

IFC Economics Notes
Note 4
The scope for an impact of infrastructure investments
on jobs in developing countries

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April 2012

Introduction¹

With the crisis recovery programs, the profile of investment in infrastructure projects as a source of jobs creation has significantly raised in developed economies. Infrastructure is not just about growth. It can indeed be about jobs as well. This observation also holds for developing and transition economies, as illustrated by a recent World Bank report looking into the potential role of infrastructure as a source of employment in the Middle East and North Africa (World Bank (2012)).

The direct jobs created by the infrastructure investments themselves (e.g. the constructions of transport infrastructures) are only the tip of the iceberg. There can also potentially be many jobs created through the increased demand for the core inputs needed for the production of these investments (e.g. in the cement, asphalt, steel, rolling stock industries, ...). And finally, there is employment payoffs more directly associated with growth. These include the jobs created by the farmers who can now rely on roads to deliver their products, industries who can cut their costs by avoiding power outages and delivering their product through better integrated transport infrastructures and workers in the service industry improving their productivity through access to fast broadband connections, for instance.

The main purpose of this note is to assess the extent to which the infrastructure sector can contribute directly and indirectly to the creation of jobs. It offers first a sense of the sort of jobs that can be created at the project level. Second, it offers a quantitative assessment of the scope for aggregate job creation as a function of possible growth scenarios and well as infrastructure specific jobs--assuming no changes in labor market practices, meaning that past elasticities of employment to growth drive the assessment of the scope for job creation.

The note is organized as follows. Section 2 provides some anecdotal evidence. Section 3 provides a rough macroeconomic assessment of the potential for job creation. Section 4 concludes with some operational implications.

**How many jobs from infrastructure?
Anecdotal and statistical evidence**

The direct and input related impact of infrastructure on jobs is not really very precisely monitored. The best data available concerns the direct jobs and is collected at the country level by the International Labor Organization (ILO).² According to the most recent version of its database, about 1.1% of the labor force of developing countries works on electricity and water and about 6.6% on transport and communications. For

¹ This note represents the views of the authors and these should not be attributed to any of the organizations we are affiliated with, nor to IFC, the World Bank or any of its members countries or agencies. Any mistake or misinterpretation is ours and ours only.

² The sectoral definitions used by ILO are quite broad. For transport and communications, for instance, they cover a wide range of activities, including possibly users of infrastructure as well as direct employees such as truck and bus drivers. These definitions are clearly not ideal, but they are the only ones available to conduct cross country comparisons.

developed countries, the equivalent figures are respectively 0.9% and 6.3%.

These aggregate numbers clearly hide significant variation across countries but they provide important order of magnitude to be able to get a sense of how much of a direct impact the sector can have in the labor market of a country. According to these figures, debates on the creation of new jobs in the sector essentially talk about increasing the share from a starting point of about 7.7% to at most 10-12%. This is not huge, but not negligible either, in particular keeping in mind that these are the direct jobs in the sector. Moreover, accounting for construction jobs would almost double this figure. If many of these construction jobs are however not infrastructure specific, it is not unreasonable to assume that infrastructure offers jobs to a fair share of the construction workers.

For the poorest countries, ILO has in fact long argued that the delivery of infrastructure services could provide a largely untapped source for providing benefits to the poor. There are no precise estimates. But ILO's annual reports regularly offer useful anecdotes of how the choices of infrastructure technology in favor of labor intensive technologies can help the poor. These anecdotes are echoed by many other development agencies such as DfID, the World Bank or the OECD.

Research currently being conducted on the scope for jobs from renewable energy illustrates very nicely the potential for additional job creation that can result from an alternative choice of technology in a specific sector. Wei et al. (2010) may be one of the most quoted papers on the topic. They argue that the total number of jobs-years per GWh range from as high as 1.4 for solar PV (0.87 on average) to as little as 0.11 for gas or coal. If employment is a serious concern, accounting for the scale of the job per unit

of energy produced should be considered in the evaluation of projects in the sector. Similar stories can be told for the road sector. ILO (2011) for instance argues that, promoting labour intensive road construction will generate twice the number of jobs compared to capital-intensive road construction and irrigation.

What does this mean in practice for specific countries? According to DfID (2011), in China, the renewable energy sector generates output worth USD17 billion and employs 1 million people. Of these, 600,000 are employed in making and installing solar thermal products, such as solar water heaters. India enjoys a similar potential scope for job creation in the sector. It could generate 900,000 jobs by 2025 in biomass gasification. In Brazil, biofuels have produced about 1.3 million jobs in rural areas while recycling and waste management employs an estimated 500,000 people. Brazil and many other countries expect to see more jobs in this sector expected to grow rapidly as a result of escalating commodity prices.

It is likely that many of these estimates will be revised over time, but their orders of magnitude are important enough to illustrate in very concrete settings that if employment is a concern, infrastructure can help but it depends on the choice of technology made

Of course, how much of an impact also depends on the specific characteristics of labor markets, the infrastructure policy environment in which a project takes place, and the skills available to match the needs. Skills are indeed an important dimension and quite subtle way. For many transport projects, low skills may do the trick but for energy and in particular ICT, infrastructure jobs can cater to the employment needs of a growing and skilled middle class.

A back-of-the-envelope global assessment of the scope for job creation from infrastructure across developing countries.

The intuition

To get a sense of likely global national job creation that can be generated by the sector, the easiest solution is to do it at the macroeconomic level. This assessment has to recognize that two main dimensions need to be taken into account: (i) infrastructure as a direct supplier of a job (i.e. constructing and maintaining infrastructure creates jobs and generates income that can itself help create jobs); (ii) infrastructure as an input into a growth process that creates jobs across sectors, including infrastructure. This note is about the second dimension. The second one is the most encompassing and thus the most relevant to get a sense of the potential job payoffs from investment in infrastructure.³ Ideally, this would require constructing a general equilibrium model but this requires a lot of data typically not available.

The following is a simpler much less data demanding approach. This estimation can be done in two stages. The first is an assessment of the impact of infrastructure on growth—i.e. using the orders of magnitude of elasticities of growth to infrastructure discussed in Note 1. The second stage is the assessment of the impact of growth on job creation. This means that we also need to have a sense of the elasticity of employment to growth. The idea is thus that when infrastructure makes growth possible, it also makes job creation possible and the two facts need to be coordinated. It is quite easy to rely on basic math to derive the elasticity of employment to infrastructure. This exercise is possible because ILO (2011) provides region specific estimates of

these elasticities. These are indeed used by the ILO to forecast job prospects around the world. The approach followed here can be used to generate a rough estimate of the scope for job creation from large scale infrastructure jobs.

Methodological approach

This section is divided in three parts. Each explains a relevant elasticity concept used. It starts with the elasticity of growth to infrastructure. It then covers the elasticity of jobs to growth and concludes with the elasticity of jobs to infrastructure.

a) Output elasticity with respect to infrastructure

With Y_t as the economic output at time t —measured as GDP—and Inf_t as the stock of infrastructure at time t , the basic definition for output elasticity with respect to infrastructure is given by

$$\varepsilon_{infra} = \frac{(Y_t - Y_{t-1})/Y_{t-1}}{(Infra_t - Infra_{t-1})/Infra_{t-1}}$$

Since this elasticity measures the output percentage point increase for a 1 percentage point increase in the stock of infrastructure, once we have been able to estimate it from past data or from international experience, we can get a sense of the infrastructure investment needed associated with various scenarios for growth prospects in the region.

Alternatively, we can assess the extent to which infrastructure commitment considered by governments will lead to growth. This is the simplest way of reflecting the fact that growth can be constrained by lack of investment in infrastructure without getting into a lengthy modeling exercise.

Since we do not have access to country or even region specific

³ This is the same approach used to generate assessments for MENA in a background paper for their flagship report.

elasticities, in this note, we rely on a survey of the international experience on developing countries to obtain an estimate of the output elasticity with respect to infrastructure. Although there is quite a large literature on the topic, few are for developing countries. The basic average elasticity used draws on the estimation results from studies summarized in Note 1.

Table 1: Employment elasticities with respect to GDP per region across regions (2004-08)	
Central & S.-East. Europe (non-EU)	0.041
East-Asia	0.021
South-East Asia & the Pacific	0.083
South Asia	0.062
Latin America & the Carribean	0.103
Middle East	0.145
North Africa	0.145
Sub-Saharan Africa	0.104

Source: International Labor Office (KILM)

b) Employment elasticity with respect to economic output

A very similar approach is followed to assess the employment elasticity with respect to economic output (i.e. GDP). More specifically, note E_t , the aggregate level of employment in the economy and Y_t , the economic output at time t , then the basic definition for the employment elasticity with respect to output is given by

$$\epsilon_E = \frac{(E_t - E_{t-1})/E_{t-1}}{(Y_t - Y_{t-1})/Y_{t-1}}$$

As for the elasticity of growth to infrastructure investment, since ϵ_E measures the percentage point increase in employment for a 1% increase in GDP, we can use it to get a sense of how much

job creation could be expected to result from various growth scenarios.

We rely on region specific estimates provided by ILO database. Table 1 reports these region specific estimates. It is useful in that it shows that some regions have a particularly sensitive employment level, indicating that they could also be more receptive to policy efforts to promote job creation in the short run.

c) How to get a sense of how employment will react to investment in infrastructure?

The final elasticity to focus on is the one that allows us to get a sense of the relative importance of infrastructure in any effort to create jobs, i.e the employment elasticity with respect to infrastructure. The easiest approximation of this information can be obtained from the following expression which combines the two earlier elasticities:

$$\epsilon^* = \frac{(E_t - E_{t-1})/E_{t-1}}{(Y_t - Y_{t-1})/Y_{t-1}} \frac{(Y_t - Y_{t-1})/Y_{t-1}}{(Infra_t - Infra_{t-1})/Infra_{t-1}}$$

Table 2 presents employment elasticities with respect to infrastructure at the regional level (2004-08). Its interpretation is relatively easy. In East Asia for instance, a 1% increase in the stock of infrastructure would give rise to 0.02% increases in job number. It would be 7 times as large in the Middle East and North Africa. Of course, this depends on many factors such as wages, skill mix involved, labor market regulation and other sources of rigidity, initial share of women in the labor force, etc.

Table 2: Employment elasticities to infrastructure across regions (2004-08)	
Central & S.-East. Europe(non-EU)	0.2
East-Asia	0.1
South-East Asia & the Pacific	0.4
South Asia	0.3
Latin America & the Carribbean	0.5
Middle East	0.7
North Africa	0.7
Sub-Saharan Africa	0.5
Source: International Labor Office (KILM)	

It should be noted that these elasticities will only help in getting a sense of the lower bound of the potential payoff. It is indeed essential to try to get a full picture by considering the full ranges of indirect effects that can be generated from reducing infrastructure bottlenecks for instance.

This is one of the main lessons of a recent report on employments from infrastructure in MENA (World Bank (2012)). MENA's infrastructure sectors, including construction and infrastructure services, employ close to one fifth of the regional workforce, or 18.2 million people with 7.5 million involved in infrastructure services. Within these services, the transport and communication sectors represent about 7% of total employment and energy and water 1% on average--with significant variation across countries.

The recent study shows that in the short-run every one billion of US\$ invested in infrastructure has the potential of generating, on average, around 110,000 infrastructure-related jobs in the oil importing countries, 49,000 jobs in the developing oil exporting countries, and 26,000 jobs in the GCC economies, respectively. The region could therefore generate 2.0 million direct jobs and 2.5 million infrastructure-related jobs just by meeting estimated, annual infrastructure investment needs—and

this ignores the further growth impact from any investment in infrastructure that could result from an effort that goes beyond what is needed to meet the added infrastructure needs to support growth in a business-as-usual-scenario. While this is less than 2% increase in direct jobs and an extra 2.5% in indirect jobs in the region, it is politically an important potential tool for countries going through major adjustments. Similar conclusions could easily be drawn for other regions.

A word on PPI and jobs

The discussion so far has focused on the positive impact of infrastructure on jobs. Yet, the first thing that comes to mind for many casual observers analyzing PPI, the common wisdom is that, in the short run, a large share of the efficiency gains achieved through PPI comes from employment reductions. One of the best documented study, Andres et al. (2008)), confirms for a large data set that the impact on employment includes unambiguous reductions in the workforce. There are many academic documenting this in a wide range of context, across sectors.

Are these results incoherent? Not really. The PPI evidence is mostly short term, the elasticity story is long term. Moreover, for studies on PPI enjoying the benefit of time, the evidence sometimes merges.

The changes in technology in the ICT sector for instance has created new businesses which represent new jobs. Clearly people working in the historical companies did not necessarily keep their jobs in the original company. Many also, in particular, those with few skills or outdated skills, did not make it to the new company. But for many young workers, the sector has offered good opportunities. At the other extreme, large scale PPI in the water sector have almost

systematically resulted in non-reversed job losses.

Energy and transport are somewhere in the middle. Many efficiency studies show that their labor productivity improved significantly. Estache et al. (2002) show that within 3 years of the Mexican port reform, the most successful terminals had higher employment levels than before the reform, reversing the often drastic initial cut. But the same story did not hold for every country. Argentina never really recovered its original employment levels—many ports were closed. A similar hybrid story could be told about the railways or electricity PPIs in Brazil for instance.

Overall, this is one of the dimensions of PPI that requires a lot more serious analytical work. Monitoring what is happening would avoid having to rely on imperfect assessments. In the short run, the elasticities computed here can provide a first order approximation of the scope for job creation from a major scaling up of investment in the sector, from major projects.

Main messages

While political speeches promising strong job creation from infrastructure are quite common in this post crisis area, it is useful to keep in mind a few lessons from the research on the topic:

- Infrastructure investment (including PPI) can create jobs
- Job creation can be direct (within the industry) but also indirectly by creating jobs in other sectors, among the providers of inputs into infrastructure but also among new businesses made possible by new infrastructures
- Infrastructure alone will not reduce unemployment or underemployment problems of the world

- The full impact of infrastructure on jobs needs is quite sensitive to the impact of infrastructure on growth and since this impact varies across countries, the job payoffs of infrastructure will vary across countries.
- Specific rough estimates for any given country can be generated from the elasticities reported here but these will always underestimate the scope for creation of jobs as they do not pick up in detail secondary growth enhancing effects than can result from improvement in the efficiency of the economy that stems from gains such as improved network externalities-- which by definition, for a given country, cannot easily be extrapolated from the past data.
- To maximize the direct and indirect job creation impact, technology choices would have to be biased in favor of labor intensive technologies—which in some cases may actually improve total factor productivity since it would offer a better match between local resources constraints and opportunities, on the one hand and technological choice on the other
- Different sectoral ranking will have different impacts on the demand for skills and the middle class is most likely to benefit more directly from ICT investments while transport is more likely to benefit lower income classes—although within transport, technical jobs at airport and ports for instance are likely to benefit the better educated better while road maintenance will offer opportunities to the low skilled workers.
- It is important to start documenting systematically that PPI will eventually lead to more employment in the more dynamic sectors (ICT, energy, including the switch to renewable and to a lesser extent ports and rail). The

analysis should also show the extent to which it will probably require reductions in employment to achieve productivity gains which should, under proper regulation, lead to lower tariffs for users.

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