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Natural Gas and Human Development

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NATURAL GAS AND HUMAN DEVELOPMENT

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This paper presents two ways to think about the connection between natural gas and human development. The paper first reviews current gas production and the opportunities for increased domestic gas consumption from shallow-water or onshore gas production, before focusing on the potential from larger-scale, higher cost, deep-water gas. I then use a framework that treats sub-surface gas as an asset, which is then put through a sequence of transformations to turn it into human capital, and other assets that sustain higher living standards, as the first way to think about linking natural gas to human development. The second way to think about making more of gas simply tracks the linkages to jobs and economic growth associated with this process of asset transformation. Thinking in terms of an asset transformation provides a focus on the public finances; viewing the linkages to the process of asset transformation with an eye on the implications for jobs provides a focus on the business environment for associated private investment and job creation.

[1] This paper was supported by the International Growth Centre country programme for Tanzania.

INTRODUCTION

This paper outlines some of the links between natural gas and human development in Tanzania. I first set out some of the main parameters of expected natural gas production, in essence setting out the questions that will define what we are talking about when we talk about "gas". I then present two ways to think about the connections between natural gas and human development. The first is a framework which provides a consistent treatment of gas as an asset. Gas – or indeed other large-scale mineral deposit – starts as a sub-surface asset, which is then subject to a sequence of transformations into a financial asset in the public finances. At which point the public finances have the opportunity to further transform it into a physical asset as public infrastructure, and into human capital by strengthening the delivery of health and education outcomes for Tanzanians. The second approach looks at the opportunities for jobs and economic growth arising from the linkages to the broader economy associated with the process of asset transformation.

The idea of asset transformation naturally provides a focus on the public finances; the linkages associated with an asset transformation process provide a focus on the business environment for private investment and job creation. In turn, these points of focus lead first to a discussion of the public policy challenges of turning finance into public assets – typically investment in economic and social infrastructure undertaken by government – which is more or less the same as the challenges of 'aid effectiveness' or 'development effectiveness' more broadly; second to a discussion of local content policies and the challenge of building the capabilities of firms to industrialise and create jobs at scale in Tanzania.

The conclusions of this paper throw up some initial research questions for consideration by the ESRF and other researchers in Tanzania; their work will support the development of thinking on how to make the most of natural gas in Tanzania for the benefit of the people of Tanzania.

"GAS": WHAT ARE WE TALKING ABOUT?

Not all gas in Tanzania is created equal. Broadly, there are two sorts of gas reserves. There are on-shore or shallow-water fields, such as Songo Songo and Mnanzi Bay, and there are a set of offshore deep water fields, such as recently discovered by consortia led by BG Group and Statoil.

Scale

There are two main differences. First, they are different sizes: the deep-water offshore fields are very much bigger than the on-shore or shallow water ones. The technically recoverable gas in Songo Songo is about 1TCF; Mnazi Bay holds about 0.75TCF.[2] Estimates vary for recoverable gas in deep-water offshore fields, but a significant part of the reserves announced by the Ministry of Minerals Energy and Mines of over 43TCF are made up of the deep-water offshore discoveries made since 2010. BG Group has recently confirmed reserves in their blocks alone of 13 TCF.[3]

[2] 'TCF' is 'trillion cubic feet'; source: Wood McKenzie.

[3] See: http://www.bg-group.com/MediaCentre/Press/Pages/2Oct2013.aspx.

A second indication of scale can be provided by the volume of gas that goes through one LNG 'train'.[4] Most modern LNG trains process around 3.5 MMT per year. That is a production volume of about 500 million scuf/d,[5] which is about five times the current production in Tanzania; moreover, the expectation is that the discoveries so far reported could support at least two trains of LNG, making for minimum LNG volumes of greater than 10 times current production, or more. Offshore deep-water gas is very much bigger than the on-shore or shallow water gas.

Cost of production

The second difference relates to the first, and it is the time and costs involved in bringing each sort of gas field to production. Big deep-water fields take longer to bring to production once a final investment decision has been taken, and they cost very much more as well.

To give a rough comparison – again as a matter of an order of magnitude rather than precise estimates for anything specific in Tanzania – the cost of bringing deep-water gas ashore is about US$7/boe; gas from the shallow-water on the continental shelf costs about US$6/boe, and onshore gas costs about US$4/boe.[6]

As well as having lower unit costs, the time it takes to bring onshore or shallow-water gas to production is significantly shorter than deep-water gas, mainly reflecting the fact that the scale and engineering involved is easier (which is part of the reason why it is lower cost). In addition, the minimum volumes of production needed to cover the initial capital investment over a reasonable period of time are also smaller. This idea of a minimum, or 'anchor', volume for production, below which investment would not make commercial sense, helps explain why the large volumes of deep-water gas are needed for any production at all, and that given the scale of production volumes required to justify the investment, the majority of the gas will go for export – where there is the demand for gas at world prices in sufficient volumes.

Potential domestic use

There are 'domestic market obligations' included in the contracts for deep-water gas. That means that some minimum percentage of gas, likely between 5 and 10 per cent of production will be sold into the domestic market if required. That may initially appear to be a low number, but recall that the volumes of gas needed to make an LNG export project work commercially are so big, that 5% of a two-train LNG project would be roughly the equivalent of two-thirds of total current gas production, and broadly equivalent to the gas presently used in power generation.

Increased production from the shallow-water, and on-shore gas reserves will be both more immediate and lower cost when delivered to the domestic market than the gas delivered through the domestic market obligation for deep-water gas.

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[4] An LNG 'train' is the refrigeration plant that cools the gas, and slightly compresses it, so that it is sufficiently cold – -161^{0}c – to turn from gas to liquid, which then allows it to be shipped in specially designed LNG carriers to export markets.

[5] These units are millions of 'standard cubic feet per day', usually written as 'mscuf/d'. For a full set of conversion tables across the various units used in gas and LNG, see the tables on the inside cover of the BP Statistical Review of World Energy, which is itself an invaluable source of global energy data: www.bp.com/statisticalreview.

[6] This unit is 'barrels of oil equivalent' (boe) – the equivalence is in terms of the energy, or calorific, content of the hydrocarbon. It provides a comparison between costs of processing and production of gas with those of oil.

There is a range of potential uses for increased gas supply to Tanzania, including significantly more gas into power generation. Just as not all gas reserves are created equal, not all domestic uses of gas are equal. It is the economics of the alternatives which mean that some uses are good supports for economic growth and human development, such as gas going into properly priced power generation, but others would likely destroy value or waste the investment such as, for example, a 'gas to liquids' plant in Tanzania. The key to identifying which uses add value for Tanzania is to examine the project economics, and to take care in using the price assumptions for valuing the costs and the benefits of alternative domestic uses of gas.

Timing?

At the time of writing, the information available through press releases indicates that the offshore gas fields are going through a programme of appraisal to confirm the scale of reserves in each of the blocks.[7] Together with other elements of project evaluation and appraisal these activities are part of the planning phase of large-scale hydrocarbon projects. The complexity of these projects means that the phases of planning andpreparation take a number of years. Then, once a 'final investment decision' has been taken, construction will take another 4-5 years before production can begin. Cumulatively that could mean 8-10 years before gas is exported as LNG from Tanzania.

For the shallow-water or onshore fields, lower cost and less complexity means that production can come on relatively earlier – depending on the readiness of infrastructure for gas transport, and the extent to which reserves are confirmed as supporting investment in production capacity, and appropriate contracting and pricing arrangements.

GAS AS AN ASSET

In the rest of this paper, I principally refer to the newer deep-water gas discoveries. In economic terms, new gas discoveries are assets. Of course, the gas was actually there all along. So the discovery doesn't change anything apart from the anticipation that the gas will be brought to production. Once there is a reasonable degree of certainty of future gas production, then the government holds an asset in the sense that it yield a future stream of government revenue.

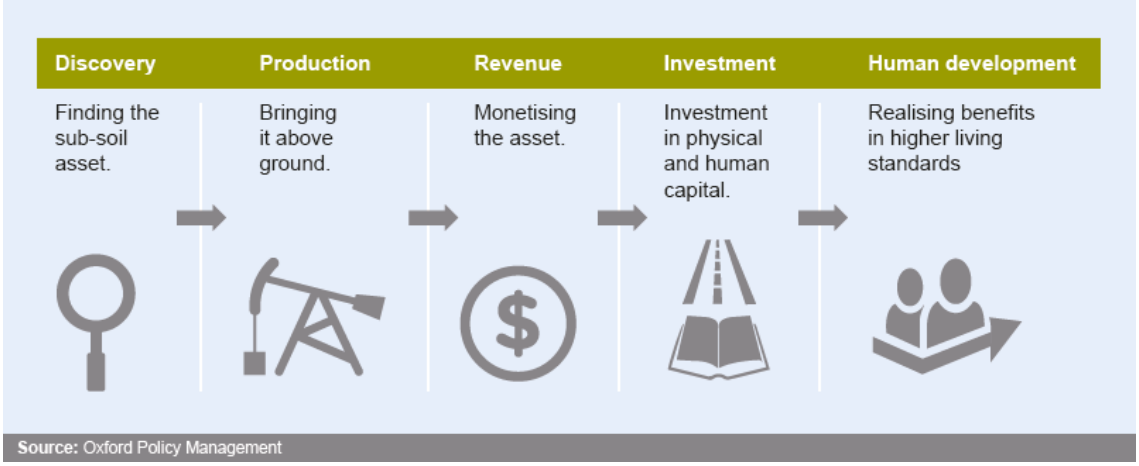
The beneficial ownership is defined in the constitution as being in the hands of the state 'on behalf of the people'. Viewed in this way, gas reserves are an asset for the state, but they only have value to the state if gas can be produced. Finding the gas and then bringing it to production is a risky, technically complex and high cost activity. As in almost all resource-rich countries, the state therefore uses a specialist contractor to shoulder the risk of exploration, and to take on the large up-front costs of capital investment that allows the gas to be brought to production. It would not be a responsible use of scarce public funds to sink large amounts into a venture for which the risks to the state would be significant.

[7] See: http://www.bg-group.com/OurBusiness/WhereWeOperate/Pages/Tanzania.aspx.

A sequence of asset transformations

Thinking of the gas reserve as an asset, means that the process of gas production can be thought of as a sequence of transformations: the gas goes, via well, gathering station and pipeline, from being under the sea-bed to the onshore LNG plant that will cool, compress and so liquefy it for export. Sale of gas for export then turns the gas into money. These exports will show up in the balance of payments. The government gets its share of revenue, which shows up in the fiscal accounts, and then faces the development challenge of investment in physical and social public capital, and supporting human capital accumulation, all of which, in turn, contribute to human development. This sequence of transformations is illustrated in Figure 1.

Figure 1: Asset transformation



Production

The contract that the government has with the contractors who produced and export the gas provides for the reimbursement of the sunk capital costs, a return on capital employed, and reasonable compensation for exploration and commercial risk. Most large extractives projects have on-going sustaining capital investment as well as operating costs. Being intensive in technology, there will be some significant on-going imports of specialist equipment and services. These will add to imports in the balance of payments.

Revenue

The government will receive revenue from gas, which will typically show up in the fiscal accounts as a stream of recurrent revenue. But if we are thinking of gas as an asset, and we wish to be clear in our conceptual thinking on the economic impact of gas, then the receipts going to government are in large part the recording of the state claim on the gas asset once it has been transformed from hydrocarbon into money. In some fiscal accounting frameworks, such asset transactions are shown 'below the line'.

An example is provided by the conceptually correct treatment of receipts from privatisation. When the government sells a state-owned enterprise it is transforming an asset – the shares in the SOE – into another asset – cash in the bank – and this holds whether the government sells all

the shares all at once or whether it just sells part of the shares. The same logic applies to the annual transformation of a hydrocarbon asset into a financial asset through the production and sale of gas, and then payment by the contractor of the share of the rent due to the government.

This is more than just a fine conceptual point. Since gas is an asset when sitting in reserves under the seabed, then when it is transformed into money it is still an asset. That means that the treatment of the stage payments each year in the 25-year long transformation from hydrocarbon to cash should not be thought of as recurrent revenue – even if it presented as such in the fiscal accounts.

The point is that changing the fiscal accounting treatment shifts the debate on what to do with the money. In particular, rules that are predicated on the exhaustibility of a revenue stream are not applicable to the steady accumulation of the monetary manifestation of a natural asset.

In practice, this means ignoring crude guidelines such as 'only spend the interest on the accumulated savings from hydrocarbon revenues' (the "bird in hand" rule), and it allows us to avoid some of the heroic assumptions that under-pin Hotelling's rule, such as the price of the sub-soil asset for valuing it increases in line with the world rate of interest, which if the past track record is anything go by is not going to hold.[8]

For the circumstances that prevail for almost all newly resource-rich countries, including those in East Africa, a transformation into the next Kuwait is not in prospect. In which case, thinking consistently about gas as an asset, and treating the receipts to government consistently, means that questions on what to do with the money are actually questions about the management of the portfolio of options for the financing public investment – including domestic non-resource taxation, domestic and foreign borrowing, and donor finance.

To be more specific on scale, in the absence of publicly available projections for Tanzania, I will draw upon a set of projections made for oil receipts for Uganda which are of a comparable scale in terms of rents relative to GDP.[9] Based on the maximum projections of production available 18 months ago, using available information on the Production Sharing Contracts for Uganda, making a set of largely industry-standard assumptions on other aspects of the PSA[10], and making some Uganda-specific assumptions on costs of crude oil transport, provided a rough estimate for receipts to government from oil to 2050. Clearly such a projection hinges on the assumptions that were used to construct them. But they depend more on the price of oil, which is inherently uncertain. Nonetheless, our projections imply that oil revenue to government will be in single

[8] There might be one caveat to this assertion which is that it hinges on the scale of the natural asset. If there is so much gas that it transforms Tanzania into a place like Kuwait or Qatar, then that is a different matter.

[9] Henstridge and Page, 2012: the projections we made for Uganda were based on hitting a plateau of oil production of 120,000 barrels of oil per day. The scale of gas production discussed above for LNG is comparable to around 180,000 barrels of oil equivalent per day – using the rough conversion factors in the BP Statistical Review of World Energy – so the scale of the hydrocarbons is comparable, and the scale of the rents likely to accrue to government all the more so once one allows for there being considerably bigger rents in oil compared to gas, owing to the influence of OPEC on oil prices.

[10] 'PSA' stands for 'Production Sharing Agreement', the contract under which the production of gas in Tanzania will operate, and which similarly governs the production of oil in Uganda, sometimes also called a 'Production Sharing Contract', or 'PSC'.

digits of GDP in about 2025-30, and so is not transformative – in the sense of turning Uganda into Kuwait – but nonetheless will be an important part of public finance.

The comparison with Tanzania is valid. The volumes of LNG produced by a two-train liquefaction plant would generate gross receipts of a comparable order of magnitude as oil in Uganda – something in the teens of GDP – and therefore a comparable scale of hydrocarbon revenue to government: something in single digits of GDP.

Table 1

Tanzania: Central government operations:

The resource envelope: 2012/13 % GDP (proj.)		*Conventional presentation:* 2012/13 % GDP (proj.)	
Tax revenue	16.4	Revenue	18.2
Non-tax revenue	1.8	Grants	3.7
Grants	3.7		
Foreign finance (net)	5.6	Recurrent spending	18.7
Domestic finance (net)	0.2	Development spending	8.9
Resource Envelope	27.6	Overall balance	-5.8
Spending	27.6	Financing	5.8
Of which: Recurrent	18.7	Foreign (net)	5.6
Development	8.9	Domestic (net)	0.2

Source: IMF (2013) cr13166; may not sum due to rounding.

Table 1 illustrates the scale of prospective revenues in the context of the fiscal accounts for Tanzania for 2012/13. On that basis something in single digits of GDP is comparable in scale to recent foreign financing, and equivalent to about one third of current tax revenue: a significant addition to the resources available for public spending and investment.

The questions that this sense of scale and timing then throws up for thinking about public finance will reflect the macro-fiscal context for additional revenue, and will include:

- How much to borrow in advance?
- How to gauge the return on public spending? – which shapes the decisions on how much to spend in aggregate, and when, and:
- What about the broader macroeconomic context – which conditions spending and financing decisions.

Investment and human development

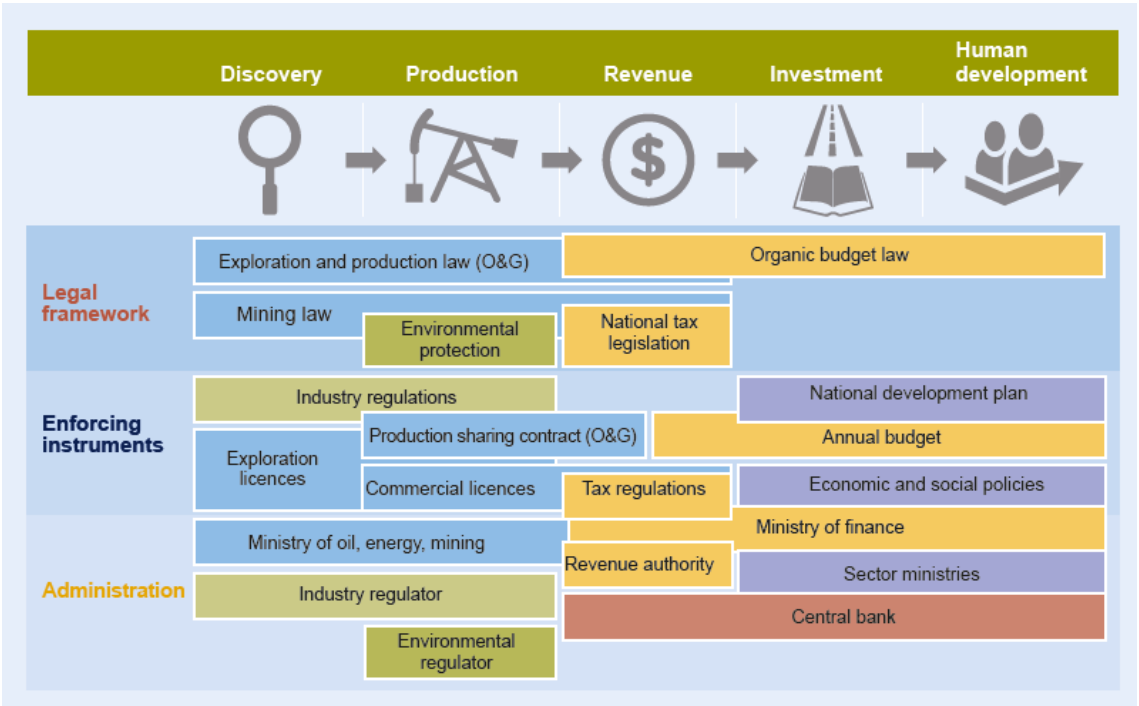
Given that some of the receipts from gas – recall they are stage payments as the mineral asset is transformed – can go towards spending on human development, the next questions relate to how the state can best invest these assets to support the accumulation of human capital by private citizens, and what associated investments in public physical and social capital can help raise individuals' productivity – and so further contribute to human development.

For example, it might be that human development is best strengthened through a road maintenance programme which provides credible assurance of access to markets to allow farmers to invest in higher yields, so raising rural incomes and strengthening health and education outcomes as a result. But it might also be that those outcomes hinge on further investment in public service delivery – without which even better-off farmers would not be able to secure stronger health or education outcomes. The likely answer is some combination of them both. This is no different from the usual 'development' challenge that governments everywhere face when trying to turn money into higher living standards – this has certainly been a challenge for traditional donors for many decades.

The idea of a sequence of asset transformation – from subsoil mineral asset in the hands of the state to private citizens benefiting with strong human development – is conceptually clear, but in practice hard to hold fast to in the midst of the process of making an annual public budget and then executing it.

In addition, the sequence of transformation is governed by a chain of associated governance and public policy choices. As a result, the sequence is vulnerable to the weakest link in that chain. In addition, the size, complexity, and strategic importance of any major extractive industry means that the legislation, regulation, and administration needed to sustain the governance and policy chain is complex, and hard to coordinate securely. Figure 2 provides an illustration of this point in terms of just some of the legal framework, enforcing instruments, and administrative agencies along the sequence of asset transformations.

Figure 2

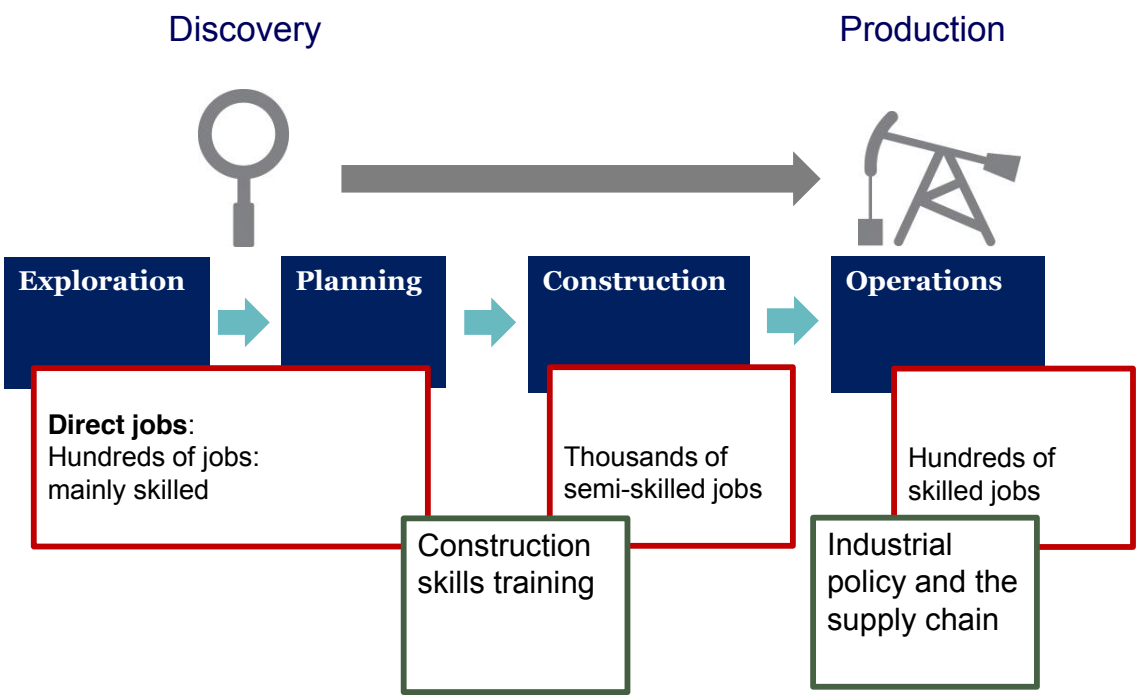


HUMAN DEVELOPMENT AND THE PROCESS OF ASSET TRANSFORMATION

While the long sequence of transformations can be vulnerable, the externalities to the *process* of transformation offers opportunities to support human development. In this section we only highlight the linkages to jobs, on the premise that more jobs is closely associated with stronger human development outcomes.

Most extractive industries, particularly oil and gas, have limited direct employment; their impact on jobs is indirect. For example, a typical LNG plant will only create a few hundred jobs during the planning phase, then some thousands through the construction phase, but only a few hundred when operating. One link to jobs is through the training opportunities if people are involved in building the plant. Another is through the possibilities for job creation in the supply chain, both for the construction phase and for the operations phase – as illustrated in Figure 3. We next review both in turn.

Figure 3: Jobs and the project cycle



Jobs and skills

The process of exploration and planning for a major extractives project does not require many people, but it does require specific skills and experience. For Tanzania, or other newly resource-rich countries, those skills and experience will largely need to be imported, financed by the FDI that finances exploration and planning phases. The operation of oil and gas facilities, including LNG, also requires high skill levels, but by being run over long periods of time, there is scope for people to develop the necessary experience, and to acquire skills through the life of the asset.

In contract, the time needed for construction is relatively short – something between 4-6 years – needs thousands of people, for at least part of the construction phase, and for many of those people, only medium-levels of skills are needed.[11] This raises the opportunity to train people to take up jobs during the construction phase.

Although the construction phase is limited to a few years, construction skills are not specialised for one sector alone. Indeed, the usual corollary to a natural resource boom is a construction boom across the newly resource-rich economy, which means that there will be a sustained demand for people with skills in elements of construction.

One approach to training people to take up jobs during the construction phase of a major extractives investment is to identify people with the necessary basic skills, and train them to do the jobs that are needed for the construction of the extractive asset. Since there is a fixed cost to such a training programme, the marginal cost of training many more people than are needed for the construction of the extractive asset will be relatively low. A larger number of people with construction skills means that the contractor who is to build the extractive asset will have a big group of trained people from which to select their workforce, and there will be a bigger supply of semi-skilled construction worker for the rest of the country for when the construction boom kicks in. That will lower the unit cost of construction.

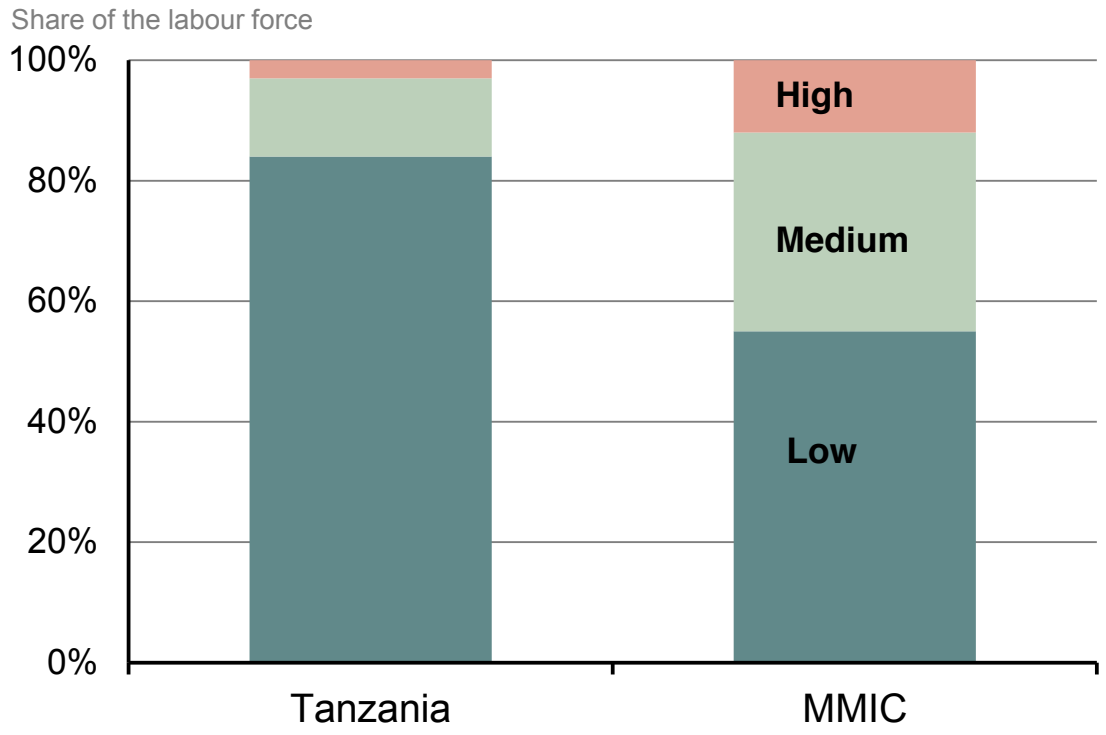
This can also be thought of as 'investing in the capacity to construct real estate investments'. In addition, by lowering the unit cost of construction, this also helps reduces any change in the increase in the price of non-tradeable capital – such as buildings and other fixed assets – relative to tradeables, and so dampens real exchange rate appreciation, and any subsequent 'Dutch disease' effect.

Tanzania's vision for the achievement of middle-income country status was explored in Moyo et al (2012), in which the skills composition of Tanzania's labour force and the labour force of a median middle-income country (MMIC) were compared, as shown in Figure 4, which strongly reflects the predominantly rural and agricultural nature of Tanzania's workforce, and shows by how much skills in Tanzania still need to be developed to come close to the skill levels, and productivity, of a median middle-income country.

This has two implications for effort to build skills as part of the construction phase of an LNG plant. First, even modest increases in skills can make significant contribution to the development of skill levels in Tanzania, given a relatively low starting point. Second, that low starting point makes it hard to find people who are prepared for further training and skill development to move from being low-skilled to semi-skilled.

[11] However, the most basic requirement for training for semi-skilled work in factories and some construction jobs is completion of secondary schooling.

Figure 4: Tanzania's skills compared to a median middle-income country



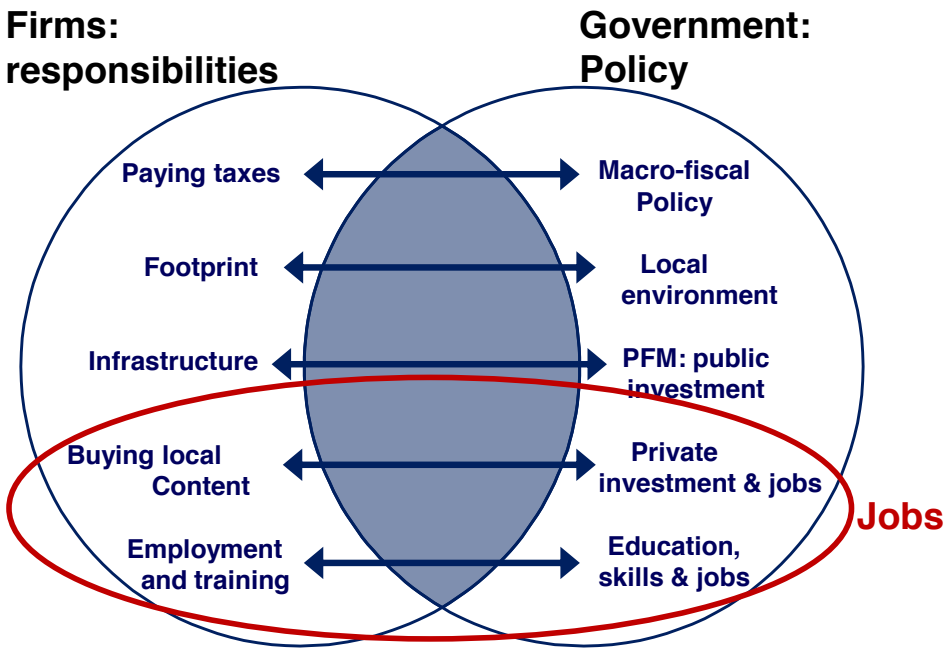
Source: Moyo et al (2012), ILFS data

Jobs and local content

Efforts to develop skills can be thought of as being on the supply-side of the labour market. The role of efforts to develop 'local content' in the supply-chain for major extractive projects seeks to create jobs on the demand-side of the labour market. Both are examples of externalities to the process of an extractive industry – along with paying taxes, building infrastructure that has multiple uses and the local footprint of such projects, illustrated in Figure 5.

The usual approach to local content is a regulation that commands a certain share of absolute level of spending on goods and services provided by 'local' firms. This has one major difficulty, and is not sufficiently linked to sustained job creation. The problem is the meaning of 'local'. A firm registered in-country, and indeed majority national-owned, may be simply a licencee of a foreign firm, and in effect just an importer. In Zambia, some 80 per cent of spending on inputs for the major mines consists of 'local' transactions, and almost all inputs to mining are imported. At one level, 'local content', as measured by the share of input spending or by a dollar amount of spending is very high. On a more meaningful assessment, local content is not as high as those indicators suggest because so much of that spending is on imports. Of course, many such imports will be both essential and even with best efforts unavailable locally. But at the margin, there will be inputs that could be locally supplied in time. But what it takes is a focus on the development of the necessary firm capabilities to deliver reliably to quality specifications and in sufficient volumes, not a focus on the share of locally-purchased inputs or an absolute value of local spending. This re-defines the challenge and opportunity of 'local content' policies. They become complements to government policy on private investment and job creation.

Figure 5: Externalities to extractives



In a series of publications, John Sutton of the LSE (and co-authors) has mapped out industrial enterprises in Ethiopia, Ghana, Tanzania, and Zambia, with the equivalent 'Enterprise Map' of Mozambique forthcoming. Those books have identified the existing firms some of which have the potential to scale up and develop the necessary capabilities to supply into extractive industries, likely in partnership with established firms in bigger industrial centres such as Nigeria or India, and by so doing, to create jobs. As Professor Sutton put it at the launch of the book 'An Enterprise Map of Tanzania': "If oil industry supply chains can be fully integrated with Tanzania's domestic industrial sector, then the payoff to medium term growth will be huge… no single issue in Enterprise policy is more important right now…."

Conclusion

This paper has set out two ways of thinking about the links between natural gas and human development. Neither are direct simply because large-scale extractive industries do not have a direct impact on human development. The first took a conceptual approach to the transformation of a sub-soil mineral asset in the hands of the state through production, monetisation, and the public finances, into public physical and social infrastructure and the support to human capital development through the delivery of public services in health and education. The second approach was to look at the opportunities for skills development and job creation as positive externalities to the process of gas production.

The asset transformation framework puts the link between natural gas and human development into the realm of the public finances, and the familiar development challenge of turning money into higher living standards. This also raises questions on where, across the spectrum of public policy, the biggest human development 'bang' for incremental resource revenue 'bucks' can be

found. It might be through the more direct targeting of human capital formation through the delivery of public services in health and education. It could be through a credible road maintenance programme sustaining market integration, and so supporting farmers' investment in higher yields, productivity and income. One intervention with high, but long-term, payoffs is investment in early childhood development (ECD), with provides an opportunity to support the the accumulation of human capital assets for the next generation through the transformation of natural resource assets today, with a payback period that is close to the typical life of a gas field.

Thinking about externalities to the *process* of asset transformation provides a focus on training initiatives on the supply-side of the labour market, and on the demand-side of the labour market, a focus on job creation, the business environment, private investment and the development of firm capabilities, and the intersection of job creation with local content policies.

These frameworks also throw up some questions that could form something of a research agenda in Tanzania. Such an agenda could include:

- The labour market: what data exist for the exploration of formatlity, informality and job creation?
- How does education and skill formation relate to jobs – both formal and informal – and the development of firm capabilities?
- What scale are absorption constraints in Tanzania? modelling the monetary and exchange rate implications of more public spending
- What determines the efficient delivery of public investment: is it *ex ante* project evaluation? or project management? or *ex post* operations and maintenance?
- Investments in early childhood development have a pay-back period equivalent to the typical life of a gas field: what are the constraints on delivering ECD investments?

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