Measuring the Indirect Impact of Businesses in an Investment Portfolio: a job estimation tool

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Abstract

This paper describes a job estimating tool developed by the UK development finance institution CDC Group plc and impact and sustainability consultancy Steward Redqueen. The tool enables investors to estimate the total number of jobs and livelihoods that are likely to be supported by a portfolio of investee businesses. Businesses require inputs to operate. Demand for direct labour or intermediary products and services results in employment opportunities. Outputs such as electricity and credit also enable other businesses to operate and support employment. The tool is parsimonious in its data requiring just five inputs: direct full-time equivalent headcount and basic financial data (revenues, earnings, taxes and wages). These inputs are fed into a set of multipliers derived from national social accounting matrices and labour force surveys to yield an estimate of the total number of jobs and livelihoods likely to be supported directly and indirectly by business operations in a given year. In 2018, for a sample of 473 businesses in CDC's investment portfolio, we find that 4.2 supply chain jobs were supported for every direct job, but with broad variation by region, sector and firm size. Estimates of the induced effects of wages and economy-wide employment from power and loans are also substantial, albeit the evidence base for these drivers is less certain. Evidently then it is worth the effort of trying to track indirect jobs beyond direct employment metrics to get a fuller picture of how development finance contributes to Sustainable Development Goal 8. However, results must always be considered in the context of numerous caveats about jobs models (the paper includes as annexes two critical reviews). Caveats notwithstanding, judicious use of a continuously upgraded indirect jobs estimation tool can provide investors with rapid insights into the broader impacts of their portfolios and could be a useful addition to the impact management toolkit, with potential applications ranging from portfolio shaping through to reporting.

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Contents

1. Introduction

CDC Group PLC, the UK's development finance institution (DFI), has the mission of supporting the building of business throughout Africa and South Asia to create jobs and make a lasting difference to people's lives in some of the world's poorest places.

The Department for International Development (DfID), CDC's shareholder, has the ambition *"to create an unprecedented increase in the number and quality of jobs in poor countries; enable businesses to grow and prosper; and support better infrastructure, technology, connectivity and a skilled and healthy workforce"* (DfID, 2017).

CDC has a large and diverse portfolio of around 870 private sector investments across multiple sectors in 43 African and South Asian countries. The investments are a mix of direct and indirect equity and debt. To meet its mission, CDC directs capital towards directly labour-intensive sectors such as construction, food and agriculture and manufacturing, and towards infrastructure and financial institutions that support other businesses to grow.

In 2012, Steward Redqueen, an impact and sustainability consultancy, helped CDC and DFID classify sectors for their propensity to support jobs by amalgamating national-level social accounting matrices (SAMs) and labour force surveys, an approach they had previously developed for multinational clients (Kapstein & Kim, 2011).

While CDC has for over a decade collected from investee companies and reported on direct headcount (Lerner *et al.*, 2015), the literature suggests that direct employment is a fraction of 'indirect employment' in supply chains and induced employment from the spending of wages (IFC, 2013). There are also large economy-wide employment impacts from electricity and financial services (ODI, 2015). Measuring direct employment alone, therefore, is likely to be a misleading measure of overall jobs impacts. Nevertheless, it continues to be the focus of impact investing metrics (HIPSO, 2017; Iris+, 2019).

Beginning 2014 CDC worked with Steward Redqueen to develop a tool to estimate the indirect employment of the businesses within its Africa and South Asia portfolio. The first results were published in CDC's 2014 annual review (CDC 2015) and subsequent editions.

After three years of piloting, in 2018 CDC commissioned economists Professor Fiona Tregenna at the University of Johannesburg and Dr Alex Bowen of the London School of Economics (LSE) to critically review the tool. Tregenna and Bowen made a wide range of observations and a number of recommendations to improve the tool. Their papers are attached as an annexe. Consequently, the tool described in this paper has been upgraded in terms of the timeliness and specificity of the data behind the model.

Other changes relate to how the impacts being modelled are described, clarifying that estimates are of gross jobs supported, not net (Carter & Sedlacek, 2019), and that the impacts cannot be attributed to capital providers. Importantly, levels of confidence are indicated for different types of indirect jobs modelled in the annual review, and the outputs of different impact pathways are not aggregated (CDC, 2019, pp38-41).

2. Methodology

The job estimation tool is designed to capture the key employment-supporting activities of firms in an investment portfolio. As businesses are born, survive and grow, their outputs require direct employment and intermediary inputs. This

in turn leads to activity among existing and new suppliers, thereby supporting and creating jobs. Some products and services – notably electricity and finance - remove constraints for other businesses, enabling them also to prevail and hopefully to expand. In Africa and South Asia, electricity and finance are among the biggest obstacles firms face, with implications not just for employment generation but for firm survival (AfDB 2019). Many other constraints - such as tax rates, regulatory uncertainty and corruption – also impact on employment prospects, but since they cannot be directly influenced by investors they are not included in the jobs tool.

The total employment impacts that the tool does capture are then five-fold:

1. *Directly-employed workers*: at business level, i.e. in the company or project that CDC has invested in (directly or through a fund);
2. *Supply chain jobs*: within the investee's direct and indirect suppliers;
3. *Induced jobs*: due to the spending of wages earned by employees of the investee and its direct and indirect suppliers;
4. *Economy-wide jobs via financial services*: due to lending to businesses and individuals; and
5. *Economy-wide jobs via power generation*: due to supplying electricity to businesses to increase productivity.

This tool does not measure any indirect employment impacts arising from government spending of corporate, value added and payroll taxes and royalties that firms pay, from the productivity impacts of better logistics and connectivity, or from the provision of personal loans, insurance, mortgages or guarantees, due to the current lack of evidence for these potentially important pathways.

To measure indirect jobs supported, there are two options. The first is by direct observation. This works for one-off studies of individual businesses, where the researcher has access to detailed personnel and supplier information, and can make site visits to suppliers, firms where employees spend wages, and users of credit and electricity. (IFC, 2013). For larger portfolios, however, the approach is impractical (KfW, 2015a).

The second option is by developing a set of sector- and country-specific multipliers. Various methods have been proposed for this; the tool described in this paper uses input-output models derived from social accounting matrices (SAMs). The results may be less precise than through direct observation but where results can be generated affordably across a large portfolio and updated regularly for impact measurement.

SAMs describe the financial flows of all economic transactions that take place within an economy, sector to sector. The literature on SAMs originated in developed nations (Leontief, 1951), but recent input-output tables are now available for developing countries ranging from Benin to Zambia.[2]

Employment multipliers are now used in a wide range of applications, from responses to economic depressions and understanding the impact of computers on employment, to global trade negotiations (GTAP, 1996), the immigration and climate change debates, and regional development

[2] Global Trade Analysis Project, https://www.gtap.agecon.purdue.edu/databases/regions.aspx?Version=10.131, accessed 3/7/2019.

(Bess & Ambargis, 2011). Models have also been used to inform decisions on large public infrastructure and sporting projects, and for corporate policy (Kapstein & Kim, 2011; BT PLC, 2015). Most recently, the approach has been trialled by development finance institutions to forecast or monitor the likely indirect employment of their investments (IFC, 2013; KfW, 2015a, 2015b; FMO, 2015).

The disadvantages of the approach are well recognized in the literature (Miller & Blair, 2009). Fiona Tregenna identifies the following caveats:

"Technical coefficients of production are assumed to be fixed (although these could always be 'manually' altered in the base data should there be valid reasons for doing so). This implies no change in returns to scale and a fixed production structure with no substitution of inputs. It is also assumed that prices do not change. Employment multipliers are thus most accurate for projecting the employment effects of relatively small and short-term changes in demand. Furthermore, the simplest way of computing employment multipliers assumes that there are no supply or capacity constraints, although these could be built into a model. Another consideration in the calculation of employment multipliers is that, unless imported intermediates are separated out, the backward linkages and thus the employment multipliers are not confined to the domestic economy, and may thus be overstated (with this being uneven across sectors depending on how much of a sector's intermediate inputs are imported). Finally, it should be noted that, unlike for example a computable general equilibrium (CGE) model, IO or SAM analysis does not deal with monetary policy, savings, innovation, and so on. Employment multipliers thus do not account for the effect of changes in demand for the output of a given sector on employment through such channels" (Tregenna, 2015).

More detail on these and other caveats can be found in the two annexes to this paper.

Mitigating these drawbacks, for example through direct observation of employment at suppliers or through the use of CGE models, would be a costly exercise and arguably impracticable for investors backing multiple businesses in multiple countries. However, CGE models are available or under development in a range of developing countries, such as South Africa and India (NCAER, 2015). CDC is currently working on a CGE project to understand its feasibility.

Relevant SAMs were accessed from Purdue University's Global Trade Analysis Project (GTAP). There are relatively recent SAMs available for 141 countries and regions, including over 40 in Africa and South Asia. These SAMs cover 57 sectors, across three reference years: 2004, 2007, 2011 and, from mid-July 2019, 2014. This means a major increase in granularity, with sectors up from 16 to 57 and regions/countries up from 10 to 121.[3]

Figure 1: Recent SAM coverage in Africa & South Asia (courtesy of GTAP 10)

[3] So increasing the sector-by-country permutations from 160 to 2,451 for the 43 countries that CDC has active investments in.

For each sector, an employment intensity multiplier (jobs per US$ of output) was calculated, based on recent GDP data (from the World Bank Group) and employment data (from the ILO).[4]

The methodology then applies these multipliers to the input data on financial flows generated by each business operating in that country and sector, to estimate indirect employment impacts.

3. Calculations

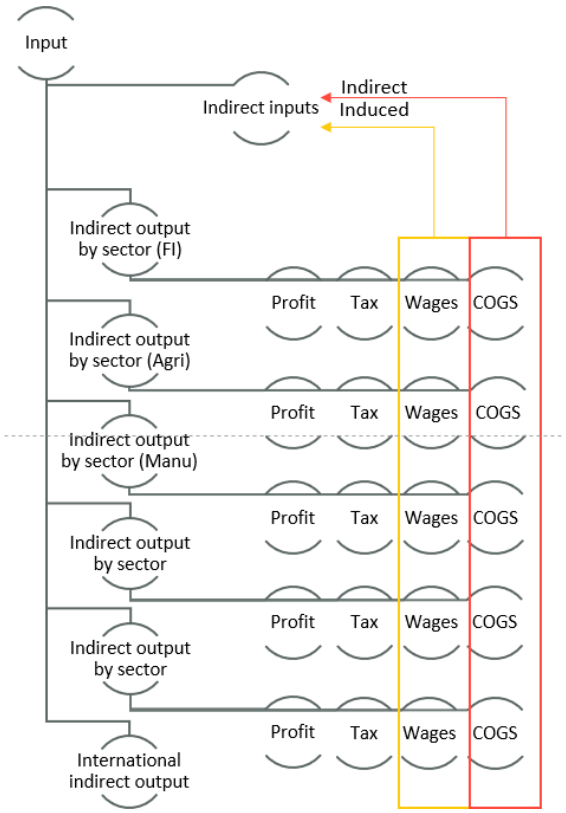
As indicated in section 2 we distinguish between direct, supply chain and induced employment.

3.1 Direct jobs

The direct employment at the business itself uses hard data reported to CDC annually by the investee business, in full-time equivalents and broken down by gender where this is reported. We have a higher level of confidence in the robustness of this data.

3.2 Supply chain jobs

Supply chain expenditure is based on the cost of goods sold (COGS).[5] Where COGS is not reported by companies, it can be estimated as the residue of sales revenue minus earnings minus wages minus taxes. The proportion of COGS directed domestically is derived from the SAM. The domestic COGS estimate is routed through the SAM in order to calculate the output generated at its direct suppliers and their suppliers.



These outputs are multiplied by the relevant sector-specific employment multipliers to estimate the jobs and livelihoods in the supply chain. We have a reasonable degree of confidence in these estimates.

$$\left[\begin{matrix}\text{Related}\\ \text{indirect output}\end{matrix}\right] \times \left[\frac{\text{Employment}}{\text{Output}}\right]$$

3.3 Induced jobs

To calculate the induced employment resulting from the spending of wages the methodology takes business-level data on actual wages paid in the business and prevailing wages earned in the relevant sectors of the supply chain and routes these through the SAM to determine where wages are spent. Multiplying the resulting output

[4] https://www.ilo.org/ilostat

[5] Where COGS is not available, it can be estimated as the residue of sales revenue minus earnings minus wages. The proportion of COGS directed domestically is derived from the SAM.

by the applicable sector-specific employment multipliers gives an estimate of the jobs and livelihoods resulting from the spending of wages. It remains for us to test the assumptions in the model about the proportion of wages that are used for consumption, as household savings ratios vary widely across Africa and South Asia, from near zero to c.20 per cent. Consequently, we have a lower level of confidence in these estimates.

3.4 Jobs supported by loans from financial institutions

The methodology here is derived from work first developed for Standard Chartered Bank, by treating the loan book of a financial institution (FI) as a series of financial flows into specific sectors which the FI lends to (Kim & Kapstein, 2014; Standard Chartered, 2017).

The sectoral allocation of the loan portfolio is normally reported by FIs in their annual reports as part of their risk reporting. Bank loans to government, personal loans and mortgages are not routed through the model. Because of leverage, the employment from lending is expected to be quite significant.

Since the original methodology paper (MacGillivray *et al*, 2017), we have collaborated with IFC on studying an Indian bank's loans to small businesses, which generated insight on how loans can translate into new hiring (Kehoe & Khanna, 2017).

This prompted us to revisit the recent literature and survey data on enterprise borrowing and expansion.

There is strong evidence of the relationship between bank credit and employment in borrowing firms from natural experiments resulting from the financial crisis, in the USA (Chodorow-Reich, 2014), and in Europe (eg Cornille *et al.*, 2017 for Belgium). In an elaborate double-natural experiment study, Huber (2018) found that employment fell by five per cent at German firms dependent on Commerzbank when that bank stopped lending in 2009-10.

There is a lack of comparably strong evidence for emerging markets, due to the lack of firm census and worker census data that can be matched. Banerjee and Duflo (2014) studied borrowing changes resulting from an Indian policy intervention in 1998-2000, and found that removing severe credit constraints led to very high marginal rates of return to capital. Other studies of the outcomes of credit shocks have been completed in Indonesia, Pakistan and Peru.

Capital ratios in total factor productivity across multiple countries can be calculated from World Bank Group *Enterprise Surveys*. Capital output ratios vary significantly by country (Saliola & Seker, 2011); by sector (Seker & Saliola, 2018); and by firm size (Dao & Liu, 2017). Other researchers have used Bureau van Dijk's Orbis database [6] to generate comparable findings. Orbis has records for over 1,100 firms in 17 countries in Africa and South Asia (Ahmad *et al*, 2018).

Drawing on this recent work, CDC is currently working with SRQ and other DFIs to develop more robust estimates for the relationship between credit inputs, productivity outputs and subsequent revenue and employment growth in order to agree a harmonized tool. Until we complete this project, lower levels of confidence should be attached to our current financial sector jobs estimates.

[6] https://www.bvdinfo.com/en-gb/our-products/data/international/

3.5 Jobs supported by electricity generation and distribution companies

The methodology here involves calculating what amount of GDP is attributable to an increase in gigawatt hours (GWh) of electricity supplied to the national system. A study in Uganda found that a 1% increase in electricity in the period 2011-14 was responsible for an increase of 0.06% in GDP (Steward Redqueen, 2016).

Subsequent studies in Turkey (Steward Redqueen, 2017) and elsewhere confirmed the role of electricity in driving growth, with ratios varying at national level. Proparco, the French DFI, and Steward Redqueen then collated relevant studies across emerging markets to enable the allocation of an appropriate conversion factor to each country.

The resulting additional GDP is then allocated sectorally according to the prevailing economic structure of the host country. Because power generators tend to operate at maximum efficiency, the model tends to show large numbers of jobs supported but little incremental change between years until new capacity is added. We attach a reasonable degree of confidence to these estimates.

3.6 Jobs from other activities

The methodology does not attempt to model employment effects from other goods and services such as improved logistics and connectivity. Nor does it attempt to model the employment effects of payments to government (taxes, royalties etc.), personal or mortgage lending, and guarantees.

4. Results

As hypothesised in the literature (Moretti, 2010; IFC, 2013), we discover that the indirect employment footprint is substantial in a sample of 473 African and South Asian businesses. As expected, the largest number of jobs supported were from power and from loans.

Across the portfolio, we found that on average each direct worker is associated with over four supply chain jobs. A further two estimated jobs result from the spending of wages by workers in the firm and in its supply chain.

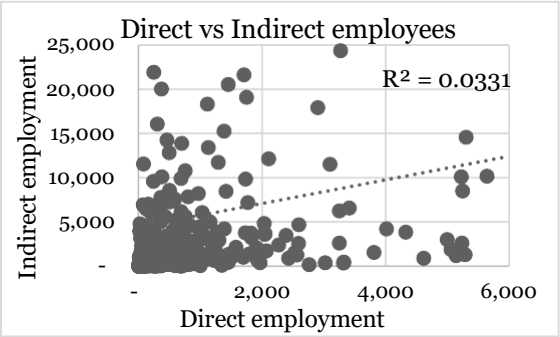
Table 2: Employment multipliers: average indirect supply chain jobs associated with each direct worker across 473 businesses (by region, sector and firm size)

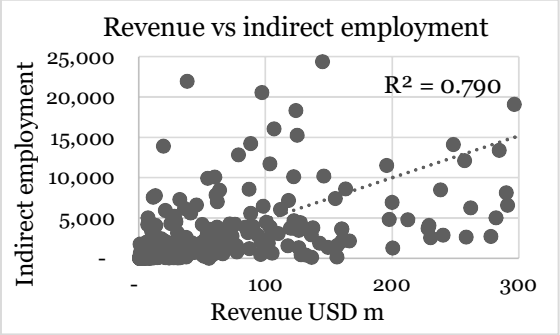
	Sample	Supply chain multiplier
Africa	266	5.9
South Asia	184	2.9
Food & agri	71	11.1
Industrials	82	6.1
Services	297	2.5
Small	45	25.2
Medium	149	11.3
Large	256	3.9

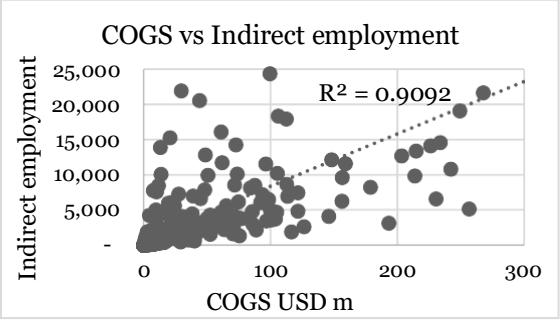
These multipliers vary significantly by region, by sector, and by firm size, underlining the importance of a granular approach to measurement and a targeted approach to impact strategies focused on decent work and economic growth (SDG 8).

There is a poor correlation between direct employment and estimated indirect employment at the firm level, suggesting that direct employees are a bad proxy for broader employment impacts. Sales revenue is a better predictor (r^2=0.79), but since COGS diverges from revenue quite widely, the use of COGS is preferable as the input (r^2=0.91), where it is available. The same findings apply to induced effects.

Figure 2: Correlations between direct employees, revenues and COGS with estimated indirect jobs







5. Discussion

Despite some challenges in data quality and completeness, the methodology allows for the measurement of direct and indirect employment in an investment portfolio that encompasses many hundreds of businesses across multiple regions and sectors, a task that could otherwise appear daunting to impact investors and DFIs that may wish to measure results for impact management.

CDC has trialled the tool for a range of purposes, including, among others, ex-ante impact due diligence, sector-level analysis, country and regional analysis, identifying outliers for further research, and for annual reporting. Annual reports can ether be for a set of investments made that year, forcasting future employment or for a whole portfolio's annual activities. European DFIs are currently working to build a joint version of this tool. This will enhance its usefulness, enabling benchmarking and learning among investors.

It is important to emphasize the following limitations inherent in the methodology:

a) Employment is driven by the total productivity of the business, deriving from capital, labour and residuals. DFI investment is one among many inputs to business growth and so the results should only be attributed to the individual businesses in their entireties.;

b) Business growth impacts on the inter-relationships between sectors within an economy (for example, through competitive changes and displacement), but our methodology is not dynamic and does not consider likely changes in employment intensity;

c) Supply chain impacts are calculated using sectoral averages. In reality, each business has a unique way of procuring its goods and services, and businesses backed by DFIs are likely to be atypical of their sectors (they may be more capital intensive, for example);

d) Other firm-level development impacts (e.g. from tax contributions, product innovations, foreign exchange savings from exports, knowledge spill-overs) are not accounted for, even though they likely create further employment impacts; and

e) The methodology is dependent on the quality of firm-level data and national statistics, both of which can be unreliable (Jerven, 2013). Getting reliable year-on-year headcount and financial data for hundreds of businesses is a challenging

process, particularly if they are held through intermediary private equity funds.

f) The methodology can estimate the proportion of jobs and livelihoods likely to be available to women, based on sectoral averages. But it does not otherwise give any indication as to whether the modelled jobs are likely to be good quality jobs as envisaged in global goal 8 on decent work and economic growth. To do so would require additional modelling based on wages and health and safety data, for example. For the indirect estimates, it should be borne in mind that the jobs are likely to be typical of prevailing labour standards in the relevant sectors and countries included.

Building on recent efforts to upgrade the tool, further research is still clearly necessary to test and if necessary change some of the assumptions in the job estimation tool. In the mean time we invite we invite critique and comment on the methodology.

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Appendix A: Data sources

Investment-related data are retrieved directly from CDC which in turn are collected either by the client or CDC itself, but macroeconomic data are retrieved from various public sources. See Appendix B for background information on the data used by the tool per indicator.

Source	Description
GTAP Data Base	The Global Trade Analysis Project (GTAP) is a global database describing bilateral trade patterns, production, consumption and intermediate use of commodities and services consisting of over 100 tables for individual countries or a group of countries and 57 sectors. The database uses input from a global network of institutes, researchers and policy makers conducting quantitative analysis of international policy issues. It is coordinated by the Center for Global Trade Analysis in Purdue University's Department of Agricultural Economics.
World Bank Development Indicators Databank	These are the primary World Bank collection of development indicators which are compiled from officially-recognised international sources. It presents the most current and accurate global development data available, and includes national, regional and global estimates.
National Statistics	Country-based statistical information is compiled and produced by National Statistical Offices and Central Banks.
IEA Energy Statistics	The International Energy Agency (IEA) coordinates a database with statistical information on energy production, consumption and prices across various regions and countries.

GTAP		
Data	**Base year**	**Input to**
Firms' domestic purchases (in mln USD)	2011	SAM
Household & government domestic purchases, exports (in mln USD)	2011	SAM
Firms' expenses on endowments (in mln USD)	2011	SAM, capital intensities
Corporate income tax, payroll tax, import duties, commodity tax, consumption tax, other taxes (in mln USD)	2011	SAM
Firms' imports (in mln USD)	2011	SAM
Total capital stock (in mln USD)	2011	Capital intensities

WORLD BANK DEVELOPMENT INDICATORS DATABANK		
Data	**Base year**	**Input to**
Gross fixed capital formation, private sector, per country (% of GDP)	2007-2011	Capital intensities

Gross fixed capital formation, per country (% of GDP)	2007-2011	Capital intensities
Electric power consumption, per country (in kWh)	2007-2013	Forward employment
Electric power transmission and distribution losses (% of output)	2007-2013	Forward employment
Total GDP , per country (in current USD)	2007-2013	Forward employment

IEA ENERGY STATISTICS

Data	Base year	Input to
Total electricity net consumption, per country (in bln kWh)	2010-2011	Forward employment

Appendix B: Definitions

Term	Definition
Capital-intensity	The amount of output per US $ 1 of capital.
Direct employment	Total FTEs at the investee business/end-beneficiary of CDC's investment.
Employment-intensity	The number of jobs per US $ 1 of output.
Forward employment	Jobs that are supported at direct consumers of electricity that can be related to CDC's investments.
Full-time equivalent (FTE)	The equivalent of one person working full time as defined by local laws.
GDP- intensity	The amount of output per US $ 1 of GDP.
Induced employment	Total FTEs related to the re-spending of salaries earned by employees of the CDC investee/end-beneficiary investee and its (in)direct suppliers that are related to CDC's investment.
Job multiplier	The number of jobs per US $ 1 million invested.
Jobs supported	Total number of jobs supported in a specific year.
Supply-chain employment	Total FTEs at the investee/end beneficiary's direct and indirect suppliers that are related to CDC's investments.
Total employment	Sum of all jobs related to CDC investment at a particular moment in time per annum. Expressed in full-time equivalent (FTE).

Appendix C: Assumptions

In order to have a consistent methodology, the tool uses a number of assumptions. However, to make it fit the full range of CDC's portfolio there also some exceptions required.

Assumptions	
Employment	1. Country-specific employment intensities are used for India, Kenya, Nigeria and South-Africa. For all other countries we make use of employment proxies specific to the region in which the country resides.
	2. Employment intensities differ per formal/informal investee type as the formal sector is considered to be 70% more productive than country average of the formal and the informal sector.[7] • Rule is applied to Manufacturing, Construction, Trade, Communication, Transport and Other services • Mining, utilities and financial and business services are considered to employ only formal jobs • Agriculture is considered to employ only informal jobs
	3. Formal SMEs are considered to generate 33% and formal corporates 67% of formal GDP. Distinction between SMEs and corporates based on output per employee.
	4. Formal SMEs are considered to employ 45% and formal corporates 55% of formal employment.
	5. CDC investees are considered to operate in the formal sector meaning the following intensities per round of impact: • Direct based on formal intensities per investee type (exc. Micros) • Indirect based on country average • Induced based on country average
Spending patterns	**6.** Micros/SMEs and corporates in the same sector and country/region have the same spending patterns.

[7] Source: *IFC SME Access to Finance in the Developing World*

Review report:

REVIEW OF CDC'S JOBS METHODOLOGY

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Table of contents:

Acknowledgements

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This second draft of the report has benefited from feedback from both CDC and Steward Redqueen on the first draft report.

Naturally, I take full responsibility for any errors or omissions, including any misunderstanding of information provided to me.

List of acronyms

CDC	CDC Group PLC
CGE	Computable General Equilibrium
FTE	full-time equivalent
GTAP	Global Trade Analysis Project
IO	input-output
SAM	Social Accounting Matrix
SR	Steward Redqueen
WIOD	World Input-Output Database

1 Introduction

1.1 Purpose and scope of review

Job creation is central to CDC's mandate. CDC invests in and supports a number of businesses in developing countries, specifically in South Asia and Africa. Given the important of employment creation to CDC, the employment impact of these investments is a key tent of CDC's work. In addition to the absolute number of jobs associated with these investments, CDC must also consider the quality of these jobs and the promotion of 'decent work'. This brings to the fore the importance of accurate measuring, and reporting, the employment impact of CDC's investments.

Since 2013, CDC has reported on the number of jobs that have been directly created through their investments. From 2014, CDC worked with consultancy firm Steward Redqueen (SR) to develop a methodology and model to estimate not only direct job creation arising from CDC's investments, but also indirect and induced job creation. This model is based on Social Accounting Matrices (SAMs) derived from the Global Trade Analysis Project (GTAP) database, combined with hard data obtained by CDC from hard data reported to CDC annually by the investee business.

Having applied this methodology for three continuous years, CDC is reviewing its approach with a view to assessing its value and ways in which it can better evaluate the employment impact of its investments.

Both CDC and SR are alive to the limitations of the model and methodology, and are aware of the strengths and weaknesses and with the trade-offs involved in the choice between alternative methodologies.[1] Rather than being defensive of the model, there appears to be a strong desire to find the optimal way of measuring CDC's employment impact, whether this be through enhancing the current model or finding a more suitable alternative.

[1] See for example MacGillivray, Kim, Van Moorsel and Kehoe (2017).

The starting point of this assessment is that there is no 'best model' or 'ideal model'. The most technically sophisticated model might garner interest in the pages of academic journals, but may be inappropriate for practical application to projects such as CDC's. Different models can be more or less suited to particular objectives and circumstances, including data availability and the costs and feasibility of developing and utilising the model. The objective should therefore be to find the approach that is fit for purpose for CDC's own particular needs.[2]

1.2 Methodology of this review

This review was commissioned to take place over a defined period of time and number of days work, as a desktop review.

A set of documents was provided to the reviewer by CDC, as listed in the reference at the end of this report. Materials provided by CDC include the interactive toolkit, which is structured as two excel spreadsheets (an 'ex-ante interface' for assessing the employment impact of potential investments, and an 'ex-post interface' for assessing the employment impact of current investments).

In addition, there were formal and informal discussions with key CDC staff concerning the employment impact methodology. A teleconference was also held with René Kim and Tias van Moorsel of SR.

1.3 Structure of the report

Section 2 identifies and discusses various aspects of the CDC model. This discussion implicitly weighs up strengths and weaknesses of the current methodology, and discusses possible improvements. The following issues are discussed here: whether a more sophisticated model

[2] This is explored further in section 2.1.

should be utilised; the purpose and usage of the model; how jobs are attributed to CDC; the verification of model outputs through case studies; the degree of sectoral disaggregation in the model; two aspects of source data (updating to more recent data, and consideration of data sources other than GTAP); assessing the employment impact of forward linkages and enabling investments; extending the model to disaggregate jobs by worker characteristics and job type; accounting for part-time work; reviewing the institutional home for the model; and other miscellaneous issues.

Section 3 summarises the recommendations emerging from section 2. These recommendations are listed in the following categories: overall model; improvements and extensions to the model; interpretation and use of the model; institutional issues; and other miscellaneous recommendations.

2 Assessment of CDC model: issues for consideration

2.1 Adopt a more sophisticated model?

A balance must be consciously maintained between, on the one hand, utilising a rigorous, accurate and credible methodology, and on the other hand, not over-investing excessively in a model that is more sophisticated than necessary. For those involved in modelling or using its outputs, it can be tempting to get carried away in upgrading to increasingly sophisticated models, in the hope of addressing the limitations of a simpler model. While improvements in impact evaluation are of course positive, it must always be borne in mind that for an organisation such as CDC the jobs model is a tool, and not a goal in itself.

Furthermore, while impact evaluation is undoubtedly of crucial importance for CDC and must be done rigorously, resources spent on impact evaluation ultimately come from the same source as funds for investment. Impact evaluation must thus serve to improve the effectiveness of that investment, and give CDC's stakeholders and the public at large an

accurate account of CDC's employment creation impact, while using as little resources as is reasonably possible.

Put succinctly, a jobs model for an organisation such as CDC must be *fit for purpose*. It must be rigorous, credible and as precise as possible, giving valid estimates of both the likely employment impact of any investment options as well as the likely magnitude of jobs associated with any investment *ex post*.

The standard limitations of input-output (IO) and SAM modelling are well known (see for example Tregenna, 2008). CDC is well aware of these (see MacGillivray *et al*, 2017). The chief drawbacks can be briefly summarised as follows:

- An assumption of no changes in returns to scale – i.e. an assumption that expanding production in one sector would need a proportionate increase in inputs from other sectors;
- Technical coefficients of production are fixed over time;
- Price changes are not modelled;
- Macroeconomic dynamics are not explicitly modelled;
- The models are generally static[3];
- Usually assume that there are no supply or capacity constraints;
- Accuracy of estimates declines, the larger the scale of the change and the longer the time horizon.

These limitations need to be weighed up against the advantages of the methodology for the purpose for which CDC needs to use the model. CDC has correctly characterised the current model as a 'lean data methodology'.

It does not have overly demanding data requirements, with the necessary data inputs being available at low cost. The outputs of the model are easy to understand and communicate. This is important in an environment where the model needs to be practically applied and the

[3] With exceptions such as the International Labour Organisation (ILO)'s DySAM model; see Alarcón, Ernst, Khondker and Sharma (2011).

results communicated to non-specialist audiences. It is relatively low-cost and, once set up, is not difficult to maintain and to run. It does not rely on a range of assumptions and model closures, which can be subjective and can undermine both the accuracy of the model and of confidence in its outputs.

In addition, certain of the limitations and inaccuracies associated with SAM modelling can balance out when applied to a large number of investments. There is likely to be greater accuracy when looking at aggregate results across CDC's investments, than for individual investments.

Broadly speaking, a methodology such as the one that CDC is currently using seems appropriate for its intended purposes. Alternative approaches such as a macro-econometric model, Randomised Control Trials or attempted direct measurement through ongoing case studies have more drawbacks than advantages for the purposes at hand.

If there is appetite for a more sophisticated model, consideration could be given to developing a CGE model, as an extension of the current model. A CGE model can be seen as more theoretically grounded and more complete that an IO or SAM model. It allows for the modelling of additional dynamics and channels, including macroeconomic effects. A CGE model is also inherently more dynamic. However, it has concomitant drawbacks, including: more extensive data requirements; higher levels of technical skills are needed to develop and run the model and to understand its results; the model is less transparent; and outputs are sensitive to assumptions and choice of model closures. There would also be additional cost implications for CDC.

In my view, CDC would be well served by an augmented and improved form of the current model and methodology. Various suggestions are put forward below, which seek to strengthen and enhance the current model. However, should CDC wish to upgrade to a more advanced and complete model, the obvious next level would be a CGE model.

2.2 Purpose and deployment of the model

The current model seems to have two primary objectives and uses: *ex ante* assessment of possible employment impact as an input into investment decisions; and *ex post* evaluation of possible employment impact. In practice, CDC seems to utilise it more for the second of these than the first. It could be useful for CDC to reflect on the central purpose/s for which it wishes to use the model. This could help in informing what the priorities are for the model going forward. For example, what is the necessary degree of sectoral disaggregation.

Like all similar organisations, CDC is understandably expected to demonstrate value for money, of its own investments and of public funds put into CDC itself. Part of this is demonstrating the number of jobs created across countries from CDC's investments. The employment impacts estimated through the model become part of the reporting on CDC's achievements.

Those people interacting with the model are sensitive to its limitations and to the caveats of any results obtained through it. However, it is easy for these nuances and cautions to be lost at higher levels of reporting. Insofar as possible, it is important to always avoid claims around actual numbers of jobs created by CDC (unless limited to direct job creation attributable to CDC's own investment). In line with CDC's current reporting practice, it is important to consistently present job numbers as 'estimates' rather than as actual numbers or as results, as well as to separately report direct, indirect and induced jobs. It is important for CDC's stakeholders to appreciate the relevant caveats, so that these nuances are not lost in the policy domain or in public discourse.

2.3 Attribution of jobs to CDC

A related issue is the calculation, interpretation and communication of 'attributed' jobs. With equity investments, this is calculated according to CDC's share of total capital (percentage of equity capital, indicating CDC's equity stake in the company). With debt investments, the

attribution of jobs is based on CDC's contribution to the company's total balance sheet (the debt that CDC provided as a percentage of the company's total balance sheet).

Needless to say, these are imperfect measures of CDC's total contribution, and may underestimate the extent of CDC's role. CDC's contribution to a firm and hence to its overall employment impact typically also includes a range of non-financial contributions, including the provision of strategic and technical advice to a business and the mobilisation of third party capital. Furthermore, there may be economies of scale or indivisibility of capital investments, such that a given percentage investment could arguably be associated with a higher percentage of a firm's total jobs and wider indirect and induced employment impact. These considerations suggest that CDC's total impact on employment would in all probability exceed its simple proportionate financial contribution. Furthermore, the exact contribution of CDC to a firm's employment creation is difficult to calculate precisely in practice.

According to SR, while the model generates estimates of attributed jobs, CDC generally reports total jobs rather than just the attributed portion. This would undoubtedly lead to an overestimation of the number of jobs associated with any CDC investment. Even if attributed jobs underestimate CDC's job impact, CDC's real contribution would still be less than the total number of jobs. It thus seems inappropriate to report total jobs, as though none of those jobs would have been there in the absence of CDC's investment.

If there is a clear basis for believing that straightforward attribution of jobs according the current simple formulae do not represent the totality of CDC's contributions and hence underestimate CDC's job impact, then a better way needs to be found for estimating attributed jobs.

To be manageable in a model without overly complicating things, this would necessarily be some crude measure, such as a parameter for quantifying CDC's wider contribution to a firm. For example, CDC may have contributed 30% of a firm's total capital, but assign an additional 10% 'other contribution' based on non-financial support. Even if crude and subjective, this would at least give some basis for arriving at a reasonable estimate of attributed jobs. It would then be preferable to report these jobs, and not total jobs, with appropriate caveats and

careful interpretation around the additional imputed portion of attributable jobs (i.e. the portion in excess of that directly associated with CDC's own financial contribution).

Another aspect of the interpretation and use of estimates from the model is that the degree of precision tends to be lost in the public domain and job estimates are interpreted as though they are exact. An extension to the model could produce confidence intervals (or similar) for the model's employment estimates. It would be most practical if these conveyed a range in terms of likely number of jobs. This would also encourage caution in the reporting and interpretation of results. The extent to which such an extension to the model is technically feasible (and any cost implications associated with greater technical complexity) would need to be evaluated.

2.4 Calibration and verification of model outputs through case studies

A key purpose of the model is to obtain employment impact numbers without actually having to track the real job impact for each project, which would certainly not be feasible. However, it is important to verify the model outputs against actual impact. If the model consistently generates inaccurate estimates of employment impact, it would be crucial to know this, and to recalibrate the model accordingly.

It would thus be helpful to undertake a select number of micro case studies, studying supply chains and associated job creation in a small number of projects. Practically, it would not be feasible to follow these supply chains throughout the economy, but an indicative analysis could be feasible. If the employment impact indicated through these case studies differs significantly from estimates from the model, then CDC would need to understand the source of the difference, and assess how to adjust the model parameters accordingly.

This could be quite a demanding and costly exercise. This would depend *inter alia* on the sample of investments selected for these case studies, frequency of these reviews, and how thoroughly and rigorously the case studies are carried out. If it is to be undertaken, CDC may wish to consider what other information and insights could be obtained through the same

exercise, so that it is more worthwhile. For example, information on labour standards, impact on poverty, or other issues of interest.

2.5 Degree of sectoral disaggregation

The current model allows for the calculation of intersectoral linkages for 57 sectors, which are then aggregated to 16 sectors for the application of employment/output ratios in order to calculate sectoral employment multipliers. Sixteen sectors is quite a high level of aggregation, which significantly limits the precision of the model for the practical purposes for which it is intended.

There would be considerable heterogeneity in the degree of labour-intensity within each of these 16 sectors. This means that the model may over(under)-estimate employment outcomes for projects in subsectors that are less (more) labour-intensive than the average for the sector in which they are classified. From this perspective, a greater degree of disaggregation at the stage of calculating employment multipliers would be desirable, and would improve the accuracy and precision of the model.

Countries' labour force surveys microdata may support the calculation of employment/output ratios at a higher level of disaggregation than published labour force statistics. For example, a country's national statistical agency might publish labour force statistics at the two-digit industry level, while the survey microdata allows for a three-digit disaggregation. In such cases, if there is an appetite for a greater degree of sectoral disaggregation, then it could be worthwhile utilising labour survey microdata to calculate this directly.

Linked to the issue of the degree of sectoral disaggregation, as well as to that of which source of data to use, is *whether there need be consistency in the structure of the model across countries*. If the intention were to compare (whether *ex ante* or *ex post*) the employment impact of a given quantum of investment across countries, it would be important to have a consistent sectoral structure across countries. However, this does not appear to be an

important objective in CDC's use of the model. The requirement of a standardised structure reduces the level of sectoral disaggregation by imposing on all countries the level of disaggregation available in all cases, whereas some would have a higher degree of disaggregation. A limitation of a non-standardised structure across countries would be that it would complication the aggregation across countries by sector.

An advantage of the standardised structure across countries is the 'neatness' and parsimony of the model and associated toolkit. If different countries were to have different sectoral structures and degrees of disaggregation, this would mean for example that the options for 'sector' in the toolkit would vary depending on country. Furthermore, although such an approach would not be technically difficult in developing the model, it would entail more work as there would be variation in the size of the matrices across countries.

Whether to stick with consistency in sectoral structure and level of disaggregation across countries, or to allow for variation, depends in part on the priorities in using the model, in particular whether there is value in precise cross-country comparisons. My view is that the value of the model would be considerably enhanced by having greater sectoral disaggregation. If this can be accomplished while retaining consistency across countries, that would be ideal. If not, consideration could be given to a varied structure across countries, despite the drawbacks of this.

If variation across countries is unavoidable, then this could be minimised by having just a few sectoral structures into which all countries would fit, rather than each country having its own. For example, there could be three sectoral structures based on the degree of disaggregation. This would at least allow for some comparisons across countries in the same group, and would make the model neater and more computationally streamlined than having country-specific structures.

2.6 Source data

Updating with more recent source data

SR has indicated that the source IO data for the model is from 2011, although they do use newer IO tables by country where available. Furthermore, even where the IO data is from 2011, where possible this is combined with more recent employment/output ratios, in order to make the results more current.

Still, the use of 2011 IO tables do make the model somewhat dated, reducing its accuracy. Especially in developing countries, economic structure can change significantly. Among other things, changes in technical coefficients (the structure of forward and backward linkages in an economy) would both affect calculations of the employment of any investment. This would make it important to update the model periodically. At the same time, too frequent updates would mean working with a 'moving target', making planning difficult for CDC and affecting the consistency and comparability of reported employment impact across years.

Going forward, if updates and extensions are to be made to the model, this could also be a good time to update the source data. A useful exercise could be testing how sensitive results are to just this updating, which could give some sense of whether and to what extent this updating makes a difference to results. In general, it would probably be advisable to update source data every five years or so, and certainly not to go longer than ten years without updating.

Consideration of alternative sources of IO data

The model currently uses IO data from the GTAP database. This is a valuable and credible source of IO data. Part of its value lies in its wide country coverage, including of developing countries. This is essential for CDC given the concentration of CDC investments in low-income and some middle-income countries for which data is less readily available. The standardised structure available from GTAP is also appealing for CDC's purposes.

The quality, coverage and availability of IO data internationally has grown considerably in recent years. Apart from GTAP, two other prominent databases with wide international coverage are the World Input-Output Database (WIOD)[4] and the Eora database[5]. The limited country coverage of the WIOD (mainly advanced countries, with others combined as 'rest of the world') precludes it from use for CDC's model at present.

At this point there is no specific recommendation of a data source that would represent a worthwhile improvement on GTAP. However, it is worth periodically assessing whether there are benefits to changing to an alternative data source, especially as country coverage and degree of sectoral disaggregation improves.

2.7 Employment impact of forward linkages and enabling investments

Power supply

The standard methodology for calculating employment multipliers combines a sector's backward linkages with data on the employment intensity of each sector. This standard approach is applied in the CDC model. An exception is CDC's investment in power projects, where the forward effects of increasing power supply on production and employment are also modelled. The growth and hence the employment impact of power investments are projected to come through two main channels: mitigating outages, and reducing the costs of power. Power supply projects are the most prominent among CDC's infrastructure-related investments.

The modelling of the employment impact of power supply seems to be quite imprecise, although it has become more nuanced over time. A study commissioned by CDC from SR for the case of Uganda (Steward Redqueen, 2016) suggested that GDP could increase by 0.06 percent for every one percentage point increase in power supply. Studies have since been

[4] http://www.wiod.org/home
[5] http://www.worldmrio.com/

undertaken for other countries, yielding estimated coefficients generally ranging between 0.03 and 0.13. In applying these coefficients to estimate the impact of power investments in other countries, countries are classified into categories based on three key variables, and interpolation is used in identifying which coefficient to apply. Inaccuracies in these coefficients will bring significant inaccuracies in estimated employment impact.

It would be advisable to improve the methodology for estimating the employment impact of power supply investments. Options for consideration could include: commissioning additional case studies from different country circumstances and different types of power supply projects; utilising other coefficients from the extant literature; and calculating and reporting the employment impact of power supply investments as a range (preferably associated with an explicit confidence interval) rather than as a single specific number of jobs.

Other forward linkages

Moreover, consideration could be given to whether any other types of CDC investments are also likely to generate significant employment through forward linkages. This is most likely in cases where there the project unlocks a supply constraint that had been limiting downstream production. Apart from the case of power supply, this could be the case in other types of infrastructure projects. IO analysis is generally not a good tool for modelling employment impact through forward linkages.

Projects, especially large-scale projects, would need to be examined on a case-by-case basis to ascertain whether these effects are likely to be significant and whether they are worth modelling. If they are significant and are not modelled, this could lead to an underestimation of the employment impact of these sort of investments.

2.8 Analysis of employment impact by job and worker characteristics

There is considerable heterogeneity across employment. This heterogeneity is both in terms of characteristics of the *job* (by job quality, location etc. as well as by sector) and also by the

characteristics of the *person/worker* occupying a particular job. Clearly, the main interest of CDC in measuring employment impact of investments lies in the number of jobs. However, the more the information available about both relevant job and worker characteristics, the greater the information about the overall impact of investments, as well as the greater the information available to feed into forward-looking investment decisions. This is also important in terms of assessing the overall welfare and developmental impact of CDC's investments.

Information is currently available in the CDC model on the composition of employment by sex, with the model able to produce separate measures of female and male employment. If of interest to CDC, the model could be extended to provide information of additional dimensions in terms of both job and worker characteristics.

In terms of job characteristics, of particular interest to CDC may be: whether a job is formal or informal; spatial location within a country; and some rough measure of job quality ('decent work').

In terms of formality, all CDC investments are in the formal sector, with the procurement chain including both formal and informal enterprises. The IO tables include the informal sector. Sourcing data on the proportion of jobs that are formal/informal by sector, from countries' labour force surveys, would allow for separate estimates of formal and informal employment impact by sector.

Job quality is not easy to measure, but is important, especially in light of DFID's emphasis on the promotion of decent work. For practical purposes, decent work would need to be proxied by a small number of indicators. There is also a link between formal/informal categories and decent work; although they are obviously not the same and cannot be conflated, if it is not feasible to utilise a proxy indicator of job quality or decent work then the formal/informal distinction can be considered as an (imperfect) proxy. If the proxy of decent work is too poor, however, then it may be better to avoid such reporting at all, to avoid misleading policy implications being drawn.

Technically, the easiest way of producing estimates of 'decent employment impact' with the current model, would be to use a simple measure such as value added per job, assuming a correlation between job quality and value added per job. This is already implicit in the model and could readily be extracted and presented. However, it is a highly imperfect measure, and if used, the interpretation would need to be carefully qualified.

Furthermore, there needs to be awareness of any potential trade-offs between targeting decent jobs and maximising the employment of those who are least skilled and more likely to be employed in low-quality jobs. This suggests that any measure of job quality should be in terms of basic levels of decent work that it would be desirable to have applied to all jobs, rather than measures such as wages. This would be technically more complex than using the measure of value added per worker, as it would entail extracting some suitable measure of 'decent jobs' from national labour force surveys by sector.

In terms of worker characteristics, of particular interest may be: age (not as a continuum but perhaps as youth/non-youth); and race/ethnicity in specific country circumstances where this could be relevant. These are in addition to the dimension of sex, which is already in the model and allows for the separate analysis of the impact on female and male employment.

The current model and methodology does not allow for this to be accurately measured on an individual project basis, which would require detailed information on job and worker characteristics in supply chains, which is not feasible. However, it can be reasonably estimated in the following way.

Countries' labour survey microdata can be used to calculate the relevant ratios by sector (e.g. what percentage of jobs are formal/informal, what percentage of workers are below a certain age threshold, etc., in each economic sector used in the model). This can be used to calculate, for example, a 'youth employment multiplier', a 'formal jobs employment multiplier', etc., in addition to the overall employment multiplier.

It would be computationally simple to produce estimations of such outcomes extending the same methodology as is currently used for overall employment estimations. Obtaining the

initial ratios from country labour force data would entail some work. Thereafter, there would be little additional time/cost involved in generating these disaggregated projections.

The same limitations and caveats would apply to these more disaggregated estimations. In addition, they should probably be interpreted with even greater caution, as precision is compromised the greater the degree of disaggregation.

2.9 Accounting for part-time work

In the national employment statistics upon which the model draws, employment is generally defined in terms of any work during the relevant period (e.g. two hours of work during the two weeks preceding the survey interview), not full-time work. This means that any projections as to the number of jobs 'created' from any intervention, actually indicate any sort of employment or income-generating activities, not necessarily full-time jobs.

This inevitably leads to an overestimation of employment impact if the jobs numbers are interpreted as 'jobs', and even more so if they are implicitly understood to refer to full-time jobs. Furthermore, this potential overestimation will be uneven between sectors and between countries, given the uneven prevalence of part-time work.

In contexts where part-time work is not especially prevalent, this problem would naturally be less pronounced. In low-income countries in which the majority of CDC investments take place, hours in the formal sector would typically be longer than in advanced economies, and part-time work less prevalent. Part-time work is however likely to be prevalent in the informal sector in particular. The issue of part-time work affects both absolute estimates of job creation, and sectoral multipliers and hence the comparison of employment impact across sectors.

The hard data numbers on direct job creation that CDC obtains from its investees, are considered and reported in terms of 'full-time equivalent' (FTE) jobs. However, the outputs of the model are not in FTE terms. That is, of the number of indirect and induced jobs

calculated through the model and reported by CDC as jobs created, these could include 'jobs' in which a person is working just an hour a week.

It would be preferable to have an indication of FTE jobs in the model. It would not be possible to accurately measure this on an individual project basis directly with the sort of model currently being used. However, it would be possible to produce reasonable estimations of this, in a similar way as for the analysis of job and employment characteristics as discussed in section 2.8 above.

That is, a parameter would be calculated for each sector for the conversion of 'number of jobs' to FTE jobs. This would be based on average hours worked in each sector (country labour force surveys generally include questions that give an indication of hours worked). This would allow for the calculation of a FTE employment multiplier, and for the reporting of FTE employment impact.

2.10 Institutional home and management of the model

Going forward, consideration should be given to the optimal institutional home and arrangements for the model. The present arrangement utilises the specialised technical expertise of SR, which is not currently available in-house at CDC. An alternative would be to house the model at CDC, beef up CDC's internal capacity, and draw on external expertise as needed.

CDC itself is probably best placed to assess the optimal institutional arrangement. Here, I offer four comments on this issue, for further consideration.

A key advantage of the current arrangement is that SR has specialised technical capacity in developing and maintaining the model and in generating outputs from it based on inputs provided by CDC. The cost-effectiveness of bringing the relevant capacity in-house at CDC would need to be carefully assessed. It may be possible to upskill a few staff members at CDC to at least maintain and run the model on an ongoing basis.

A further important advantage of the current arrangement is that the outsourcing of the model provides some distance from CDC. This can accord the model, and the estimates arising from it, a level of credibility. This is important in the estimates from the model being perceived as reliable and not being 'cooked' internally at CDC. Should the model be in-sourced, it would be essential to build in mechanisms to ensure that the integrity of the model is preserved, as well as being perceived as credible. Options for consideration in this regard could include: SR (or another external agency) maintaining some role, and an ongoing or periodic expert- or peer-review or oversight mechanism.

A secondary issue related to the institutional home and management of the model, is that the toolkit has become increasingly complex and unwieldy over time. Various add-ons have been incorporated at different points in time, rendering the model less streamlined and more opaque. This also makes it less accessible, including to CDC itself.

Another aspect for consideration is the extent to which the current arrangement makes at least parts of the model a 'black box' for CDC. It does not seem to be entirely satisfactory to have the inner workings of the model to some extent closed off to CDC's own understanding and adjustment.

A related issue is the extent to which the model should be transparent and open to stakeholders and possibly to the public as well. This could be either the toolkit version (keeping the inner workings of the model as a black box), or even opening up the model itself. For instance, a user interface of the model (online dashboard) could be made available through the CDC website, perhaps with user registration. Users would be able to generate results, without being able to access the inner workings of the model. Greater transparency can potentially give the model greater credibility, although it does also open up its limitations to scrutiny.

Opening up the model itself could lead to it (or a version thereof) being used by other organisations, even on a for-profit basis. This could be seen as a 'loss' in CDC's intellectual property and investment in the model, or as a sort of public service.

This is ultimately a decision for CDC, guided by financial and other considerations. I would only venture to offer a broad suggestion that it seems desirable for CDC to at the least have greater access to the inner workings of the model, greater intellectual property over it, and perhaps to shift some of the ongoing maintenance and utilisation of the model in-house while retaining a role for SR (or another agency) in extending or adjusting the model periodically and exercising some audit/oversight role.

2.11 Other issues

Below are some remarks on two additional issues not covered elsewhere in this report.

Sustainability of jobs

For CDC investments to have a long-term impact on people's welfare and on development in target countries, jobs must ideally be sustainable. The model measures net employment impact as the difference between jobs in the current and the previous year, so comparing 'snapshots' between two years. I comment here on three potential implications of this method of quantifying job creation, related to the sustainability of jobs.

Firstly, the model calculates employment impact as being lower where a given quantum of funding remains in an existing investment versus being placed in a new investment. In the case of a new investment, the entire employment impact associated with the full value of the investment is reported. Where funds remain in the same investment year-on-year, only growth related employment impact is reported. As a result of this way of reporting, estimated employment impact would be higher the more quickly funds are moved around between firms.[6] In practice, there is no indication or suggestion here that this affects CDC investment

[6] Consider a situation where CDC has capital invested in firm A in year 1. In the first scenario, leaving the same capital invested in firm A in year 2 would yield only minimal reported job gains when comparing year 1 and year 2. However, in a second scenario, should the funds be withdrawn from firm A and instead invested in firm B, all associated jobs in firm B would be counted as new jobs. The second scenario would yield higher reported employment impact, yet with the same quantum of CDC funds in both scenarios.

decisions, and CDC decisions are generally made for the medium- to long-term. This is just something to be aware of in the interpretation and reporting of employment impact.

Secondly, any job losses associated with the withdrawal of CDC investments are not explicitly measured or reported. When CDC funds are withdrawn from a firm, positive job creation from that firm is no longer reported, but no job losses are counted. It is unclear *a priori* whether the withdrawal of CDC funds would in practice have any negative impact on the firm's production and employment levels. This may be influenced in part by the mode of withdrawal and the source of replacement for CDC's capital, typically the sale of equity to another shareholder or the repayment of the firm's debt to CDC. The impact of the associated withdrawal of CDC's non-financial inputs is also likely to vary by circumstance. Ideally, firms that have benefitted from CDC investments should become increasingly robust and sustainable over time. It might be helpful to consider undertaking a few case studies in instances of withdrawal of CDC funds, to ascertain the extent of any associated job losses and whether jobs are sustained after the period of CDC's investment.

Thirdly, the current model assumes that there is no displacement of existing jobs due to CDC investments in competing firms. CDC investments in a firm may to some extent substitute production and jobs in a competing firm in the same line of business. This sort of implicit assumption is typical in the analysis of employment impact, and it would be challenging but possible to model any negative impact of CDC investments on competing firms. Naturally, the hope would be that there would be no or minimal such negative impacts, such that increases in production levels in CDC-invested firms could meet expanded domestic or international demand rather than displacing production from competing firms. It is conceivable that increased production in CDC-invested firms could even contribute positively to the production of other firms in the sector (beyond the impact through supply chains modelled through IO analysis), for instance through sector-wide economies of scale, learning-by-doing and benefits of industrial agglomeration. This is something that CDC should continue taking into account, both when planning and reporting on investments. Furthermore, should a dynamic CGE model be introduced in future, potential displacement of existing jobs could be factored in to the model.

Publish a research paper on the model and its application in a peer-reviewed journal

A research paper discussing the model has already been produced (MacGillivray *et al*, 2017). It would be worthwhile to draw on this and other analysis and to prepare a research paper to be submitted to a peer-reviewed journal. Such a paper could explain the model being used, discuss its practical application and policy implications, and offer a critical appraisal of the model's strengths and weaknesses.

To be of interest to a research-oriented readership, it should include some original contribution to the literature and to knowledge. If well executed, such a paper could be of interest to both academic and policy audiences. It could be targeted at a journal such as *Development Policy Review*, *Journal of International Development*, or other journals with an interest in applied issues of international development.

One advantage of this is that, through journals' peer-review system, CDC is able to obtain some critical expert feedback at no cost. More importantly, publication of the research can disseminate knowledge about CDC's model and wider work amongst both academics and practitioners. This can raise the profile of the CDC model and work. It could also be of value to other organisations doing similar work internationally.

3 Summary of recommendations

This section presents recommendations in a summary form, and should be read in conjunction with section 2. In each case, the relevant part of section 2 is indicated in square brackets for ease of reference.

3.1 Overall model

- Retain the current methodology but improve and augment it. [see 2.1]

- Should CDC wish to utilise a more advanced model in future, consider CGE. [see 2.1]

3.2 Improvements and extensions to the model

- Improve the methodology around the attribution of jobs to CDC. [see 2.3]
- Investigate the feasibility of augmenting the model to produce confidence intervals for jobs estimates. [see 2.3]
- Periodic verification and benchmarking of the model through a select number of targeted micro case studies. [see 2.4]
- Adopt a more disaggregated sectoral structure in the calculation of employment impact (i.e. calculate employment multipliers using a higher number of sectors). [see 2.5]
- Update the model with more recent source data. [see 2.6]
- Periodic consideration of whether there are superior sources of IO data, especially in terms of country coverage and degree of sectoral disaggregation. [see 2.6]
- Improve the methodology for estimating the forward employment impact of power supply investments. [see 2.7]
- Consider modelling the employment impact of forward linkages where relevant, especially for large infrastructural projects. [see 2.7]
- Extend the model to disaggregate employment impact by job type (such as formal/informal) and worker characteristics (such as youth/non-youth). [see 2.8]
- Extend the model to account for part-time work, by estimating the number of full-time equivalent (FTE) jobs. [see 2.9]

3.3 Interpretation and use of the model

When CDC's employment impact is reported in the public domain:

- Ensure that (in line with CDC current practice) jobs are consistently reported as *estimated* jobs, not as results or actual jobs. [see 2.2]
- Insofar as possible, reporting of employment impact should consistently be nuanced with the relevant caveats. [see 2.2]

- Where relevant and possible, a distinction should continue to be explicitly made between direct, indirect and induced jobs. [see 2.2]
- Improve the accuracy of reporting of jobs attributable to CDC. [see 2.3]
- If confidence intervals for jobs estimates can be calculated, then either these should be reported alongside jobs estimates, or jobs estimates should be reported in a manner that takes these confidence intervals into account. [see 2.3]

3.4 Institutional issues

- CDC to give consideration to the optimal institutional arrangement for housing the model and whether to (partially) in-source it. [see 2.10]
- CDC to consider whether to open up the model, or at least parts of it, in the public domain. [see 2.10]

3.5 Other

- Submit a research paper on the model and its application to a peer-reviewed journal. [see 2.11]

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Other sources:

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Review of CDC's jobs methodology, with particular reference to jobs created by financial institutions

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Executive summary

- Empirical evidence at the macro level (subject to some caveats about econometric specifications) points towards a causal link from finance to economic development, with, for example, the size of the banking sector a robust predictor of GDP per capita (across countries). The link seems to be stronger in low- to middle-income countries, perhaps because credit constraints are more pervasive and financial intermediation less so than in the OECD.
- However, the evidence does not all point in the same direction. The growth of a financial sector can divert resources to less productive rent-seeking activities and divert skilled workers to less productive firms. It may also increase the risk of financial crises with major real-side effects.
- The beneficial impact of financial deepening on growth appears to work more through improved resource allocation, accumulation of knowledge and productivity growth than through additional capital accumulation.
- The expansion of output in response to increases in lending may not lead to an increase in net employment. Increases in gross employment in the firms that grow and become more efficient may be offset by falls in gross employment in less successful firms.
- Despite the rigour of microeconomic studies utilising 'natural experiments,' they are not necessarily the most useful tool for estimating the aggregate impacts on output or employment of an extension of credit.
- The economics literature suggests that there is broad support from high-quality micro studies and more macro evidence for CDC's underlying thesis about the role of finance in promoting productivity and output growth. Its role in net job creation is more ambiguous, depending on the characteristics of entering and exiting firms and on the macroeconomic environment.
- The extended input-output (I-O) approach – or Social Accounting matrix (SAM) approach – adopted in CDC's jobs tool-kit is one of several different approaches that can be used to estimate job creation stimulated by new projects.
- Case studies may provide more accurate estimates of direct job creation, but estimates can vary a lot in practice. Random control trials are more rigorous but difficult to set up. They are not very useful in estimating aggregate impacts on output and employment because lending may affect the macro environment (e.g. through wage levels) in which both 'treated' and 'non-treated' firms operate.
- The number of jobs created by an increase in lending in a country depends on *both* the link from increased lending to changes in the behaviour of individual firms *and* the way in which the macro economy responds, through changes in factor and product prices, imports, productivity and other macro variables. Computable general equilibrium (CGE) models and I-O/SAM models both face up to this problem of macroeconomic responses to increased lending. CGE models can incorporate I-O production structures but require more calibration of behavioural relationships and may surreptitiously introduce contested views about how an economy works.
- The I-O/SAM approach adopted by CDC is coherent, relatively economical in its demands on data and widely used. It embodies a simple, Keynesian demand-driven view of how economies work and hence is not ideal for studying the impact of supply constraints affecting credit (or labour supply, foreign currency and other constraints that may bind

in the countries in which CDC lends). In particular, the implicit assumption of a perfectly elastic supply of labour to firms is problematic.

- Given the need for a 'lean data' approach, low costs and the desirability of having a standard tool-kit for producing estimates (rather than a succession of ad hoc estimates), CDC's choice of an extended I-O approach using SAMs is understandable. No other 'off-the-peg' method looks obviously more attractive. Nevertheless, there are some problems with this approach:
  - First, studying a supply constraint – the supply of credit to firms – through the lens of an I-O/SAM model, which intrinsically focuses on the impact of exogenous changes in demand, is problematic.
  - Second, the way in which SAMs are used in the CDC method for different years does not appear to be equivalent to the standard textbook approach to estimating the impact of a supply constraint in a particular industry.
  - Third, in the real world, several of the assumptions behind I-O/SAM models may be invalid. As a result, the CDC 'employment effect' estimates are likely to exaggerate the likely net employment impact of relaxing firm-level borrowing constraints.
- The CDC method might usefully be tweaked.
  - One possibility would be to focus on the direct and indirect 'supply-chain' job numbers, which are less uncertain than the estimates of the induced employment effects, but to report each category separately.
  - A more challenging alternative would be to utilise the technique sometimes used in I-O/SAM-style models to deal with absolute sectoral supply constraints that are thought to kick in when a particular output threshold is reached.
  - It may also be possible to draw on (i) relevant micro studies and (ii) country-specific macroeconomic/labour market knowledge to cross-check the job creation estimates from the CDC method. In particular, it would be a useful robustness check if, for a small number of countries, a CGE model calibrated to specifics of the country in question could be used for cross-checking. Also, varying the assumption about how new lending affects a firm's choice of capital-labour ratio would be another helpful robustness check.
  - Regardless of what changes are made to the methodological approach, careful use of language in describing the job creation estimates is warranted and spurious precision in reporting job creation numbers should be avoided.

1. The remit of the review

This review focuses on the inputs, assumptions, model design and overall analytical framework of the methodology used by CDC to estimate the number of indirect jobs supported by financial institutions. The approach is considered in the context of the broader jobs methodology laid out in MacGillivray et al (2017), given the need for the different elements in the latter to be consistent with each other. The ultimate objective of this review is to help CDC interrogate the evidence on economy-wide employment effects of loans from financial institutions in Africa and South Asia, given CDC's lending to such institutions.

In essence, the jobs created by financial institutions in CDC's portfolio are estimated as the sum of the following components:

i. Direct employment in the financial institutions;
ii. Indirect employment in the firms supplying financial institutions with inputs, calculated from an input-output (I-O) table;
iii. Employment induced by the spending of wages paid out by the financial institutions, calculated by using a social accounting matrix (incorporating the same input-output table but also reporting how incomes are earned and spent);
iv. Employment created by the lending of the financial institutions to firms in other sectors, permitting those firms to make larger capital investments and thereby create jobs, directly, indirectly through their supply chains and indirectly through spending by their workers in the rest of the economy.

An assessment of the approach for estimating the number of jobs created by financial institutions indirectly must consider the robustness of the supply chain method (ii), the calculation of second-round (and possibly further) induced employment effects from spending wages (iii) and the projection of the employment effects of financial institutions' lending (iv).

However, before those components of the specific CDC approach are considered in more detail, this report covers two more general issues.

First, it considers briefly some of the broader evidence that financial institutions have a special role in economic development because of their ability to relax binding constraints on lending for productive activity. This is important because the estimates obtained by CDC via component (iv) are large relative to the input-output-based components (i), (ii) and (iii) (nearly 50 times bigger in the example of DFCU Ltd. In Uganda, according to CDC's consultants Steward Redqueen). Component (iv) grafts a particular theory of economic growth on to the more common I-O approach in the jobs literature (which simply adds up components (i), (ii) and sometimes (iii)).[1] The I-O approach in contrast combines a particular accounting framework that is agnostic about the sources of growth with an – often implicit – assumption that growth is driven by the level of demand and the industrial structure of demand and supply.

[1] This is also the case with the special treatment by CDC of investments in the power sector. It is not clear why this is not desirable for other key infrastructure sectors or indeed any sector benefiting the rest of the economy through links not represented in I-O tables, such as R&D spill-overs.

Second, it discusses alternative methods in the literature of estimating the job creation attributable to particular projects and spending.

2. Finance in development: relaxing financing constraints on output

The literature on finance and development is vast, as illustrated by Beck (2012), Popov (2017), Beck and Levine (2018) and the references therein. Beck (2012) noted that the common view used to be that financial development primarily follows, rather than causes, economic growth. Lucas (1988) argued that economists "badly over-stress" the role of the financial system in growth. Authors such as Stiglitz (2000) and Arestis (2005) have expressed scepticism about the benefits of financial liberalisation. It can divert resources to less productive rent-seeking activities and divert skilled workers to less productive (financial) activities, as argued by Cecchetti and Kharroubi (2015), who found that, in the OECD, financial growth disproportionally hurts financially dependent and R&D intensive industries. This they interpreted as a warning against financial booms, which may also be harmful because of the risk of economy-wide disruption in the busts that follow them.

Yet the empirical evidence at the macro level (subject to some caveats about econometric specifications) points towards a causal link from finance to economic development (in the Granger causality sense), with the size of the banking sector a robust predictor of GDP per capita (across countries). The link seems to be stronger in low- to middle-income countries, perhaps because credit constraints are more pervasive and financial intermediation less so than in the OECD. Popov concluded, "The bulk of the historical evidence suggests that financial development affects economic growth in a positive, monotonic way." This backs up the contention of CDC that providing extra finance tends to boost growth (although not necessarily employment) in the developing countries in which it operates.

There are persuasive *theoretical* reasons why this might be the case, too. Beck suggests six channels through which finance can promote growth:

i. Providing payment services to reduce transactions costs;
ii. Pooling savings to overcome investment indivisibilities and to exploit scale economies;
iii. More efficient screening of proposed investment projects to improve investment and resource allocation;
iv. Better monitoring of adopted projects, thus reducing principal-agent problems;
v. Reducing liquidity risk, thereby promoting long-term investment;
vi. Allowing cross-sectional diversification across projects and over time, thus reducing portfolio risk.

However, Beck concludes from his survey that the beneficial impact of financial deepening on growth appears to work more through improved resource allocation, accumulation of knowledge and productivity growth than through additional capital accumulation. This would be represented in an I-O context by changes in the coefficients of the I-O matrix rather than by an expansion of output as a result of additional capital expenditure, the mechanism invoked in the CDC tool-kit. Also, the expansion of output may not lead to an increase in net employment. Increases in gross employment in the firms that become more

efficient may be offset by falls in gross employment in less successful firms. It is worth remembering that there is considerable "churning" in labour markets, with firm entry and exit constantly imposing shocks on labour demand while raising average productivity levels.

High-quality micro-econometric studies utilising relevant "natural experiments" that changed credit conditions exogenously have provided more direct evidence that relaxing credit constraints tends to boost firms' growth. This type of approach is of relatively recent vintage. For example, Bazzi et al. (2017) investigated the impact of a large-scale expansion of credit availability for small and medium-sized enterprises (SMEs) in Brazil between 2003 and 2014 through a new scheme of the National Development Bank of Brazil. They found that the targeted expansion of credit led to the increased entry of higher-quality firms, particularly in the manufacturing sector and in regions where prior credit supply for SMEs had been more limited. The credit was not extended for new capital purchases, however, but for financing input purchases. Although productivity was boosted by the entry of new firms (presumably with benefits for aggregate growth), there was no change in employment in the short run because increased competition reduced employment in the less competitive firms.

The two important features of the Brazilian case may be the targeting of new loans and the very limited prior supply of credit in some regions. In a study of measures to reduce the costs of firm entry to markets in Portugal, Branstetter et al (2014) found that "the reform resulted in increased firm formation and employment, but mostly among 'marginal firms' that would have been most readily deterred by existing heavy entry regulations. These marginal firms were typically small, owned by relatively poorly educated entrepreneurs, and operating in low-technology sectors (agriculture, construction and retail trade)." Thus, unlike the Brazilian policy change, the Portuguese reform did not appear to raise productivity and promote more efficient firms.

Banerjee and Duflo (2014) used variation in access to a targeted lending programme in India to estimate whether firms were credit constrained. They argued that, "while both constrained and unconstrained firms may be willing to absorb all the directed credit that they can get (because it may be cheaper than other sources of credit), constrained firms will use it to expand production, while unconstrained firms will primarily use it as a substitute for other borrowing." They concluded that "many of the firms must have been severely credit constrained, and that the marginal rate of return to capital was very high for these firms." There was "no evidence that directed credit is being used as a substitute for other forms of credit. Instead the credit was used to finance more production." In France, firms targeted by a loan guarantee programme were found to raise systematically more external finance, pay lower interest expenses, and enjoy higher growth rates than other similar firms (Lelarge et al. (2010)). This helped existing small credit-constrained firms to grow.

Popov and Rocholl (2015) examined the impact of exogenous funding shocks to German savings banks during the US mortgage crisis that were unrelated to local conditions and looked specifically at employment. They found that firms with credit relationships with affected banks experienced a significant decline in employment and in labour compensation relative to firms whose credit relationships were with healthy banks. They also found that the employment effect increased, and the wage effect decreased, with firm size. Gerlach-

Kristen et al. (2015), in a study of Irish SMEs, found a negative and significant effect of SME credit constraints on employment for firms that are discouraged from applying for credit. They also found a negative effect of constraints on the probability of an SME investing. This effect was driven by firms that were credit rationed when seeking capacity expansion loans. These studies illustrate the point made above about the degree of churn in labour markets and the difference between gross and net changes in employment.

Despite the rigour of the micro studies utilising 'natural experiments,' they are not necessarily the most useful tool for estimating the aggregate impacts of an extension of credit. Quite apart from the difficulties of grossing up to national level from a non-random sample of firms, these studies compare treatment groups of firms with non-treatment groups. Yet the extension of credit may have impacts on all firms, through the operation of markets for factors of production. Such impacts cannot be identified by the 'natural experiment' approach. To illustrate this point, consider an economy that is at full employment and suppose that aggregate labour supply is fixed. An extension of credit to some firms may lead to an expansion of their output and employment relative to the experience of the firms that do not receive new credit. But aggregate employment cannot increase because of the conditions in the labour market as a whole. Instead, real wages are bid up; this is the mechanism by which the firms without new borrowing find their workers bid away from them. Overall output may go up or down, depending on the relative productivity of the two groups of firms. If firms in the tail of the distribution of labour productivity are the ones receiving new credit, overall productivity in the economy will fall, leading to a fall in output after the extension of credit. If, on the other hand, new lending goes to the more productive firms (because, perhaps, financial intermediaries are performing well their credit monitoring functions), aggregate output will increase.

Firms themselves tend to identify the importance of credit constraints, too. Ayyagari et al. (2006) used firm-level survey data to analyse how firms' growth rates were affected by a range of obstacles reported by the firms themselves. The authors found that, of all the reported obstacles, only crime, policy instability and barriers to financing directly affected firms' growth. The financing constraint was binding regardless of which countries and firms were included in the sample and also had the largest quantitative effect on firms' growth. But the study was silent on the topic of employment.

Separately, a new mechanism linking credit conditions and employment has been identified by macroeconomists utilising the Diamond-Mortensen-Pissarides job-matching model of equilibrium unemployment. The idea is that tightening credit conditions makes it less profitable for firms to post job vacancies, because a decision to advertise a new job is akin to an investment. According to this theory, loosening credit conditions lowers the long-run equilibrium rate of unemployment in an economy and reduces the persistence of unemployment. There seems to be some empirical support for this link (e.g. Kehoe et al. (2016), Dromel et al. (2009), using US and OECD data respectively) but it is not clear that the canonical search-theoretic model for analysing unemployment rates is the most helpful in the context of developing countries where segmented labour markets differ greatly in their search-vacancy characteristics.

Popov (2017) noted that there are several aspects of the impact of finance on development that need more micro research. He picked out, in particular,

(i) The need to understand why, in some studies, beyond a threshold of economic and financial development, the positive impact of an additional unit of value added in the financial sector on the real economy disappears. Candidates include (inter alia) excessive risk taking, the misallocation of human capital, and the exacerbation of the growth-risk trade-off at high stages of financial development.

(ii) The relationship of economic performance to the quality of financial intermediation.

(iii) The respective roles of credit institutions and capital markets at different levels of development (one might add informal lending and internal finance to the list).

(iv) The costs (and possibly benefits?) of financial crises.

This cursory sampling of the literature suggests that there is broad support from high-quality micro studies and more macro evidence for CDC's underlying thesis about the role of finance in promoting productivity and output growth. Its role in net job creation is more ambiguous, depending on the characteristics of entering and exiting firms. However, neither thread of research can be said to vindicate the precise method used to represent this role in the CDC jobs tool-kit: a mapping from loans outstanding from financial institutions to capital purchases and hence output and employment.

3. Methods of estimating job creation

The extended I-O approach – or Social Accounting matrix (SAM) approach – adopted in CDC's jobs tool-kit is one of several different approaches that can be used to estimate job creation stimulated by new projects. CDC's partners Steward Redqueen have scored four methods on various criteria, as shown in the following table. The alternative methods they cite, in addition to I-O/SAM modelling, include:

i. case studies;

ii. random control trials;

iii. computable general equilibrium (CGE) modelling.

Macro-econometric studies may be used to help calibrate I-O/SAM and CGE models but are unsuitable for investigating the impact of sector-specific exogenous changes when credit conditions and labour intensities vary across sectors.

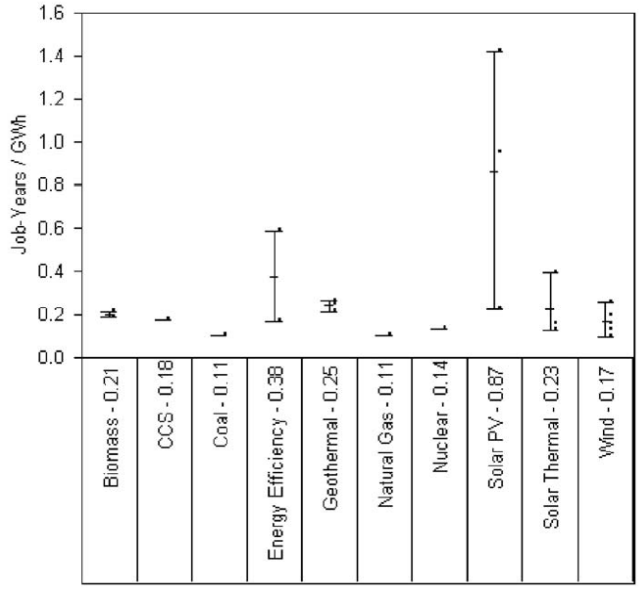
	Case studies	Random Control Trials	IO modelling	CGE modelling
Ease of studying multiple interventions	–	–	+	+
Theoretical consistency and robustness	+	+ +	0	+
Captures value chain effects	0	0	+	+
Captures enabling effects	+ +	+	0	0
Captures dynamic effects (potentially)	+	+	0	+
Level of detail for specific interventions	+	++	0	0
Disaggregation of employment results	+	0	+	+
Ease of data collection	–	–	+	-
Time and cost efficiency	–	– –	+ +	0
Economy-wide results	–	–	+	+

Source: Steward Redqueen slide-pack

Case studies

As Steward Redqueen note, case studies across the board are impractical for CDC's purposes given the size and heterogeneity of CDC's portfolio. Also, they are often based on estimates of labour requirements in the firms under investigation derived from engineering studies. These can be an inaccurate guide to employment impacts in real-world situations. They can also differ a lot in the time profile of employment effects, depending on their treatment of the project life-cycle. In any case, looking at gross job creation in a given portfolio of firms is not going to give an answer to the question, what is the *net* number of jobs created across the economy?

Two meta-studies of the impact of clean power generation on jobs illustrate the problem of variety in underlying direct employment impacts. In the first, Wei et al. (2010) surveyed 15 studies of the job-years that would be generated by expanding a range of clean and fossil-fuel-based power sources and improving energy efficiency. The 'candle' chart below illustrates the range of results obtained, especially for solar PV and energy efficiency.



Source: Wei et al. (2010)

In the second, which examined the potential for wind power in India, three research institutions came up with three quite different employment profiles.

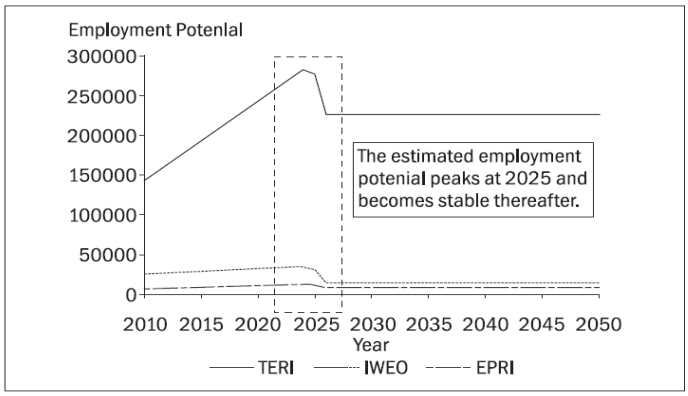


Figure 1 Employment Potential for High Growth Scenario

Source: Upadhyay, H., Pahuja, N., 2010. Low-carbon employment potential in India: A climate of opportunities, Centre for Global Climate Research TERI and Global Climate Framework Discussion Paper TERI/GCN – 2010:1. New Delhi: The Energy and Resources Institute, Global Climate Network.

Lambert and Silva (2012) also noted the wide variation in estimates of employment creation for specific energy technologies and across technologies. Blanco and Rodrigues (2009), for example, found that estimates of the direct jobs created per MW installed in the European wind sector varied from 6.97 in Belgium to 0.76 in Austria. They emphasised the big differences between the number of jobs created in the stages of technical development, installation, and operation and maintenance, which they speculate may lie behind the large variation in national estimates that they observed.

Random control trials

Random control trials are very expensive to set up and do not offer an obvious way to extrapolate results to a whole portfolio. However, their theoretical consistency and robustness are attractive. In some situations, it is not necessary to design and implement a random control field study because past policy changes (or other interventions) can be analysed as if they had been deliberately applied as an experiment. Such 'natural experiments' utilise exogenous shocks to financing conditions for exogenously determined subsets of firms (as in several of the studies discussed in section (2)). They may generate quantitative results at relatively low cost that can be used as a cross-check of estimated employment or output multipliers derived from other methods. The results of such studies are usually difficult to gross up to estimate a country-wide effect on output or employment, given the often narrow scope of the natural experiment and the emphasis on effects relative to some control group that might itself be affected by a change in macro credit conditions (e.g. through induced changes in overall wage levels).

CGE modelling

CGE modelling is not incompatible with the use of I-O tables. CGE models can be organised around an I-O matrix or SAM, especially if industry-sector detail is of interest (Thorbecke (2000)) or may be derived from simple growth models focused on the determination of output, with little attention paid to factor inputs. Alternatively, they can use nested production functions, limiting their ability to reflect the richness of interindustry connections but allowing for more substitution possibilities in production.

CGE models introduce explicit equations describing behavioural relationships (such as a consumption function or a labour supply function) and equilibrium conditions (such as prices adjusting to equilibrate demand and supply in certain markets). Solving a CGE model requires that there be as many equations as endogenous variables. The choice of variables treated as endogenous and the behavioural relationships regarded as important determine the characteristics of the model solution (Taylor (2016)). Thus, the results of CGE models depend on the 'closure rules' adopted. For example, if aggregate investment is treated as exogenous, driven by 'animal spirits', models may have a much more Keynesian flavour than if they include behavioural relationships for saving and investment, which are reconciled by the adjustment of an interest rate to equate ex ante saving and investment (the financial market clearing condition). Goods prices and wages may also be assumed to adjust to equilibrate product and labour markets.

The treatment of employment varies across CGE models, as discussed in Boeters and Savard (2013). Labour supply may be assumed to be exogenous or respond to real consumption wages; the response may differ according to the group of labour market participants concerned so that these groups have to be distinguished in modelling (e.g. there are often pronounced differences between male and female labour supply responses). The labour market may be assumed to clear, equating labour demand with labour supply through the adjustment of wages, or employment may be determined by simple technologically determined labour intensity multipliers.

Hence CGE modelling offers a wide range of possible approaches to modelling employment creation, with the choice determined by data availability and modellers' priors about how economies work. If those priors include simple neoclassical assumptions about market clearing and perfectly inelastic aggregate labour supply, policy interventions including credit expansion will have absolutely no effect on employment. New jobs created in any one firm will simply displace jobs somewhere else in the economy.

That proposition does not seem to be a sensible implication in most of the countries in which CDC lends. The danger of importing inappropriate labour market assumptions by using a standard CGE model is argued, for example, by Storm and Isaacs (2016) with respect to the impact of minimum wages in South Africa. But the particularities of each country's labour markets are likely to limit the usefulness of any single, 'off-the-peg', CGE model, even one that allows for important phenomena in developing countries, such as collectively bargained formal sector wages, subsistence agriculture, induced migration and social security systems with incomplete coverage. Kuralbayeva (2018) illustrates some of these issues in the context of changes in energy taxes in a middle-income developing country with formal and informal urban sectors and a large informal agricultural sector. Böhringer et al (2012) shows how neglecting general equilibrium feedbacks can lead to misleading conclusions about net employment creation as a result of expansion of a more labour-intensive sector of the economy (in their case, renewable energy).

Hence computable general equilibrium (CGE) models face up to the problem of macroeconomic responses to increased lending. CGE models can incorporate I-O production structures but require more calibration of behavioural relationships and may surreptitiously introduce contested views about how an economy works.

I-O/SAM modelling

An I-O table can be thought of as an accounting framework that captures the interdependence that exists within an economy. But it can also be the basis for attributing movements in employment to changes in exogenous variables. In a sense, I-O analysis can be thought of as a simple CGE model where (some) elements of final demand are treated as exogenous and factor inputs are in infinitely elastic supply (in other words, an increase in the demand for a factor calls forth an equal increase in its supply without any increase in the factor's real remuneration being necessary). Using a Social Accounting Matrix to allow for income distribution effects on spending is one step towards a more elaborate CGE approach. It allows for the calculation of 'induced employment' generated by spending by the workers whose jobs depend directly and indirectly on final demand for a particular industry. It can also allow the examination of the impact the spending of different types of income, such as wages, profits and tax revenues. Another elaboration is the use of techniques[2] to 'update' the technological coefficients in I-O matrices to allow for productivity growth. As Thorbecke (2000) wrote,

[2] Techniques such as the extrapolation of trends between estimates of I-O tables at different points in time and the so-called RAS technique (Breisinger et al. (2010), Miller and Blair (2009)).

> "… the SAM can be used as a conceptual framework to explore the impact of exogenous changes such as a variety of shocks (e.g. trade shocks, droughts, financial crises) and policy changes and reforms (e.g. structural adjustment and stabilization) on the whole interdependent socioeconomic system. As such, the SAM becomes the basis for simple multiplier analysis and the building and calibration of a variety of general equilibrium models. Although the assumptions under which SAM multiplier analysis is valid tend to be rather heroic (i.e. that any increase in exogenous demand is to be satisfied by a corresponding increase in output), calling for a Keynesian world in which excess capacity and unused resources prevail and prices remain constant, the taxonomy and format of a given specific SAM define and predetermine the channels through which influence is transmitted within the socioeconomic system captured by that same SAM."

The assumption – often implicit – that excess capacity and unused resources prevail is not necessarily any more attractive than that there is always full employment (or that an economy is always at its 'natural rate of unemployment'). Constraints on increasing employment may arise from social security and minimum wage legislation, for example, or the need to attract people away from traditional family-based production activities in rural areas. It is possible, however, to allow for supply constraints in I-O models in some sectors, by assuming that increases in demand for the output of constrained sectors is satisfied entirely by imports after the absolute domestic constraints are met (Breisinger et al. (2010)). This approach necessarily assumes that there is no balance of payments constraint, which may be just as implausible as assuming away the industry supply constraint(s) in the first place.

As acknowledged in MacGillivray et al (2017), I-O/SAM analysis is subject to a number of drawbacks when used to project the impact of exogenous changes in an economy, such as a boost to credit, rather than as a way of examining a single snapshot in time of the structure of the economy. The common assumption that technological coefficients of production are fixed implies that there are constant returns to scale in production, that substitution among factors of production does not take place, and that there is no technological progress. An ILO study, Ernst et al. (2015), provides a useful comprehensive summary of the pros and cons of both basic I-O modelling and the extended SAM method.

Conclusions

The number of jobs created by an increase in lending in a country depends on *both* the link from increased lending to changes in the behaviour of individual firms *and* the way in which the macro economy responds, through changes in factor and product prices, imports, productivity and other macro variables. CGE models and I-O based models have the virtue of making some allowance for the macro responses, but in simple ways. In particular, I-O based models usually assume a perfectly elastic supply of labour to all firms, which is likely to be misleading, even in developing countries with lots of underemployed people. Ideally, but at the cost of considerable research effort and data collection, models can be adapted to reflect more closely the individual characteristics of the economy under consideration.

Even if this is done, precise estimates of job creation are likely to give a spurious impression of precision.[3]

4. Implications for the CDC method of calculating 'total employment effects'

According to Section (2), the literature on finance and development suggests that there is robust evidence that relaxing credit constraints has promoted the growth of output. Financial deepening in economies does not appear to have been simply induced by growth. There is less, but nevertheless supportive, evidence about the positive impact on *gross* employment growth – employment growth in the firms receiving credit. Extending credit may lead to capital deepening and some substitution of capital for labour but in practice much lending is used to finance inputs and work in progress, not the extension of new, more capital-intensive, production processes. (A standard I-O modelling framework would treat both labour-output and capital-output ratios as fixed.) This supports CDC's contention that its lending is likely to have had positive employment effects in the firms receiving loans (but not ruling out the possibility of negative employment effects in the firms with which the recipients compete). Productivity is likely to be improved without a net increase in capital in a sector being necessary if expanding firms are better managed.

According to Section (3), a range of methods can be used to derive quantitative estimates of the employment effects of changes in exogenous conditions by policy-makers, financial institutions and other autonomous agents. Given the need for a 'lean data' approach, low costs and the desirability of having a standard tool-kit for producing estimates (rather than a succession of ad hoc estimates), CDC's choice of an extended I-O approach using SAMs is understandable. No other 'off-the-peg' method looks obviously more attractive.

Nevertheless, there are some problems with this approach:

- First, studying a supply constraint – the supply of credit to firms – through the lens of an I-O/SAM model, which intrinsically focuses on the impact of exogenous changes in demand, is problematic.

- Second, the way in which SAMs are used in the CDC method for different years does not appear to be equivalent to the standard textbook approach to estimating the impact of a supply constraint in a particular industry. There is a related semantic issue about the use of the term 'employment effects.'

- Third, in the real world, several of the assumptions behind I-O/SAM models may be invalid. As a result, the CDC 'employment effect' estimates are likely to exaggerate the likely net employment impact of relaxing firm-level borrowing constraints.

The I-O/SAM model as a 'Procrustean bed'

[3] This is nicely illustrated by a meta-study of the impact of tourism on employment in Malta. Cassar et al. (2016), which evaluated the estimates derived by previous key studies in the context of both the strengths and weaknesses of their respective modelling frameworks, which ranged from the construction of tourism satellite accounts, to input-output models and computable general equilibrium modelling. GVA multipliers derived from CGE modelling tended to be around half the size of those derived from I-O modelling.

One of the key features of the I-O/SAM approach is that it focuses on the impact of variations in exogenous elements of aggregate demand, commonly government spending, investment and exports. The approach has been used widely in the so-called structuralist approach to analysing developing economies, which places much more emphasis on the importance of demand and income distribution than does the orthodox neoclassical approach (Taylor (1979), Ocampo et al. (2009)). In the 'green jobs' literature, versions of the approach have been used to project the employment effects of spending more on clean energy (government and investment spending) and to compare the impact on jobs from different types of fiscal stimulus (e.g. GGGI/UNIDO (2015)). But modellers have thought it necessary to turn to CGE modelling to examine the likely impact of the key supply-side intervention of carbon pricing (e.g. the LIMITS project, http://www.feem-project.net/limits/ and other projects using Integrated Assessment Models).

The CDC method envisages new lending (whether direct to a particular firm or indirectly via a financial intermediary to a portfolio of firms across sectors) relaxing a binding supply constraint on output in the relevant sector by the amount of the loan. Output in that sector is then higher and the consequences of this for output (and employment, through fixed labour input coefficients), in terms of indirect and induced effects, augment the initial effect. Normally in I-O analysis, sectors are not constrained on the supply side at all. The financial sector may be identified but only as a source of value added and demands for intermediate goods and services. The approach is not clear about what is supposed to be happening to demand. One way to think about the implicit CDC thought experiment is to imagine that there is an exogenous increase in demand for the output in the sectors where lending increases. That is consistent with the way in which direct and first-round indirect employment effects are calculated. But increases in exogenous demand in I-O/SAM models lead to second-, third- and further round effects, through the input-output relationships. The demand induced by the spending of the extra incomes generated by previously credit-constrained borrowers also ripples through the system.

The CDC approach is also not clear about the pattern of credit constraints implicit in the story used to motivate the calculations. Why are other sectors supplying the previously credit-constrained borrowers from CDC assumed to be able to expand without being credit-constrained themselves?

How does the CDC method actually use SAMs?

The description of how the CDC method is actually implemented is not entirely consistent with the motivating story of the dynamic effects of increasing lending in an economy. According to Steward Redqueen slides, 'jobs supported' are calculated for two years, 2013 and 2014. The totals for the two years are then compared. In one version of the approach, this is done using the output of borrowing firms/sectors in each of the two years; in another version, that portion of the output that can be attributed to CDC lending (by calculating CDC's share of the relevant total funds available) is used. Hence the numbers are calculated for 2014 independently of the numbers for 2013 (except in so far as the same SAM is used).

This is not the same as calculating what increased lending during 2013 would be expected to do given the 2013 I-O/SAM – in other words, comparing employment with the extra lending in 2013 with what it would have been without that lending. Yet this counterfactual exercise would be the analogue to the way in which I-O/SAM models are used to calculate employment multipliers for exogenous increases in demand.

The CDC method is more akin to an accounting exercise repeated for two years than a counterfactual experiment about the impact of loosening credit constraints. Factors other than credit that affect firms' employment and accounts between the two years could introduce extraneous shocks into the calculations.

First, consider the employment attribution problem for one of the years. In treating a SAM as an accounting framework for a given year, the indirect employment generated in the supply chain of a firm can be attributed to that firm. However, that firm's own employment (and indeed the employment in its supply chain) can be attributed to the proximate sources of demand for its output (i.e. from other firms and final demand). Ultimately, it is only the exogenous elements of final demand that are given (in the I-O way of organising data) and therefore in a meaningful sense responsible for the employment in the economy. Similarly, the indirect employment generated by the spending of the firm's workers can be ascribed to the firm or to the demand for its output from other firms, workers in other firms and other elements of final demand. There is an arbitrary aspect to concentrating on one firm or sector when the whole point of the I-O framework is to stress the interdependence of sectors' supply and demand. Also, if repeated across all firms or sectors, the sum of direct and indirect employment effects across those firms or sectors would entail some double-counting, with the direct employment for one firm/sector also counted as indirect employment created by other firms/sectors further along the supply chain and indirect employment created by the workers in other firms/sectors who buy its products.

Second, moving on to the issue of the jobs comparison between the accounting snapshots in two different years, the CDC method describes as an <u>effect</u> of lending on employment, any increase in 'jobs supported' between the two years, with the 'jobs supported' calculated independently. In a more conventional SAM framework, increases in employment between the two years would be assumed to be the result of the autonomous increase in the exogenous elements of demand between the two years. In a full dynamic counterfactual exercise, a change in exogenous circumstances in a given year would typically be assumed to take some time to work through – not necessarily just a year. A heuristic discussion of supply-side constraints not explicitly modelled would then point out that some of the increase in employment might have been due to relaxation of some of those constraints. Those constraints would include not only credit constraints but also availability of raw materials, foreign exchange, skilled workers and so forth. It would be invalid to ascribe all the increase in employment in the firms/sectors supported by increased lending (e.g. by CDC) to that lending. One may regard it as a matter of semantics, but it seems inappropriate to describe the entire increase of jobs as calculated by CDC as 'effects' or 'attributable to increased lending' by CDC or the financial institutions to which it lends. The term 'supported by' is less dogmatic but still in danger of being misleading.

Invalid I-O/SAM assumptions

Putting aside the issues raised in the two previous sub-sections, some of the typical assumptions of I-O/SAM modelling (as distinct from using I-O/SAMs simply as accounting frameworks) are problematic. Over two years, changes in technological coefficients may not matter too much, as long as there have not been sharp changes in relative prices (such changes might trigger larger substitution effects). Some tests of robustness by making different assumptions about capital deepening and technical progress by borrowing firms, along the lines of Steward Redqueen's proposals for revisions to the jobs methodology, would be useful (other ways of updating the SAMs used could also be tried).

However, the calculation of induced spending effects on output and hence employment depends crucially on the assumptions made about supply constraints and leakages of demand through imports, taxation and saving. Breisinger et al. (2010) cited evidence from developing countries that consumption linkage effects (from spending by employees) are much larger than production linkage effects (through supply chains), accounting for 75-90 per cent of total multiplier effects in sub-Saharan Africa and 50-60 per cent in Asia. The same study noted that, by ignoring supply constraints, unconstrained SAM-multiplier models typically overstate the impacts of linkage effects. They cited findings by Haggblade, Hammer, and Hazell (1991) that these models overestimate agricultural growth multipliers by a factor of between two and ten for this reason.

The role of supply-side constraints differs across economies and sectors, and development economists disagree on their importance. Some supply constraints may not be absolute but affect relative prices and wages (e.g. a rising labour supply function with respect to the real consumption wage) – something that I-O/SAM models are not well-placed to accommodate. They may work through other 'ripple effects' in the economy, such as induced migration between countryside and city or changes in 'search unemployment' in the informal sectors of the economy. But it seems inconsistent to assume no other supply-side constraints at all when focusing on one particular supply-side constraint i.e. finance. This problem with calculating induced employment effects led the GGGI/UNIDO (2015) study to exclude induced effects from their calculations of the advantages of a clean energy programme, writing:

> "In this report, we focus on direct and indirect effects. Estimating induced effects – i.e. multiplier effects – within I-O models is much less reliable than the direct and indirect effects. In addition, induced effects derived from alternative areas of spending within a national economy are likely to be comparable to one another. We therefore do not lose a significant amount of information in terms of relative employment effects between spending on renewable energy and energy efficiency versus fossil fuels when we exclude induced effects from our estimations."

5. Conclusions

It is argued above that the literature on finance and development supports the notion that relaxing credit constraints has promoted the growth of output and, by extension, employment. Extending credit may lead to capital deepening, some substitution of capital for labour and some adoption of more advanced technologies but in practice much lending

is used to finance inputs and work in progress, not the extension of new, more capital-intensive, production processes. This supports CDC's contention that its lending is likely to have had positive *gross* (but not necessarily economy-wide *net*) employment effects.

Various methods can be used to derive estimates of the employment effects of exogenous changes in demand or supply conditions. Given the need for a 'lean data' approach, low costs and the desirability of having a standard tool-kit for producing estimates (rather than a succession of ad hoc estimates), CDC's choice of an extended I-O approach using SAMs is understandable. No other 'off-the-peg' method looks obviously more attractive.

However, the approach is not ideal for analysing the impact of relaxing a supply constraint such as credit because, when used as a modelling tool instead of simply an accounting framework, it is intrinsically demand-focused. This is likely to lead to an exaggeration of the so-called induced employment effects (notwithstanding their undoubted importance in most developing country contexts) and a neglect of other (non-credit) supply constraints (in particular, constraints on labour supply).

It also appears that the CDC method as actually implemented does not correspond precisely to the story told to motivate the exercise. In other words, the empirical estimates are not akin to the estimates from employment multipliers calculated in conventional I-O/SAM exercises to examine autonomous changes in aggregate demand. Rather, they follow from successive static snapshots of a SAM accounting statement across years in which exogenous elements of aggregate demand may have changed.

How might the CDC method be tweaked? One possibility would be to focus on the direct and indirect 'supply-chain' job numbers, which are less uncertain than the estimates of the induced employment effects, but to report each category separately. Some observers may prefer to concentrate on the direct gross effects as they are more robust, even though they are partial. This is important if there is a suspicion that the firms receiving more finance are displacing other firms as a result, as some micro studies suggest happens.

A more challenging alternative would be to take the increase in components of exogenous demand between two years (e.g. 2013 and 2014) and calculate what impact they would have had on jobs if industries had run into credit constraints in the absence of the credit flow unlocked by CDC lending; in this counterfactual, imports would increase instead of domestic production in these industries once the constraints had been hit, with a corresponding reduction in induced and supply-chain jobs created. That method would utilise the technique sometimes used in I-O/SAM-style models to deal with absolute sectoral supply constraints that are thought to kick in when a particular output threshold is reached. A simpler approach along these lines would be to take the SAM and elements of exogenous aggregate demand for the base year used for calibration and calculate the change in total jobs for a given dollar reduction in output in each industry one-by-one (i.e. calculating the impact of a given dollar supply constraint for each industry in turn). That would provide a ready reckoner for jobs (keyed to the particular SAM in question) but would not allow for the interaction of supply constraints across several industries at once.

Also, it may be possible to draw on (i) relevant micro studies and (ii) country-specific macroeconomic/labour market knowledge to cross-check the job creation estimates from the CDC method. In particular, it would be a useful robustness exercise (and the basis for a valuable analysis in any case) if, for a small number of countries, a CGE model calibrated to specifics of the country in question could be used for cross-checking. Also, varying the assumption about how new lending affects a firm's choice of capital-labour ratio (as Steward Redqueen have suggested) would be another helpful robustness check.

Regardless of what changes are made to the methodological approach, careful use of language in describing the job creation estimates is warranted (e.g. it may be better to refer to increases in labour demand rather than employment, to distinguish carefully between gross and net employment effects and not to lump direct, indirect and induced job creation together). Spurious precision in reporting job creation numbers should be avoided. The metrics computed may be more useful for ranking different projects than for generating a robust number for absolute net job creation.

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