the financial crisis. The recent study on Africa edited by Foster and Briceno (2009) shows that Sub-Saharan Africa fits roughly that mould. However, the share of the private sector in financing infrastructure drops from 22 to 10 percent once ICT is ignored, suggesting the limited commercial interest of the "life-and-death" businesses such as water and electricity distribution or secondary, yet essential, road networks in developing countries.

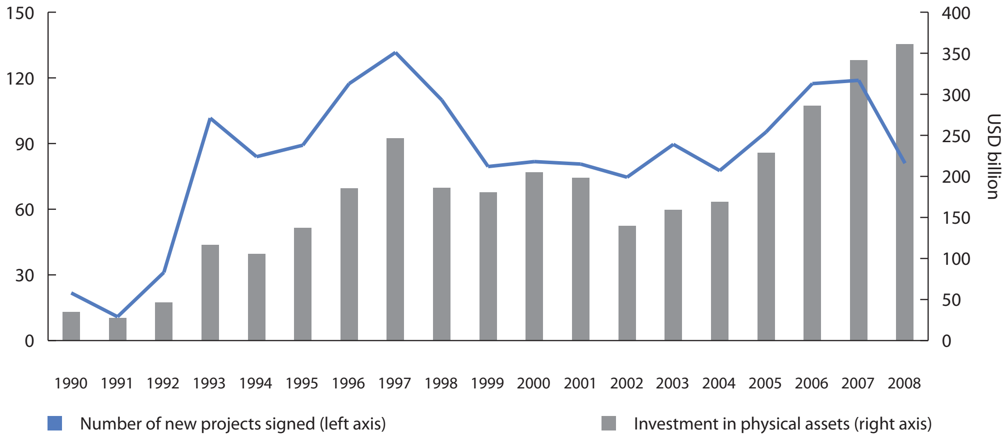
There is not much detail in the ODA data. The most interesting one may be that roughly two thirds of the support given to infrastructure investment in developing countries corresponds to multilateral aid and one third to bilateral aid. The distribution across sectors was also relatively stable. The transport sector tends to get just over a third, the electricity sector just below a third, water and sanitation just above a quarter and telecoms around 2 percent of the total.

It may be important to point out that new players are becoming increasingly important in some regions. These are not strictly speaking official development agencies but it is often financial support organized by foreign governments just like ODA. There is a lot of talk about the growing role of China, India and the Arab funds in Africa for instance. These sources of funding are becoming quite important. As for so many other dimensions of this sector, precise measures do not exist. The order of magnitude of the importance of these non-traditional sources of funding turns around 10 percent of total ODA but they are growing fast. Many projects which were in the pipeline of international agencies are now funded from these sources. Their main advantages seem to result from their much simpler procurement processes and finance packaging.

The growing presence of these alternative sources of financing is also likely to change the nature of, and the opportunities for, private-sector involvement. It may thus also be useful to get a sense of the current characteristics of the private investment in infrastructure. The information on PPI commitments collected by the World Bank provides the best approximation available although actual disbursements by all private operators are not monitored. It focuses on large contracts involving private counterparts. The dataset generated by the World Bank has become a standard reference in the field even if we do not really know by how much commitments are overshooting actuals. Despite the limitations, the data can be used to assess the evolution of the number of contracts with private operators and their amounts since 1990 across regions, sectors and contract types.

Since the hope is that private financing continues to make it to the top of the political agenda of many countries, the discussion starts with the evolution of the size of large-scale private investment in infrastructure. Figure 1 shows that the case for such hope is not as strong as some argue. Prospects were indeed good from the early 1990s to the 1997 East Asia crisis, when the volume of private commitments to physical infrastructure assets followed a clear upward trend, with acceleration as of 1995. However, the East Asia crisis resulted in a fast drop. As PPI was recovering over a three-year period, the Argentina crisis hit in 2001-2002 and this resulted in a new drop. It took again about three years to notice a recovery and it is only in 2006 that PPI reached levels comparable to those of the earlier 1997 peak. After 2007, the crisis explains the drop in new project commitments and the stagnation informally observed since. The full impact of the crisis will only be seen in 2011, since the infrastructure project cycle is such that it can take up to two years for a project to reach a preparation stage that lands it in these statistics.

Figure 1. Investment commitments to infrastructure projects with private participation in developing countries, 1990–2008



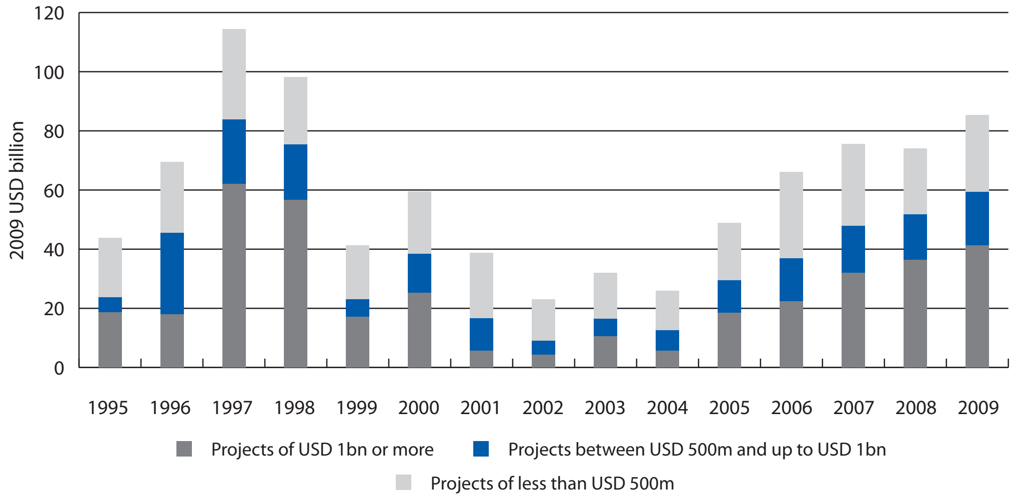
Source: World Bank and PPIAF, PPI Project and impact of the crisis on PPI databases

Private investment commitments are pro-cyclical, and the volume of large projects varies more than the volume of small projects.

Figure 2 shows two interesting characteristics of PPI in developing countries. First, investment commitments tend to fluctuate quite a lot and tend to be pro-cyclical. This is bad news for governments in times of crisis since it means that their share has to increase when their own ability to pay is lower due to slowing tax revenue. Second, it shows that the volume of large projects varies more than the volume of small projects. This suggests that most of the adjustment in commitments is done through delays in medium-sized and large projects. This is somewhat surprising and may be the consequence of a bias in the World Bank data set which does not pick up many of the small local projects without foreign investment. One would indeed expect that the lower costs associated with the preparation of small projects would make the latter easier to postpone.

Figure 3 tracks the recent evolution of the types of contracts under which PPI is taking place. For the last 10 years, the dominating form of PPI has been Greenfield projects. Concession contracts, once very popular, in particular in Latin America and Sub-Saharan Africa, have become a much smaller component of the business. The prevalence of large-scale contracts has, however, increased in the two types of PPI. Infrastructure divestitures have only been a major PPI arrangement in telecoms, energy generation and ports. They have clearly been an important instrument in Eastern Europe during the various privatization waves, including the last one for accession countries between 2003 and 2008.

Figure 2. Investment commitments to PPI projects reaching closure in developing countries by project size, 1995–2009

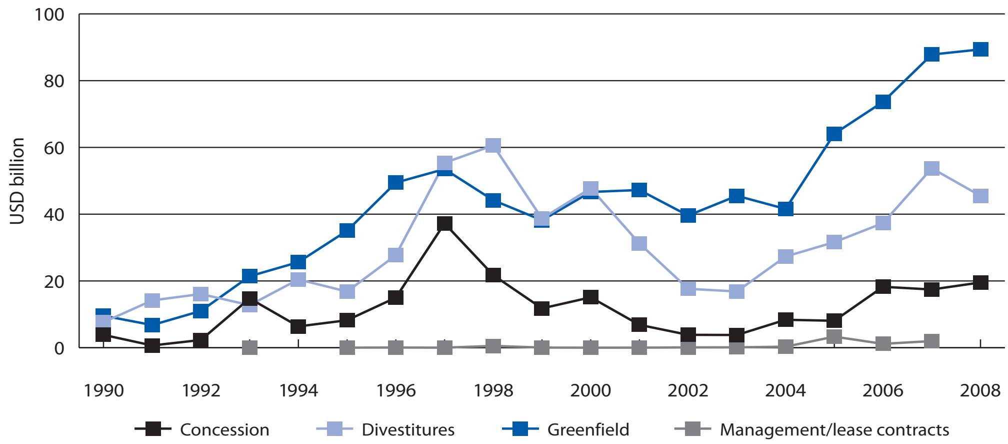


Source: World Bank and PPIAF, PPI Project and impact of the crisis on PPI databases
Note: 2009 USD are obtained by adjusting pre-2009 projects with the US Consumer Price Index.

Private commitments increasingly target the large economies within recipient regions.

Historically, Latin America and East Asia were by far the major beneficiaries of PPI. For quite a while they benefited from 70 to 80 percent of the commitments. Two changes in the directions of PPI flows have been observed in the last 5 years. First, Eastern Europe is becoming an important beneficiary with 23 percent of the total since 2000. South Asia, dominated by India, has attracted about 17 percent in the same period. But the most important change may be the huge increase in the selectivity of investment. Brazil, China, India, Russia and Turkey are now the main beneficiaries of a large share of these investments.

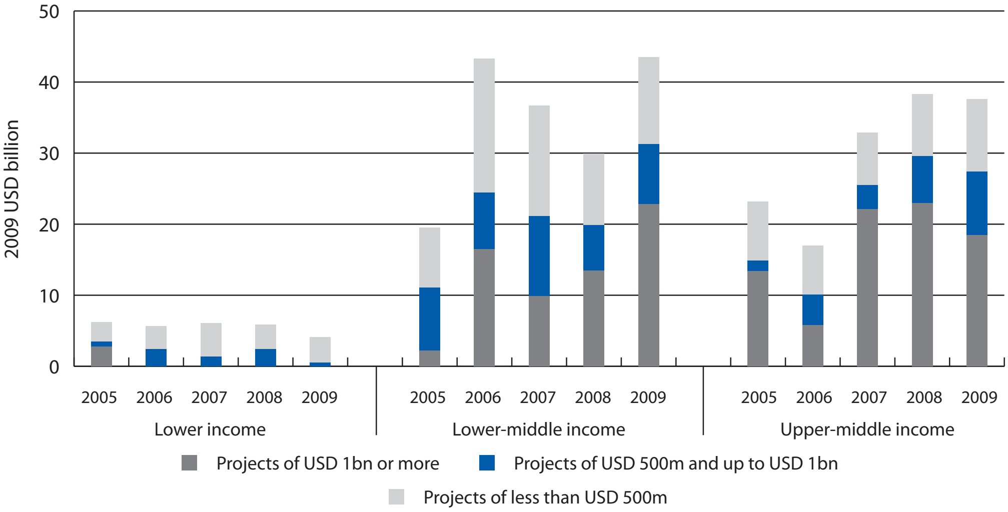
Figure 3. Investment commitments to PPI projejcts in developing countries by type of contracts,1990-2008



Source: World Bank and PPIAF, PPI Project and impact of the crisis on PPI databases

Figure 4 provides a complementary look at the data on the beneficiaries of PPI by differentiating the evolution of PPI commitments according to the *per-capita* income of beneficiary countries. If the BRICs – the country group comprising Brazil, Russia, India and China – have become the major beneficiaries of the flows of private investments to infrastructure, Figure 4 shows the extent to which the poorest countries are the main losers. They get few projects and low volumes of investment. In Africa, for instance, over 75 percent of the flows go to South Africa. The rest is concentrated in less than 25 percent of the countries of the region.

Figure 4. Investment commitments to PPI projects reaching closure in developing countries, by country income group and project size, 2005–2009

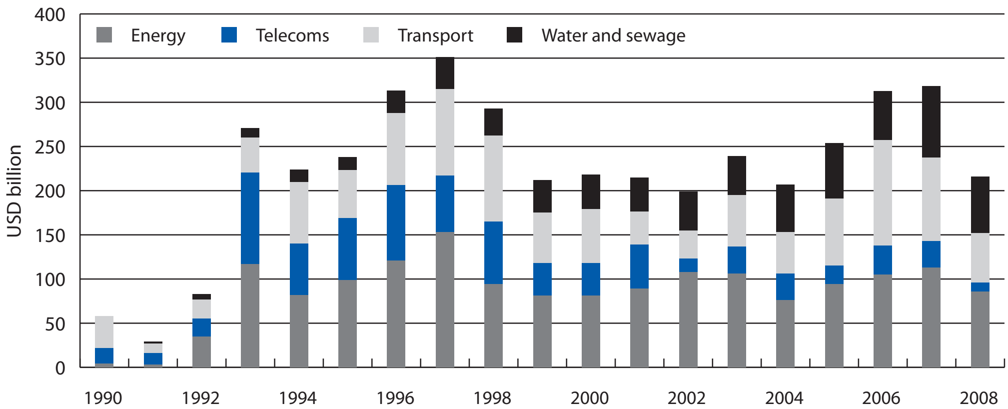


Source: World Bank and PPIAF, PPI Project and impact of the crisis on PPI databases
Note: 2009 USD are obtained by adjusting pre-2009 projects with the US Consumer Price Index.

Figure 5 provides a snapshot of the sectoral distribution of PPI. In a nutshell, the energy sector has enjoyed the strongest volume of commitments in developing countries. Until the late 1990s, telecoms tended to be another important beneficiary of PPI. Yet, most of the big profitable transactions are now a thing of the past. Big business in backbones often requires multi-country regulatory commitments and hence, represents harder-to-deal-with risk levels. The transport sector has replaced telecoms as the second-most important beneficiary of private infrastructure investment. The water sector has not been as successful as expected at attracting private-sector investment in recent years because of a series of difficult contracts that cooled the enthusiasm. This may be because water is the most politically sensitive sector and trying to recover costs in that context tends to be hard. Management contracts are likely to dominate in this sector, simply because they reduce the exposure of investors. The main drawback is that the investment in the sector will have to be financed with public money.

The energy sector has attracted the largest share of private commitments whereas the transport sector has replaced telecoms as the second-largest recipient.

Figure 5. PPI commitments per sector, 1990–2008



Source: World Bank and PPIAF, PPI Project and impact of the crisis on PPI databases

Overall, this section concludes with a mixed bag. There has been an obvious effort of the international community to monitor the financing sources of the sector. The best evidence is for the monitoring of private financing of infrastructure, which, as mentioned earlier, only covers commitments, not actual expenditures. As a rule, the more basic the need, the more public financing is likely to be needed.

5. Instruments to finance infrastructure

There are three main dimensions relevant to the discussion of instruments to finance infrastructure. The instruments to recover costs *per se* define the first dimension. The second dimension is defined by the financial instruments available to operators to operate and make the necessary investments. The third dimension is made of the institutions from which these financial instruments are available.

5.1 Financing through cost recovery

In any country, costs are recovered from two main sources: user charges and subsidies. The richer the country, the more likely it is to be able to recover costs from users. The poorer the country, the more likely a large number of users will have to benefit from subsidies. Table 6 gives a snapshot, around 2004, of the distribution of countries around the world in terms of the ability of utility operators to recover their costs through user charges. It is useful to distinguish between cost recovery of operational and maintenance costs/expenditures (OPEX) on the one hand and that of capital costs/expenditures (CAPEX) on the other. The table also shows that costs vary across regions.

The fact that costs are higher in higher-income countries as compared with lower-income countries is not a surprise. What may be more surprising is that the intra-regional variance of these average costs (not shown in the table) is quite high, in particular in Sub-Saharan Africa. The information reported in Foster and Briceno (2009) for this region suggests that these differences can be attributed to differences in technology. In energy, for instance, the relative importance of hydro sources is likely to be a major determinant of differences across regions. For the water sector, differences in the scale of operation and associated technologies and in labour cost are likely to play a role in explaining cross-regional differences. But some of the differences can also be attributed to inefficiency or high implicit profit margins which are passed on to tariffs without much transparency.

In the water and electricity sectors, cost recovery is a problem at all levels of development and in all regions.

The main interest of Table 6 in the context of this study is to show that the cost recovery problem is common for the two main utility types (water & sanitation and electricity) at all levels of development and in all regions. In electricity, roughly a third of the developing countries in the two lowest *per-capita* income groups do not attempt any cost recovery at all. These countries are spread over all regions of the world. For the water sector, the situation is even more extreme. No country in the South Asia and Sub-Saharan Africa samples attempts any cost recovery of its capital expenditures. Around the world, just over 10 percent of the poorest countries show an effort to recover at least some of the costs.

This raises two questions. The first is about the cost to the alternative source of financing, *i.e.* taxpayers. The second is about the motivation for the low levels of cost recovery in these sectors. This is dealt with in the next sub-section.

The available data (Foster and Yepes 2006) do not allow an estimate of the degree of cost recovery in each region. Foster and Briceno (2009) suggest that in Sub-Saharan Africa, on average, the electricity sector only recovers 75 percent of its costs and the water and sanitation sector recovers about 64 percent of its costs. In that region, utilities subsidies are equivalent to 0.7 percent of GDP. According to these authors, increasing cost recovery in electricity and water to 100 percent would "buy" about 5 percent of the financing needs across all infrastructure expenditures. This implies an average subsidy component per country of at least 0.7 percent of GDP across sub-sectors.

Table 6. **Distribution of country groups according to cost recovery efforts for water and electricity**

	Water				Electricity			
Country group	**Median tariff**	**No cost recovery**	**Partial cost recovery for OPEX**	**Partial cost recovery for CAPEX**	**Median tariff**	**No cost recovery**	**Partial Cost recovery for OPEX**	**Partial cost recovery for CAPEX**
By income	USD/m3		Percent of countries		USD/kWh		Percent of countries	
High income	0.96	8	42	50	0.11	0	17	83
Upper-middle income	0.35	39	22	39	0.06	0	71	29
Lower-middle income	0.22	37	41	22	0.05	27	50	23
Lower-income	0.09	88	9	3	0.05	31	44	25
Global	**0.35**	**40**	**30**	**30**	**0.07**	**15**	**44**	**41**
By region								
Latin America	0.41	13	39	48	0.09	0	47	53
Eastern Europe	0.37	58	25	17	0.06	31	38	31
East Asia	0.25	53	32	16	0.05	29	65	6
South Asia	0.13	100	0	0	0.05	29	71	0
Sub-Saharan Africa	0.09	100	0	0	0.04	33	67	0

Source: Foster and Yepes (2006)

Notes: For water, the average tariffs are based on residential consumption of 15 cubic meters for utilities in 132 major cities worldwide between 1999 and 2004, with most of the data are for 2004, among which: South Asia (24), Latin and Central America (23), East Asia and the Pacific (19), Middle East and North Africa (12), and Eastern Europe and Central Asia (6); for electricity, data are drawn mostly for 2004 from 84 countries worldwide, among which: LCA (19), EECA (18), SSA(13), EAP (8), and SA (3).

Cutting these subsidies significantly is politically unrealistic. Obviously, they could be cut somewhat through production and service cost savings from efficiency improvements. But in the world's lowest-income countries such as India and most of Sub-Saharan Africa, assuming that access was available to all, around 70 percent of households could be expected to face difficulties in paying full cost recovery tariffs. In these regions, tariffs would likely have to increase by a factor of 10 to reach cost recovery levels, and this could be expected to have a significant impact on poverty. Latin America is not exempted from this problem. In Bolivia, Honduras, Nicaragua or Paraguay, where *per-capita* income levels are quite low, reaching cost recovery tariffs would represent a significant affordability problem for around half of the population.

This does not mean that subsidies cannot be improved. The real challenge is their targeting. Any effort to improve cost recovery should be matched by an effort to improve the targeting of subsidies because of a long history of failure to make them progressive in practice. The core of the problem stems from the fact that even when tariff structures are well designed (often they are not), subsidies benefit the users who are connected. Yet, most of the poor are not. So, in the poorest countries of the world, even if tariffs have tended to undershoot costs because they were initially designed to minimize the risks of exclusion of the low-income classes – which can represent 50 percent of the population of many of the countries – they have often failed to reach those they were intended to help. The built-in subsidies are thus clearly the response to a political concern with the limited affordability of these services if charged at full cost.

There are two main lessons from this brief overview of the distribution of cost recovery between users and the government. The first is that very few countries are actually betting on a full cost recovery from users. The second is that the poorer the country, the higher the likelihood that the government will have to contribute to the financing of infrastructure services – a major challenge, since the poorer the country, the lower its tax base.

5.2 Dealing with the limited ability to pay of many users

The future generation of taxpayers will have to fund a large share of today's high infrastructure subsidies.

In view of the limited income of a large share of the population in the poorest countries of the world, it is thus useful to try to track down the subsidies that need to complement user fees to allow the recovery of infrastructure costs. In view of the narrow tax base of the poorest countries, governments essentially rely on loans, grants, and on bonds for those with relatively developed financial markets. This means that a large share of the high levels of explicit and implicit subsidies going to this sector is likely to be covered from taxes to be paid by the next generation of tax payers.

In terms of the relative size of these various options, loans from domestic or international private banks or development agencies dominate. In some of the countries with enough credibility with private infrastructure players, it may also be possible to get private operators to pre-finance some of the financing needs, but often this will require guarantees. As discussed later, guarantees and equivalent insurances have become an important complement to the more traditional sources of financing but they are also associated with fiscal costs.

Unfortunately, much of the discussion on the importance of these various financing options has to be qualitative. Indeed, how operators manage to get financing for the share of costs not recovered directly from users is poorly documented. The list of specific possible financing sources is not short. Loans can be from domestic banks, international banks or from international agencies. They can be complemented by equity provided by the operators. Some of these loans can be at costs lower than they would otherwise be, given the country and the sector, thanks to guarantees provided by bilateral or multilateral donors. This is where most of the creativity has taken place in the last 10 years or so in particular.

The number of risk mitigation instruments has indeed exploded. They include partial or full (wrap) credit guarantees, export credit guarantees (*e.g.* when energy is traded internationally) and insurances and more recently regulatory or political-risk guarantees and insurances.[5] Finally, for some of the poorest countries, operators may sometimes count on direct grants or indirect grants such as debt swaps or debt repurchases.

5.3 How can financing institutions help?

The large number of institutions interested in financing infrastructure in developing countries shows the competitive character of the development business. Moreover, the number of instruments these institutions rely on is often underestimated. The British development agency, DFID, for instance supports 14 programmes and initiatives aimed at increasing Public-Private Partnerships (PPPs) in infrastructure.

The main financing role, however, can probably be credited to development banks and agencies, and to guarantee agencies. Their place in the financing of the sector is indeed hard to overestimate. Their contribution corresponds to 15 to 20 percent of the financing of total infrastructure investments in developing countries, although the specific shares depend on the region and on the sector and this role is stronger in Sub-Saharan Africa, for instance.

It is hard to overestimate the role of development agencies in the financing of infrastructure.

Both development and guarantee institutions can be anchored locally, regionally, nationally and internationally. In principle, they offer support to projects that may not have access to commercial banks and insurers. Most of the time, they fix a market failure explained by high country or regulatory risks (for instance in post-crisis or post-conflict countries), economic returns unmatched by financial returns or simply because the local financial sector is not developed enough to be able to take on the role domestic financial institutions play in OECD countries.

The development banks and agencies generally focus on partial funding of projects through loans. The guarantee agencies or the guarantee units of development banks focus on providing insurances.[6] The fact that related institutions offer both types of instruments makes it easier to tailor the combination of instruments to specific infrastructure projects. Indeed, the two types of services are often bundled together. Loans are much more common than guarantees.

Typically, development agencies are initially solicited for loans which function as commercial loans except that they usually have the benefit of below-market interest rates, longer terms and repayment schedules that can be adjusted when needed. They are also often paired with technical assistance to ensure successful implementation of the projects as well as their longer-term sustainability. Guarantees are sometimes matched with a loan or even an equity investment when the development agencies work with private counterparts. The guarantee then acts as insurance for the equity investments and loans in countries or activities rejected by commercial insurers because of the associated risk levels. Guarantees offered in the context of development also often have the benefit of better contractual terms than private insurers tend to offer in developed countries. For instance, coverage tends to be longer term and rates can be tailored to the main risks typically associated with infrastructure projects. Political and regulatory risks are among the hardest to insure in private markets.

5 For a more detailed overview see Matsukawa and Habeck (2007).

6 Narrowly defined, guarantees refer to financial guarantees granted to ensure the timely payments of debt service. Insurances usually require claims that need to be investigated and thus have more complex trigger rules.

Multiple development banks and guarantee agencies often pool their limited resources in coordinated efforts to support specific infrastructure projects. For instance, most of the large supranational power pools tend to be sponsored by multiple donors, both domestic and international in some cases. In most such projects, one of the institutions takes the lead. This can be an important catalyser to get other players to support governments and share the risks of investing in a sector in which assets are long-lived and hence slow to be amortized. It can also be an effective way to support the development of domestic credit markets where donor resources are used to leverage local commercial banking involvement in the sector.

China and other emerging economies are entering the market for infrastructure finance in developing countries with very attractive terms.

While the multilateral and bilateral development agencies are clearly the main players and commercial banks have a notable place in the business as well, there are other players with an actually or potentially important role to play in developing countries.[7] The first is China. Its role is symptomatic of the growing role of middle-income or emerging economies as sources of funding for developing countries. The growing presence of China, but also India and Brazil, in Africa is creating a sense of competition in the infrastructure business. These countries have valuable experience in infrastructure and are less demanding in terms of procurement, resettlements or environmental concerns. Moreover, they enter the market with very attractive financial terms. Corkin *et al.* (2008), for instance, explain that infrastructure projects undertaken by Chinese companies are often financed by soft loans from the Chinese government, on the condition that they are carried out by Chinese companies.

A second player with a strong presence in some regions and with a potential for continued growth are pension funds. Pension funds offer long-term financing. When they are local, as is often the case in Latin America, for instance, they have the additional advantage of offering domestic financing, an important element when local capital markets are not yet very developed since it can reduce the exchange rate risk in project finance. A recent study financed by a major Spanish bank present in Latin America enthusiastically supports the need to develop the involvement of pension funds in infrastructure as a way to accelerate growth (Alonso *et al.* 2010). So far, however, pension funds have been relatively reluctant to get involved because of uncertainty on the size, risk, return and correlations of this diverse asset class (Inderst 2009). Moreover, infrastructure assets also involve new types of investment vehicles and risk for pension fund managers such as fluctuating leverage and ownership issues as well as regulatory, political and environmental risks they have not been used to assess.

The final player is actually an instrument with some potential in the sector. Indeed, there is a push towards relying more on local government bonds to help sub-national governments find financial resources. Hyun *et al.* (2008), for instance, offer an interesting description of how adaptations of US or Japanese revenue bonds could help in financing infrastructure in Asia. Platz (2009) gives a more general and detailed assessment of the potential for this instrument. He suggests creating specialized "project development facilities", local or national depending on the size of the country. He mentions the Municipal Infrastructure Investment Unit in South Africa and the state-level Urban Infrastructure Development Funds in India. In addition to providing financial, technical, and managerial support to municipalities and public utilities, these facilities could be used to help structure and market the sub-sovereign bond to meet domestic investor community needs. Another motivation in focusing on domestic investors is to reduce exchange rate risks. Major international development agencies are devoting significant resources to exploring and mainstreaming local government bonds.

7 In addition to the players covered here, a growing number of countries are talking about setting up infrastructure banks.

5.4 How well are the lessons from experience internalized?

The discussion so far has shown that there has been enough experimentation with various types of instruments to have a good academic sense of which ones work and which ones do not and under which circumstances. However, it is not clear whether policy circles are internalizing the lessons fast. For instance, the recognition by policy makers that full cost recovery of water and sanitation in the poorest countries was an unrealistic option was slow to come. Less than 10 years ago, it was still a goal for the main development donors. It is only recently that it has been adjusted to focus on the recovery of operational expenditure for the lowest-income classes. Similarly, guarantees have long been on the agenda of most development agencies without obvious success because they represented a high-cost high-risk option for many projects. The expectations on their potential have now been adjusted to reflect the fiscal risks.

But not all lessons are lost and the scope for self-financing of some sectors is increasing. For instance, increasingly infrastructure sub-sectors are used as tax handles to contribute to their own financing. In some instances, funds thus collected are used to feed dedicated or special-purpose funds such as road funds or universal-service funds in the telecoms and sometimes in the energy sector. In most cases, governments rely on traditional instruments such as sector-specific taxes. Local and sub-national governments have been typically keen on following this approach in developing countries. But there are also new forms of tax instruments. For instance, environmental charges or levies are an increasingly common way of complementing the financing of sanitation projects when tariff structures cannot be designed to recover all costs.

Infrastructure sub-sectors are increasingly used as tax handles for their own financing when full cost recovery from bills is not feasible.

6. Infrastructure, finance and development

This section offers a very brief summary of the evidence on the importance of the sector from three perspectives relevant to its financing. The first is the importance of the sector for the development agencies. While it is now established that development agencies are an important source of financing with around 10 percent of the total needs of the sector, it is easy to underestimate how much infrastructure is a core sector for these development agencies but also to overestimate how much more these agencies can do. The second is a discussion of some of the drivers of the limits to private-sector financing. The finance world tends to ignore the relevance of some of the social and fiscal implications of the continued efforts to rely on the private sector to finance infrastructure. The third is on the scope for improvement in the ways the public sector procures its huge responsibilities in the sector.

6.1 The importance of infrastructure for development agencies

ODA is an important source of financing to some extent because infrastructure is the dominating development business at the sector level. A glance at the annual reports of the major international (World Bank) and regional development agencies (ADB, IDB and AfdB) shows that infrastructure loans add up to at least a third of the portfolio and even to close to a half in recent years for some of them (*e.g.* the World Bank in 2009). But loans are not their only business. Technical assistance and other forms of non-reimbursable support are a strong business line as well. Although they do not finance CAPEX for developing countries, they make CAPEX more sustainable and in many instances, technical assistance is a substitute for local OPEX. For the IDB, for instance, technical assistance to infrastructure represented about 45 percent of the total budget allocated to infrastructure in 2008. For the ADB, non-reimbursable support to infrastructure was about 60 percent of its grant budget in the most recent years.

Conventional infrastructure financing from development agencies has probably reached a cap.

The main point to retain here is that financing from this source has probably reached a cap. Since the share of infrastructure is unlikely to rise further, the volume infrastructure financing to will not increase unless the overall budget of these agencies grows. Financing to the sector might increase in some regions simply because of a reallocation of resources within the sector but the major natural reallocation, which is from a reduction in ICT, has already taken place. Infrastructure may continue to benefit indirectly from international efforts to support climate change mitigation and adaptation. These resources are often on top of the regular infrastructure budget.

In the future, the main improvements are likely to come from more cost-effective support to the sector, especially from *ex-post* evaluations conducted by these agencies. What they do essentially is to recalculate the cost-benefit analysis reported in the appraisal report, replacing forecast values of the key parameters with observed values. Briceno *et al.* (2004) report the evidence from World Bank infrastructure projects for which 95 percent or more of the loan commitments had been disbursed between 1960 and 2000. Except for the water sector where the returns were relatively low at 9.2 percent on average, the assessment of the 40 years of experience revealed lower-bound estimates of *ex-post* economic returns ranging from 19.2 percent in transport to 25.4 percent in ICT. The average rates are particularly high considering that project officers often tend to assess financial rates of return rather than true economic rates of return. This is because many externalities are not taken into account and market prices rather than shadow prices are generally used.

The really interesting information in terms of improving the efficiency of support comes from a more detailed assessment of the types of loans that were disbursed. This information was recently documented for Africa (Foster and Briceno 2009, Table 2.5). It shows that among all transport projects, economic rates of return were highest for road maintenance in Africa, averaging 139 percent for the continent, well above returns for rehabilitation (17 percent) and new construction (24 percent). This raises questions about the decision to favour volume over quality in the region. An assessment of the relative importance of these conclusions at the national level shows that the highest returns to maintenance are found for networks that are already well developed, particularly in middle-income countries and non-fragile low-income countries. Economic returns to railway investments are the lowest at around 5 percent. It is also interesting to note that in spite of the very strong support for railway in the debate on climate change, railway rehabilitation interventions seem to be justified only for a few traffic systems.

6.2 What limits the scope for private-sector financing?

It is worth trying to understand more objectively why the large multinationals specializing in infrastructure activities are not a lot more involved in infrastructure in developing countries. On the one hand, the assessment of risks made by these large firms may be a lot more subjective and complex than the one reported by international organizations comparing *ex-ante* and *ex-post* performances of their own operations in the sector. But ultimately, they drive the decision to invest or to stick to an investment in environments in which culture and governance require specific skills and commitments. On the other hand, the assessment of governments of the net benefits they achieve from collaboration with these players is also much more subtle than reported in publications advocating PPPs. It is not only about finance and economics; it is also about geo-politics. This is probably why the failure of efforts to develop PPPs in developing countries is discussed so controversially. There is enough research documenting the success and the failures of privatizations and PPPs to fuel the speeches of dogmatic partisans in favour of or against an increased role for the private sector.

There are, however, a number of interesting objective facts to keep in mind when assessing the limits of the scope for infrastructure PPPs in developing countries. The first is that the common wisdom suggests that private operators are more efficient providers of infrastructure services than public providers. A recent study by Gassner *et al.* (2009) assesses the performance of 1,200 utilities in 71 developing and transition economies. The results could be used to cater to both extremes of the spectrum on the differences between public and private operators. On the one hand, the study shows that private operators score a lot better than public operators on some dimensions. They reduce losses, improve bill collections, reduce employment faster and sell more than public operators. Thus, ownership matters when it comes to looking for profit. This is an important result if it means that public-sector operators rely on excessive subsidies simply because they do not make the same efforts to cut costs and increase revenues. This matters in view of the large financing gaps of the sector. But on the other hand, Gassner *et al.* (2009) confirm less positive results identified by earlier studies. These include that all the improvements are achieved without significant differences in investment and with very little price changes. Moreover, there is no difference in efficiency between public and private operators of water and electricity utilities. What this boils down to is that the involvement of the private sector has transformed an unmanaged rent available from the poor performance of the sector into an explicit profit for the private sector. This conclusion is factual based on Gassner *et al.* (2009) and the many previous studies they survey in their book. But it has a political dimension. Indeed, these profits are at the core of many of the criticisms of efforts to scale up PPPs. Why did anything have to change since final prices and investment did not really improve?

While the critics have good reasons to complain, they are unfortunately barking at the wrong tree. Investment, prices and overall efficiency are about regulation and competition, not ownership. This point has been made many times for OECD countries as well as in regulation textbooks written for OECD countries. It is even easier to make for developing countries where higher risks are associated with higher expected private returns. An assessment of the first large-scale regional effort to transform the power sector of a developing region, *i.e.* Latin America, makes this clear. The assessment of the 1990s reforms of the Latin American electricity sector shows that privatized firms operating under rate-of-return regulation have, at most, similar labour productivity to public firms. It thus turns out that regulation drives productivity. In incentive-based regimes, both public and private firms show higher labour productivity levels than firms under rate-of-return regulation (Estache and Rossi 2004). Similar results have been found in Asia or Africa for instance.

Investment, prices and efficiency are about regulation and competition, not ownership.

The upshot is that PPP is a rational way of trying to leverage public resources, but it is not just a financial transaction. What is required from the key players involved in designing these transactions is a serious effort to get the institutional dimensions right that are needed to ensure the sustainability of private-sector participation and of the efforts to improve service delivery to all, including the poor. This is in addition to greater honesty and realism about the scope for private financing in countries in which commercial and political risks are high.

6.3 Scope for improving public procurement

The final dimension that has not yet been touched upon and which is essential is the extent to which the public sector could deliver better. In view of the fact that in many of the poorest countries, the public sector plays this role in close collaboration with international development agencies, it is useful to consider the ways in which the cost effectiveness of procurement could be improved. Keep in mind that the 10 percent or so of ODA infrastructure financing adds up to about USD 70–100 billion. Recent research shows that these financial resources are not allocated the most efficiently.

One particularly important source of inefficiency is current infrastructure procurement prices. This raises again a concern with competition in the sector since improved competition could curb public-procurement costs. Based on data from the World Bank and the Japanese Development Agency,

Competition-enhancing reforms of procurement rules (e.g. auction design) would allow for significant cost savings.

Estache and Iimi (2010) analyze procurement data from three infrastructure sectors: roads, electricity, and water and sanitation. They find that the competition effect is underutilized. That said, the problem is not equally important in all sectors. For instance, they estimate that to take full advantage of competition, at least seven bidders would be needed in the road and water sectors, while three may be enough in the power sector. Many of the competition issues identified come from auction design, especially lot division. According to this research, the developing world might be able to save up to 8.2 percent of total infrastructure development costs by reforming procurement rules to promote competition more effectively.

The scope for procurement reform has not really been looked at seriously by international organizations in a long time. If this is a wrong decision as suggested by the recent research, its cost is very high, in particular in view of the fact that many of the poorest countries are being asked to adopt the procurement rules of international organizations as their own.

6.4 Lessons learnt

The efforts to push PPPs in developing countries have not been matched in practice by efforts to reinforce the institutions needed to support the fair distribution of the gains that can be achieved from improved competition allowed by the increased participation of private players. The large technical-assistance budgets have not been sufficient to make a difference yet. The most remarkable fact, however, is that improving regulation and competition to improve the distribution of rents features prominently in the political rhetoric. Training, conferences, toolkits and similar products enjoy sound support. But the day-to-day support is too often insufficient. Politics can be very effective at slowing the much-needed institutional support. Moreover, problems with the type and sometimes the level of human capital of the players managing the PPP transactions help explain why institutions are not improving.

In practice, this means that it is important to internalize in the strategic vision and hence, in the staffing of development agencies that regulation and competition require specific skills – just as engineering, assessing the economic costs and benefits of projects or their health, environmental or social consequences do. A simple look at the distribution of staffing across these specialities in donor agencies provides a good sense of the limited concern for the regulation and competition dimensions of PPPs. Paying lip service to the institutional needs is no longer sustainable if public and private costs are to be minimized in infrastructure, if the gains are to be shared fairly between users, operators and taxpayers and if competition is to attract an increasing number of private players eager to function in a predictable environment.

7. Key challenges ahead

The failures, or limited success, of various infrastructure finance-related policy options to systematically and lastingly improve service delivery have many sources. One major source is the inability of reforms to address the complex institutional and political characteristics of the sector. The choices between policy options are made particularly difficult by the multiple goals of politics in a sector that represents a high share of public expenditures. In developing countries, primary expenditures represent roughly 25 percent of GDP on average. Infrastructure expenditures represent between 20 and 40 percent of this amount, depending on the country. That implies a lot of political power to pass on. So the key challenges are related to the size of the sector. Another major source is the lack of information.

As shown in the discussion so far, a lot of what is happening in infrastructure is hardly supported by precise data. The amounts involved, the lack of data and the political leverage that the sector generates are probably quite strongly correlated. Development agencies are addressing these problems one by one.

Progress is being made in uncovering the mechanisms of corruption, collecting essential data and evaluating them – but more is needed.

The first area of focus is corruption. Words like favouritism, fraud, cronyism, patronage, embezzlement, state capture, and cash bribes are often associated with the delivery of infrastructure services – and not just in developing countries. The Transparency International Global Corruption Index suggests that the share of the population with a direct experience with corruption in utilities is around one third. It has been less than 10 years since the analytical research has started to approximate the impact of all forms of corruption on the performance of the sector. In his recent survey of these impacts, Kenny (2009) also argues that it has been less than 5 years since research has managed to generate specific-enough information to try to figure out solutions that are politically viable.

The second challenge is the need to scale up and improve information collection efforts in the sector. The MDGs and related commitments are forcing a closer monitoring of quantitative targets. But as discussed earlier, a lot has been left behind that should be part of the agenda going forward. This includes quality and cost data. Much of this effort should start within donor agencies. For instance, most donors are unable to report unit cost at the project level. Regulators have their own agenda. The benefits of regulatory accounting or more transparent procurement rules as ways of reducing corruption are well known. Unfortunately, very few developing countries have internalized the lessons so far.

The final area is the need to systematically improve the evaluation of the information that can be collected. Addressing this problem is one of the reasons why the serious evaluation of the impact of policies in the sector is starting to pick up. Since the mid-2000s, the interest in analytically robust evaluations of the impact of infrastructure projects, programmes or policies has exploded among development academics and field workers. There is a particularly keen interest in evaluations based on randomized field experiments and quasi-experiments. These approaches are now viewed by many as the most effective technique yet to measure the effectiveness of efforts to target the poor or efforts to stimulate various types of businesses in major development projects. But it is not only about efficiency. Better evaluation also enables policy makers to ensure that the poor get their fair share of the economic and social benefits achieved through the projects. In-depth experimental or quasi-experimental impact evaluations are now mainstreamed in many health and education activities in which international development agencies are involved.

Why is this change in the way of monitoring impact happening now? First, many important donors have put significant political pressure to trigger a more systematic use of these techniques by key development agencies. This includes the British, Spanish or Norwegian bilateral agencies. They are increasingly conditioning their decisions to allocate their development resources to the commitment of doing what is needed to generate robust evidence. Most actually work on evaluations themselves.

Second, from an academic viewpoint, the explosion of interest stems from the increase in data availability and from our improved collective capacity to process the data. The academic evaluation field has been able to grow fast in recent years thanks to significant improvements in the availability, the scope and the quality of household income and consumption surveys conducted in developing countries. It has also benefited from major improvements in microeconometric and general-equilibrium modelling techniques in the last 15 years or so.

8. Conclusions and policy implications

We now know more about financing gaps, the scope for private finance and the need to promote competition, fairness, and donor-financier coordination.

This overview of the main dimensions of infrastructure finance in developing countries has shown that we have learned quite a bit since the mid 1990s:

- In view of our better sense of the size of financing needs and financing gaps across sectors and regions, the international community should be aware of the need to continue a sustained effort to this sector;
- The international community should stop being unrealistic on the scope for financing from private sectors across the board;
- It should also be less sanguine about the differences in the effectiveness of provision between public and private infrastructure services; the real differences stem from the management of competition and regulation, not that of ownership – although the interpretation of this evidence is still far from unanimous;
- In its support to the reform of regulation, the international community should internalize the lessons learned on the many sources of unfairness in the way services are provided, priced and subsidized across income groups and user types; these sources of inequity can and should be dealt with;
- It should ensure more effective coordination between the many donors and financiers, which, in spite of political commitments, continue to limit their effective joint support to large-scale infrastructure that requires multiple sources of financing;
- This improved coordination should also be reflected in the collective efforts to deal with some of the major challenges that should be on the agenda of all players in the sector, including the greening of the sector, corruption, improvements in monitoring the performance of the use of resources, and governance of the sector. That means a lot of new information to collect.

But there are also a number of dimensions which this study has not covered because they are not often discussed even though they might be important to understand. The first is related to basic data issues. This study has already mentioned how poor the fiscal monitoring of the sector is. It could also have mentioned how poor the performance monitoring is. The performance data presented here focus on quantity indicators, simply because the quality indicators that would allow a fairer assessment of the infrastructure needs are not collected systematically. A second knowledge gap is more subtle but probably even more important in a development context. Our collective knowledge of how big and costly the gaps can be has grown, but we know very little about what drives the basic efficiency-equity trade-off in this sector. The extent to which governments have traded off between social and growth concerns in their choices of policy goals and instruments may be the biggest unknown. While everyone knows that infrastructure gaps have both growth and social costs, researchers have understood that the two costs should be looked at together. Poverty researchers do their thing and macroeconomists do their own. Yet, the growth and social costs go hand in hand.

It will be challenging to get the data and the models to assess the direction that the international community and national governments in developing countries need to follow to identify win-win situations in the sector. But it is a reasonable way of making sure that the scarce international and national financial resources allocated to the sector deliver cost-effective infrastructure at a speed that is consistent with political promises and the likely pace of population and GDP growth. And this means a lot faster than in the past.

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