International Labour Organization | STRENGTHEN2

A Brief Review of Input-Output Approaches to Employment Impact Assessment

STRENGTHEN2: Employment impact assessment to maximize job creation in Africa

Authors / Guannan Miao, Luis Villanueva,
Xiao Jiang, Massimiliano La Marca

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List of Acronyms

ADB	Asian Development Bank
AUDA-NEPAD	African Union Development Agency-New Partnership for Africa's Development
CGE	Computable General Equilibrium
EIB	European Investment Bank
EIF	European Investment Fund
EmpIA	Employment Impact Assessment
GTAP	Global Trade Analysis Project
ILO	International Labour Organization
ISCO-08	International Standard Classification of Occupations 2008
ISIC Rev. 4	International Standard Industry Classification Revision 4
NACE Rev. 2	Nomenclature of Economic Activities Revision 2
NUTS-2	Nomenclature of Territorial Units for Statistics Level 2
IO	Input-Output
JCT	Job Creation Toolkit
JIM	Joint Impact Model
JRC	Joint Research Centre of the European Commission
PIDA	Programme for Infrastructure Development in Africa
SMSD	Structural Model for Sustainable Development
SRQ	Steward RedQueen
SUTs	Supply and Use Tables
SAM	Social Account Matrix

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Non-technical summary

The input-output (IO) method—a classic approach of macroeconomic modelling—is widely used to assess the employment impact of investments and is an important part of the monitoring and evaluation frameworks of bilateral and multilateral development banks and international financial institutions. There are a variety of IO techniques used by different organizations, ranging from Leontief multipliers to the computable general equilibrium (CGE) type of models that are able to incorporate more realistic constraints prevalent in an economy (such as limited production capacity and price effects) and to capture long-term employment effects. The purpose of this paper is to provide an overview of the modelling tools available, describing their methodologies and underlying assumptions.

Even within the same methodology, there are many different choices that a modeller can practically make, such as the size of the economic shocks (which may differ from total investment), the source data, and the definitions of indicators, which will lead to different estimates of employment supported/created in the country where an investment is taking place.

International organizations should play a leading role in promoting common definitions, common data, and common practices to ensure that the analyses carried out by various institutions and implementers are broadly comparable, thereby enhancing the credibility and usability of Employment Impact Assessments.

Contents

1. Introduction

Employment Impact Assessment (EmpIA)—a process of assessing the employment potential of sectoral policies or investments—has been established as an integral part of the monitoring and evaluation carried out by bilateral and multilateral development banks. An employment target is often a key consideration for investment projects financed by these financial institutions. Employment indicators, the primary outputs of EmpIA, are officially required by the donor agencies, for example as part of the EU's Global Europe Results Framework[1] and the Results Measurement Framework of the European Fund for Sustainable Development Plus (EFSD+), and are reported to the European Parliament and the European Council as part of the legislative procedure. Therefore, project implementers, such as development banks, who are often at the forefront of managing these projects on the ground, are obligated to report on various aspects of the employment impact of these interventions.

Showcasing a strategic partnership between the European Union (EU) and the International Labour Organization (ILO), the STRENGTHEN2 project was launched in 2020, with the overall goal of leveraging employment impact assessments to promote the creation of more and better jobs in sub-Saharan African countries. Meanwhile, one of the major outcomes of the project is to streamline employment impact assessments—i.e. to introduce common standards and practices, to the extent possible, in modelling tools used by various development banks and development agencies.

A variety of macroeconomic modelling tools using input-output (IO) techniques have been available for a long time. These range from Leontief multiplier analysis (some of the products using this technique are commercially available) to more advanced modelling approaches that are capable of incorporating more features and constraints of the economy. In fact, there were other important work programmes, such as the ***IFC Jobs Study*** (IFC 2013)[2] and the subsequent ***Let's Work*** initiative (2013-2016)[3], both of which shared the goal of assessing the direct and indirect impacts of private sector activities on job creation, and to some extent positive externalities such as learning, knowledge spillovers, poverty reduction, and gender inclusiveness.

This study begins with the question of understanding what has been done in terms of EmpIA by different institutions. Notwithstanding the limitations of the IO approaches to employment impact assessment, here we document, as a stock-taking exercise, the similarities as well as the differences between some popular methods used by development banks and academics. The target audience of this study comprises those responsible for conducting EmpIAs in general and those interested in understanding the employment impact of investments, including development banks and donor agencies. It is hoped that the paper will also stimulate an in-depth discussion of the differences between the approaches, and help lay the groundwork for a possible convergence between them.

This study includes the most prominent operationalized products and some well-known academic research. Two operationalized products that have been widely adopted by implementers and development finance institutions are included, namely the Job Creation Toolkit (JCT) developed by the Programme for Infrastructure Development in Africa (PIDA) and the Joint Impact Model (JIM) developed by Steward RedQueen (SRQ), and now transferred to the private JIM Foundation. It also brings more academic research overseen by international organizations into the discussion, including

[1] The Global Europe Results Framework (GERF) is the main tool which has been specifically developed to meet these monitoring and reporting requirements of the NDICI-Global Europe instrument.

[2] The objective of International Finance Cooperation's (IFC) meta-evaluation (review of 39 evaluations) commissioned by the IFC during 2000 to 2011 was to determine the employment effects of private sector interventions and the tools and combination of tools that can be used to estimate their effect on job creation, and to help shape the strategies and operations of IFC and other private sector-oriented development financial institutions.

[3] Let's Work, a spin-off of the IFC Job study, was a global partnership of private sector, international finance institutions and donors coordinated by the IFC, following the successful launch of the IFC Jobs Study in January 2013. Its objective is to implement the findings of the Jobs Study and address the needs of various companies, sectors and countries on this pressing issue. Let's Work was helping to develop knowledge and practical approaches to implementing the jobs agenda to serve as a public good for the development community. Some influential working papers resulted from this initiative (Robalino and Walker 2017 and Robalino et al. 2020).

the RHOMOLO model and various applications[4] developed by the Joint Research Centre (JRC) of the European Commission, the recent report by Elhan-Kayalar and Oum (2022) on employment impact assessment—using both IO and computable general equilibrium (CGE) approaches—published by the Asian Development Bank (ADB), and the Structural Model for Sustainable Development (SMSD) developed by the International Labour Organization (ILO).

Macroeconomic models have some advantages over microeconomic models. In particular, macroeconomic models can capture the economy-wide supply chain and income effects that occur in response to an investment project, while microeconomic models cannot. Nevertheless, job estimates using IO techniques have to confront the limitations of the IO framework. For example, these techniques represent perhaps an overly simple view of the economic structure and linkages provided by the most recent Social Account Matrix (SAM) available, they come with all the assumptions associated with multiplier studies or CGE-type approaches (such as the fixed coefficient assumption for production), and they are often static in nature. However, other types of employment evaluation techniques, such as experiments, quasi-experiments, GIS, and case studies, can complement IO studies, and may be better suited to answering certain research questions in some cases (see ILO 2020 for an overview of methodologies used for employment impact assessment and 12 studies conducted earlier and listed in Table 2 of the Annex).

The remainder of the paper is organized as follows. Section 2 describes the methodologies of the different models and the underlying assumptions. Section 3 highlights the definitions of the indicators used in each framework, and section 4 explains the potential discrepancies in employment indicators produced by using different data sources. The paper concludes with some points for modellers' further consideration and offers a few thoughts on the way forward.

[4] RHOMOLO stands for Regional Holistic Model. The standard RHOMOLO model was updated recently and calibrated with 2017 data (version 4, see García Rodríguez et al. 2023). There are also other variations of RHOMOLO model: one to assess the impact of the EIB portfolio (RHOMOLO-EIB, see EIB-JRC 2022, EIB 2022a and EIB 2022b) and one with a standard input-output approach (RHOMOLO-IO, see Mandras et al. 2019 and Mandras and Salotti 2021).

2. Methodologies

The IO multiplier approach is a special case of a general equilibrium model where all relations are linear (for example, additional demand for certain output requires a combination of input such as intermediates and labour, proportionally). Both IO and CGE models can be static or dynamic. CGE models are more complex than the IO multiplier approach in that they consider complex economic relations and interactions such as the price effect and substitution effect. While the IO multiplier approach provides a snapshot of the economic response (most likely in the short-term with a handful of pre-set rigid adjustment mechanisms), CGE models allow the assessment of long-term effects created/caused by the increase in production capacity and the investment-capital accumulation process. However, the CGE model requires more extensive data and a higher level of technical skills to develop, run, and interpret. Furthermore, CGE models tend to rely on more assumptions, especially on the various behaviours of different economic agents.

This paper highlights the differences and similarities of four different IO multiplier approaches and three CGE-type models. The IO multiplier approaches include PIDA's Job Creation Toolkit (PIDA-JCT), SRQ's Joint Impact Model (SRQ-JIM), and the models developed by Elhan-Kayalar and Oum (2022) and JRC (ADB-IO and JRC-IO, respectively). The CGE-type models include the CGE model in Elhan-Kayalar and Oum (2022) (ADB-CGE), the JRC's Spatial CGE model (JRC-CGE), and the ILO's Structural Model for Sustainable Development (ILO-SMSD). PIDA-JCT and SRQ-JIM have been commercialized and automated to generate employment estimates once input data is entered into the modelling system. Meanwhile, the ADB and ILO have published many case studies using their macroeconomic models, which at this stage are still limited to research.[5]

IO Multipliers: Job Creation Toolkit and Joint Impact Model

PIDA, as part of the African Union Development Agency-New Partnership for Africa's Development (AUDA-NEPAD) program, has a strong regional focus on Africa and is primarily concerned with infrastructure projects, especially large cross-border infrastructure projects. The Job Creation Toolkit (JCT), maintained by PIDA, is designed for project managers to conduct their own employment impact assessment and is therefore fully automated—as a practical stand-alone service available to project managers that does not rely on experts to produce the job number estimate. The JCT requires project information as input, and it generates both direct and non-direct job estimates based on the information entered by project managers or their technical partners.

The Joint Impact Model (JIM) is developed by SRQ, and regularly maintained and updated by the JIM Foundation. SRQ-JIM's coverage is global, having the same coverage as the Global Trade Analysis Project (GTAP) in terms of countries and regions, and applications often go beyond infrastructure projects. It also provides an independent interface for users to enter their financial data and obtain estimates of job creation.

Both the JCT and the JIM are based on the typical IO fixed multiplier approach, but they are very different in their applications. For example, PIDA's JCT is designed to be used at the individual project level, while in contrast, the JIM is specifically designed to estimate employment impacts at the portfolio level, because it uses "statistics that reflect sector and country averages" (as explained in its methodology notes)[6]. For instance, the JIM could be used to assess the impact of a user's "outstanding portfolio in a given year", or the change in impact of a user's "outstanding portfolio over time" (i.e. the change of the full portfolio between year 1 and year 2).

Moreover, the JCT and the JIM methodology differ in terms of ex-ante/ex-post preferences. The JCT is designed for ex-ante analysis. Based on its experience in managing large infrastructure projects in Africa, PIDA has also developed generic project expenditure breakdowns—a set of cost breakdowns by sector based on the type of project according to expert knowledge. Meanwhile, the JIM methodology states that ex-post is preferred, although it can be used for both ex-ante and ex-post analysis.

[5] The ILO is in the process of developing a web application of SMSD to allow automated or semi-automated estimates for job supported/creation of investment projects.

[6] This is likely due to the fact that data are available for 75 countries and the rest are grouped together as regional aggregations. In addition, as explained in the methodological note, the ILO employment data are more aggregated than the GTAP sectoral classification.

Most importantly, there are no fundamental technical differences between the IO multiplier analysis documented in JIM and JCT that favour project versus portfolio or ex-ante versus ex-post assessments. These practical guidelines may simply reflect the preferences of model developers regarding the promotion of their products for different purposes.

Asian Development Bank Employment Impact Assessment

A study carried out by Elhan-Kayalar and Oum (2022) compares the differences in outputs between the IO multiplier and the CGE model in conducting employment impact assessments. This study focuses on the ADB's operations (both sovereign and non-sovereign) in Fiji, Indonesia, and Thailand during 2010-2019. It is a particularly valuable investigation because it includes both methodologies and measures the differences between the two. It points out that project-level estimates for the three countries suggest that the IO multiplier approach tends to yield higher estimates of employment impacts compared to the CGE models, but the differences tend to diminish as a project gets smaller in financial terms.

This report also includes a brief case study that measures the employment impact of policy-based loans in Indonesia using the IO multiplier approach. This examines the potential impact of the stimulus package on the Indonesian economy during the COVID-19 pandemic, including government spending (US$4.5 billion), transfers to individuals and tax cuts (US$7 billion), and tax cuts and other support to businesses (US$20.9 billion)[7].

In the report, Elhan-Kayalar and Oum (2022) have treated guarantee projects in the same way as other blending operations. This is because the guarantee has lowered the risk of investment in large infrastructure projects, such as the Bangkok Mass Rapid Transit Project. Another feature that stands out in their report is that the employment impact is always attributed proportionally to the source of funding. For example, if the ADB contributes 5 per cent of the COVID-19 stimulus package, then only 5 per cent of the employment impact is attributed to the ADB's intervention.

Joint Research Centre RHOMOLO Model and its Variants

RHOMOLO is a spatial CGE model of the European Commission, developed by the Joint Research Centre (JRC) in collaboration with the Directorate-General for Regional and Urban Policy (DG-REGIO). It is a tool that is designed to support EU policymakers by providing simulations of the economic response to investment policies and macroeconomic policies. The RHOMOLO model has been used for the impact assessment of cohesion policy and structural reforms, and for the impact assessment of EU investment support policies (see Lecca et al. 2018).

The RHOMOLO model also has various extensions. Regional RHOMOLO-IO is a typical IO multiplier approach, while RHOMOLO-EIB, just like RHOMOLO, is a CGE model. Regional RHOMOLO-IO multiplier analysis formulates the potential demand-side economic effects related to investments in specific industries and regions (Mandras et al. 2019). In particular, Mandras et al. cited two case studies on employment using RHOMOLO-IO. One is on the impact of the European Globalization Fund—amounting to €150 million per annum during 2014-2020—to support workers being laid off to manage the social impact of industrial change, and another is on the direct and indirect effects of the phase-out process of coal power generation on employment. More recently, Mandras and Salotti (2021) use the RHOMOLO-IO framework to analyse the amount of indirect jobs related to coal, peat and oil shale in the EU.

The RHOMOLO-EIB framework extends the RHOMOLO model to capture both short- and long-term effects of European Investment Bank (EIB)-supported investment projects. It incorporates the business model of the EIB Group (including EIB and the European Investment Fund, EIF). The objective of the RHOMOLO-EIB study is to assess the expected macroeconomic impact of EIB Group-supported investments in general, such as European Fund for Strategic Investment (EFSI)- and InvestEU-supported operations, both of which are published annually on the EIB website and in official EIB publications such as the EIB Investment Report 2022 (EIB 2022a), and the report on the EIB Group activities in European cohesion regions 2021 (EIB 2022b). And these investments often target the EU countries and neighbouring countries in Europe. The RHOMOLO-EIB methodology paper (EIB-JRC 2022), however, does not evaluate any specific projects, but uses a normalized dataset which reflects the typical composition of EIB Group-supported investments over the past five years, and the magnitude of the investment is fixed overall at €100 billion.

What sets RHOMOLO apart from many other CGE models is its distinctive advantage: the ability to take into account the spatial (at the Nomenclature of Territorials Unit-2 regional level) and sectoral (at the 10-NACE Rev. 2 sector level) interlinkages of a specific investment activity—the impact of investment can propagate within regions and across national

[7] The report didn't provide information on how these fiscal stimulus packages are used by the economy, especially how transfers to individuals and tax cuts have propagated throughout the economy.

borders through supply chains. Moreover, the policy-scenario analyses carried out with the model can take into account both the nature of the interventions (modelled with both demand- and supply-side shocks), and the way the policies are financed, with consequences in both the short- and long-run (with the possibility of accounting for the use of grants and loans)[8].

ILO Structural Model for Sustainable Development for STRENGTHEN2 Project

The ILO Structural Model for Sustainable Development (SMSD) shares common features with CGE models, but it has different market clearance conditions, especially to adapt to developing countries' conditions, such as excess labour supply. The model has a certain degree of flexibility—easily adapted to the needs of the users depending on the available input and the required output.

The model is used by the STRENGTHEN2 (S2) project—a joint initiative of the European Union and the ILO—that focuses on job creation through investments and aims to mainstream employment impact assessments to create more and better jobs in sub-Saharan Africa[9]. The practical applications of the ILO's SMSD for the purpose of the S2 project, has been summarized in a methodology note (Jiang and La Marca 2021), as well as in various case studies—for example the Great North Road Upgrade project in Zambia (Jiang and La Marca 2023) and the M1 Road Rehabilitation project in Malawi (Villanueva and Neza 2023).

The estimate can be done ex-ante and ex-post, where ex-ante requires certain assumptions and ex-post demands more data. For jobs created by direct effects, the recommendation is to collect such data since it is often measurable (e.g. on the construction sites), which will be better than modelled estimates. Meanwhile, data on indirect jobs has to be estimated by a model. In an ex-ante study on these indirect effects in the absence of detailed project expenditure breakdowns, the PIDA expenditure breakdowns can be used. The S2 estimation tool is based on the SMSD, but offers a more streamlined application using generic SAMs (from GTAP) and employment data (sourced from ILOSTAT). One of the advantages of the S2 estimation tool is that it is offers a certain degree of flexibility, and could be used for ex-ante scenario analysis as well as portfolio assessment. The web application of the S2 estimation tool is currently under development.

Models in Comparison

The key differences between the IO multiplier approach and CGE-type models are also in their underlying assumptions (see Table 1). The IO multiplier approach uses assumptions such as constant returns to scale, fixed input structure, fixed production structure and static prices. This means that impact on employment will typically be linear, and directly proportional to the size of the investment. It also implies that the IO multiplier approach cannot capture any long-term transformative impacts on the economy. In the IO multiplier approach, price does not change with demand. Such assumptions hold when there is infinite supply for products demanded, and demand increases will create neither market shortage (hence increased price), nor increased cost of production. The reality is that it may only hold when the additional demand constitutes a small proportion of the local economy, or in a small open economy setting where price is exogenous. Moreover, the IO multiplier approach has to be either completely supply- or completely demand-driven.

While IO multipliers are standardized in terms of their underlying assumptions, CGE-type models are more flexible, and the choices of which underlying assumptions to relax and which underlying assumptions to fix are in the hands of the modellers (see Table 2). In contrast to IO multipliers, CGE models have supply and demand adjusting together, where supply is constrained by factor supply (such as labour and input for example). There are similarities between CGE models and structural models like ILO-SMSD, but the distinct differences between the two are that structural models have different closure rules, such as excess labour supply, having investment determines saving, sector constraints, markup pricing etc.

[8] Including examples such as cohesion policy (Crucitti et al. 2023), the recovery and resilience fund (Barbero et al. 2022) and horizon Europe (Christensen 2022).

[9] See www.ilo.org/strengthen2.

▶ Table 1. Specifications of the Different Models

Specification/ Model	IO Multipliers				CGE-type Model		
	PIDA-JCT	SRQ-JIM	ADB-IO	JRC-IO	ADB-CGE	JRC-CGE	ILO-SMSD
Ex-ante/ Ex-post	Ex-ante	Ex-post, but can also be used for ex-ante	Ex-post	Ex-ante	Ex-post	Ex-post or ex-ante	Ex-ante, but can also be used for ex-post
Project/ Portfolio	Project	Portfolio	Project	Project	Project	Portfolio	Project
Blending/ Guarantee	Blending	Blending and guarantee[a]	Blending and guarantee[b]	Blending	Blending and guarantee[b]	N/A[c]	Blending and guarantee[d]

Note: This table only documents the current applications of all seven models without discussing the possibility of using the model for other applications. For example, ADB uses IO multipliers and CGE models for ex-post analysis, but doesn't rule out using them for ex-ante analysis. ILO-SMSD can be used for portfolio assessments as well, but it has not been implemented so far.
[a] Guarantees are evaluated under finance-enabling impact, which includes impacts on companies which receive lending from a financial intermediary, on suppliers of companies, and on those companies' suppliers.
[b] ADB has treated guarantee-enabled large investment projects in the same way as blending operations.
[c] Neither blending nor guarantees. The magnitude of the investment is fixed overall at €100 billion, and a normalized expenditure reflects the typical composition of EIB Group-supported investments over the past five years.
[d] The model could be extended to include guarantee projects provided additional data is available (Miao 2024).
Source: Authors' elaboration.

▶ Table 2. Underlying Assumptions of IO Multipliers and of CGE-type Models

Assumption/ Model	IO Multipliers				CGE-type Model		
	PIDA-JCT	SRQ-JIM	ADB-IO	JRC-IO	ADB-CGE[d]	JRC-CGE	ILO-SMSD
Constant returns to scale[a]	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed input structure[b]	Yes	Yes	Yes	Yes	Yes	No	Yes
Industry technology assumption[c]	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Price effect	No	No	No	No	Yes[e]	Yes	Yes
Supply constraints	No	No	No	No	No	Yes	Yes[f]
Competition					Yes	Yes	Yes
Full employment					Yes	Yes	No
Saving determines investment					Yes	Yes	No
Investment optimization					No	Yes	No
Capital mobility and trade					Yes	Yes	No
Endogenous wages adjustment					No	Yes	No

[a] The same quantity of inputs is needed per unit of output regardless of the level of production.
[b] No input substitution is permitted.
[c] An industry will always produce the same mix of commodities regardless of the level of production.
[d] See Corong et al. 2017 for details.
[e] In the three countries where ADB-CGE is being applied, the Thailand and Indonesia case studies are using GTAP-CGE models which assume perfect competition and that the price will adjust to clear all markets, while the case study for Fiji is based on a static CGE model that was developed for Fiji.
[f] Only certain sectors' output is constrained. In these sectors, even when demand increases, the production capacity cannot increase to match the demand in the short term.
Source: Authors' elaboration.

3. Indicators and their definitions

The most common indicators used for job estimates are direct, indirect and induced jobs, which can be considered short-term employment effects. However, even when the terminologies are the same, not all direct and indirect effects share the same definitions. Moreover, some models also include long-term effects on job support/creation, and even here definitions and estimation methods are not standardized, and the taxonomy varies too (see Table 4 for a summary).

Direct, indirect, and induced effects on employment

The origin of the concept of direct, indirect, and induced effects can be traced back to the IO literature (see Miller and Blair 2009) on Type I and Type II multipliers:

> **Type I multiplier:** Direct and indirect effects are calculated on the basis of an open Leontief inverse matrix that links activity sectors and goods and services. The direct effect is the effect of the exogenous shock, i.e., the amount of output created by the additional final demand generated by the shock. The indirect effect is the aggregate effect of the first round, the second round, and so on, and the n-th round that are created due to additional demand.
>
> **Type II multiplier:** Also called the closed Leontief inverse. This is done by adding a row of consumption to the Leontief inverse matrix to obtain income-consumption, i.e., households earning income from direct and indirect effects and spending it on products and services provided by businesses. The induced effect is equal to the difference between the Type II multiplier and the Type I multiplier.

The ADB-IO[10] and the JRC-IO use the definitions from the IO literature. Meanwhile, PIDA also derives IO multipliers from SAMs based on the standard Leontief inverse matrices, but it makes the following modifications[11]:

- Direct jobs are the sum of the employment effects of the exogenous shock in construction, in other transport, and in other business service sectors.
- Indirect jobs are the sum of the estimates from the open Leontief multipliers plus the jobs that have not been attributed as direct jobs.
- Induced jobs are the sum of the estimates from the closed Leontief multipliers but reduced by 50 per cent, a moderation factor "to ensure that the induced impact is not over-estimated".

JIM, as a methodology and a tool for ex-post employment impact analysis, considers direct jobs as those created by the project in the company responsible for the intervention. Since direct jobs are only measurable ex-post, they should ideally be provided by the implementing company. Strictly speaking, the supply chain effect (the equivalent of indirect effect) and the induced effect in SRQ-JIM do not follow the IO Type I or Type II multipliers. JIM identifies local procurement per sector to obtain the indirect effect. It uses wages from direct jobs and supply chain jobs to calculate induced output, and additional output generates more jobs. In summary, the JIM model requires client financial data to calculate supply chain and induced job creation.

Short-term effect on employment

Direct, indirect and induced effects on employment are concepts established in the IO multiplier approach, and therefore these breakdowns are generally not well-captured in a CGE framework or structural model. They are not well-captured due to the non-linearity exhibited in the latter class of models—that is, when there is non-linearity, direct, indirect and induced effects on employment are not easily separable. The indirect and induced effect, however, can potentially be

[10] Elhan-Kayalar and Oum (2022) follow a two-phased approach, i.e., they construct CGE and IO models and apply them to ADB investments' jobs impact as captured during the 2009-2019 period to test the applicability of the models for project and program lending in Fiji, Indonesia and Thailand. They also recommend that direct jobs be obtained in real time from the reported direct job creation during the construction and operation period of the investment project. In the absence of data, detailed information on construction and capital expenditure (domestic and imported) for specific projects are required to estimate the direct, indirect, and induced effects.

[11] PIDA provides job estimates broken down by project lifecycle, which includes preparation, construction, and operation stages. If the projects are located in more than one country, then job estimates can be broken down by host country and beneficiary country. This practice is unique to PIDA. The employment supported during the operation phase of the project is comparable to that in the long-term, and to the JIM power enabling effect (see Table 4).

introduced in the general equilibrium models, for example, by switching on and off the aspects of the equations that are associated with consumption or income in order to separate indirect effect from induced effect[12].

Meanwhile, CGE-type models (including the SMSD) could track how an investment or intervention triggers economy-wide responses. Furthermore, these models are able to take into account more complex (and sometimes more realistic) behavioural rules. From a theoretical point of view, some of the short-term effects in a CGE-type model can be considered as direct, indirect and induced effects combined in the IO multiplier approach. However, even if the data input is the same, the employment estimates by a CGE-type model would not be identical to that of the direct, indirect, and induced effects for an IO multiplier because the mechanisms of the two calculations are different. The main cause for the difference between the two methodologies is the more complex structure and causal mechanism in CGE-type models (i.e. more constraints introduced in the CGE-type models). In addition, the CGE-type models often produce lower employment estimates than the IO multiplier (Type I and Type II) approach.

A numerical example of lower employment estimates being produced for CGE-type models is the case study for the Malawi M1 Road Rehabilitation project (see Table 3). We compared the employment impact using the IO multiplier approach and the SMSD, by testing the impact of different expenditure breakdowns on employment estimates using bills of quantities for a typical road construction project.

The Type II multiplier gives a higher employment estimate than the temporary effect as captured in the SMSD when using the bill of quantities, but the opposite is observed when using PIDA generic breakdowns as a proxy for project expenditure. This may be due to the fact that PIDA generic spending is concentrated in certain sectors, while the bill of quantities is spread across more sectors. A key aspect of the SMSD is that it contains a capacity to constrain different sectors' production across the economy, and therefore generates a variety of quantity, price and substitution effects, the combination of all of which has a complex aggregated effect that potentially leads to higher employment outcomes than the IO multipliers in the case of using PIDA generic breakdowns of expenditure.

▶ **Table 3. Employment Impacts Using IO multiplier and SMSD for S2: Malawi M1 Road Rehabilitation Project as a Case Study**

	Bills of quantities			**PIDA generic breakdowns**		
IO Type II Multipliers	**Category**	**# Jobs**	**Share in Total Emp**	**Category**	**# Jobs**	**Share in Total Emp**
	Male	16,189	50%	Male	3,633	50%
	Female	16,087	50%	Female	3,639	50%
	Youth	8,733	27%	Youth	2,010	28%
	Adult	23,543	73%	Adult	5,262	72%
	Skilled	2,249	7%	Skilled	504	7%
	Unskilled	30,027	93%	Unskilled	6,769	93%
	Total	***32,276***		***Total***	***7,272***	
SMSD Temporary Effect	**Category**	**# Jobs**	**Share in Total Emp**	**Category**	**# Jobs**	**Share in Total Emp**
	Male	6,708	56%	Male	4,776	55%
	Female	5,270	44%	Female	3,909	45%
	Youth	2,578	22%	Youth	1,950	22%
	Adult	9,399	78%	Adult	6,735	78%
	Skilled	2,739	23%	Skilled	1,252	14%
	Unskilled	9,238	77%	Unskilled	7,432	86%
	Total	***11,977***		***Total***	***8,685***	

Source: Authors' calculations.

The fact that the IO multiplier approach gives favourable estimates for female workers is also observable – female employment is proportionally higher in the case of Type II multipliers than in the case of SMSD estimations. This might be because the induced effect tends to generate jobs in sectors where female workers have a bigger share of employment,

[12] However, this will not be as straightforward as IO multiplier approach given the model's nonlinearity. For example, in some special cases, induced effects can be negative.

and these sectors tend to be unconstrained (such as agriculture). Similarly, the IO multiplier approach gives higher estimates of youth employment compared to adult employment, and for unskilled workers compared to skilled workers. Moreover, due to the production constraints as well as the price effect and competition effect introduced in the SMSD, it is less elastic to changes in the total amount of the shock (i.e. from €20 million to €30 million for example) due to the price and substitution effects, and employment in SMSD increases less proportionally than in the IO multipliers (see Elhan-Kayalar and Oum 2022 for a comparison of the two methodologies).

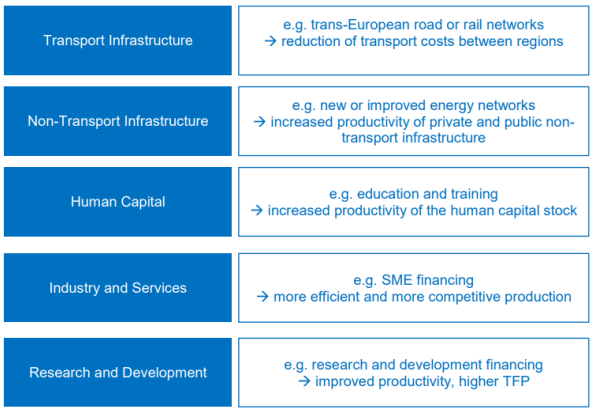
Long-term effect on employment

The long-term impact on jobs has been measured differently, if at all, by different institutions. The PIDA-JCT refers to long-term impacts as second-order growth effects or secondary jobs resulting from increased access to infrastructure (because PIDA focuses only on infrastructure projects). These growth-related employment effects of infrastructure investments are typically larger than short-term impacts and affect the entire economy. PIDA gives examples of how to calculate output changes based on the investment projects, e.g., an extra 10 per cent of electricity output or an extra 5 per cent of crop yield due to irrigation systems, are fitted into the Leontief multiplier to get the secondary effect.

JIM endeavours to capture the power-enabling effect, which can be considered as an aspect of the long-term impact by modelling power generation (e.g. additional electricity supply) and economic activity. Power generation enables additional output for each sector, which is captured by the ratio of power to output by sector, which is problematic in the context of IO modelling[13].

The analysis carried out with the RHOMOLO-EIB model (EIB-JRC 2022) provides the most comprehensive measures of the long-term effect through the so-called structural effect, which includes five different channels: 1) transport infrastructure, 2) non-transport infrastructure, 3) R&D, 4) human capital, and 5) industry and services (see Figure 1). EIB-JRC (2022) argues that each channel has a distinct impact on the local economy, for example through cheaper trade (via lower transport costs – channel 1), increased productivity of public capital (channel 2), new technologies and production methods leading to increased total factor productivity (channel 3), improved labour productivity (channel 4) and improved private capital quality (channel 5). Estimating the structural effect usually requires additional data or relies on elasticity values taken from the literature.

▶ Figure 1. RHOMOLO-EIB Model: Capturing Multiple Channels of Structural Changes



Source: EIB 2022.

[13] When "additional output" is calculated, it is put back into the IO model by multiplying it by the Leontief inverse. In other words, output changes are problematically treated the same as final demand changes.

▶ **Table 4. Assessing Employment Impact**

Indicator/ Model	IO Multipliers				CGE-type Model		
	PIDA-JCT	SRQ-JIM	ADB-IO	JRC-IO	ADB-CGE	JRC-CGE	ILO-SMSD
Direct effect	Yes	Yes	Yes	Yes	N/A	N/A	N/A[a]
Indirect effect	Yes	Yes[b]	Yes	Yes	N/A	N/A	N/A
Induced effect	Yes	Yes	Yes	Yes	N/A	N/A	N/A
Short-term effect[c]	N/A	N/A	N/A	N/A	Yes	Investment effect	Temporary effect
Long-term effect[d]	Secondary effect	Power enabling effect[e]	N/A	N/A	N/A	Structural effect	Permanent effect

[a] The SMSD does not estimate direct effect, but it recognizes that the direct effect can be measured without modelling—data can come from project documents and employment reports.
[b] JIM refers it to as supply chain effect.
[c] The short-term effect is a concept in contrast to the long-term effect. It has different names: it is called the investment effect in JRC-CGE model, and temporary effect in the SMSD.
[d] The long-term effect can be referred to as either a secondary effect, structural effect, or permanent effect, depending on which model one is using.
[e] The power-enabling effect in SRQ-JIM is a specific long-term effect and only applies to energy infrastructure projects.
Source: Authors' elaboration.

The ILO-SMSD refers to the long-term impact on employment as the permanent effect. It is generated when the outcome of investment operation pushes the economy to a higher equilibrium level of output and employment. It is permanent because it will not vanish after the construction phase of the project ends. The permanent effect can be calculated if a country's capital flow matrix (by source and destination) is available[14]. This type of information can be found in a SAM with a disaggregated gross fixed capital formation (GFCF) account, where the relationship between the supply of investment goods by source in the rows and by the demand for investment goods by destination in the columns can be captured. For example, a given increase in the capacity of an infrastructure project could increase the capacity of all other sectors. The additional output is estimated using the Incremental Capital Output Ratio (see Jiang and La Marca 2023; and Villanueva and Neza 2023).

[14] The calculation is still possible without capital flow matrix, i.e. by relying on additional assumptions about the relation between sectoral capital accumulation and output expansion.

4. Data Sources

Social Accounting Matrices, Supply and Use Tables, and Input-Output Tables

The Global Trade Analysis Project (GTAP) is by far the most popular choice for various macroeconomic models. It has been the primary source for the PIDA-JCT, SRQ-JIM, ADB-CGE, and ILO-SMSD (one version of the model is based on the GTAP) models. The GTAP project, coordinated by the Center for Global Trade Analysis in the Department of Agricultural Economics at Purdue University, provides a global database of harmonized social accounting matrices that serves as a key input to applied general equilibrium analyses of global economic issues. The ongoing releases of the GTAP represent a collaborative effort by institutions, researchers, and policy makers to standardize data from multiple sources. More recently, the GTAP 11 was released in April 2023 and provides a non-consecutive time series of 5 reference years (2004, 2007, 2011, 2014, and 2017), distinguishing 65 sectors in each of the 141 countries and 19 aggregate regions—with 20 more countries than the previous release, most of which are in Africa.

The JRC RHOMOLO model has been developed for the purpose of EU policy impact simulation. The model is based on a comprehensive statistical infrastructure available for the EU27 and the UK, broken down by NACE Rev.2 product/ International Standard Industry Classification Revision 4 (ISIC Rev. 4) sector and NUTS-2 regional level. The national supply and use tables (SUTs) are first linked to trade flows of goods and services based on estimates following the methodology illustrated by Thissen et al. (2013a;2013b), and then further broken down by NUTS-2 region using regional data on production and consumption.

The ADB-IO approach has taken advantage of the ongoing statistical work to construct Multi-Regional Input-Output Tables (MRIOTs), which provide extensive time coverage for ADB member countries. The MRIOTs form the basis of the analysis, but these data do not include labour compensation and employment. Therefore, the explicit effort was made to collect employment and wage data from national statistical offices, mainly from each country's labour force surveys.

Employment data

Employment data is also a prerequisite for estimating the employment impact of an intervention, and it commonly comes from the ILO's International Labour Statistics (ILOSTAT)—with underlying data sourced from countries' labour force surveys and household surveys. ILOSTAT provides model estimates for all data that has not been reported by these countries.

The GTAP uses ILOSTAT to complete its social accounting matrices and employment satellite accounts. In the latest release (version 11), it uses ILO data available at the more detailed industry level by the ISIC Rev. 4 and occupation wages by the International Standard Classification of Occupations 2008 (ISCO-08) to estimate imputed wages for the 2017 reference year. It also provides an employment satellite account with data broken down by skill levels (i.e. skilled and unskilled labour) and by five occupations (i.e. agricultural/unskilled workers, service workers, clerks, technicians/associate professionals, and officials/managers).

SRQ-JIM has obtained data from ILOSTAT available for 2018 and 2019, for 14 sectors (ISIC Rev. 4) and 189 countries (JIM 2021)[15]. Employment data is broken down by gender, age group and employment formality. For the formal/informal employment split, only limited data is available. The remaining missing data is imputed by SRQ-JIM. PIDA-JCT also uses ILOSTAT to disaggregate the employment data by gender, age, occupation, and skills with the 2014 data as the reference year. The industry breakdown is identical to that of SRQ-JIM.

ILO-SMSD uses the ILOSTAT data to estimate the employment breakdown by gender, age, skills, and employment formality available at the detailed sector level, which is consistent with the GTAP 65 sector breakdown. Therefore, it provides more detailed employment information than SRQ-JIM and PIDA-JCT. Missing data at the detailed sector level is

[15] The latest release of JIM methodology paper (JIM 2023, version 3.1) updated its employment data. It sourced from ILOSTAT modelled estimates for 2017, 2018, 2019, 2020 and 2021, and for 14 sectors (ISIC rev. 4, level 1) and 189 countries. Employment data is disaggregated by gender, age group and employment formality.

imputed by various methodologies. Data is collected in shares and therefore can be merged with GTAP employment satellite data (thus employment definition is the same as the GTAP's)[16].

The ADB-IO analysis uses detailed information on sector employment from labour force surveys; the model can then be used to estimate employment impacts by type of occupation, gender, full-time/part-time, and employment formality. However, only formal jobs are included in the estimation.

The JRC RHOMOLO model sourced its employment data directly from Labour Force Survey (LFS) in order to obtain data for workers across three levels (low-, medium-, and high-education) and are consistent with the aggregate data available on EUROSTAT.

Employed or Full-Time Equivalent

The international definition of employment includes all persons above the age specified for measuring the economically active population (e.g. 15 years) who were in paid employment or self-employment during a specified short period of either one week or one day. The term "employed" can be interpreted as working for at least one hour. Meanwhile, "full-time equivalent" (FTE) is a unit of measurement that indicates the workload of an employed person in a way that makes workloads comparable in different weekly working hour contexts. For example, if an employer has a 40-hour workweek, an employee who works 20 hours per week counts as 0.5 FTE.

Therefore, the labour productivity calculated based on two different employment measures could be far apart, and as a result, the employment impact assessments that estimate the number of persons being employed or the number of FTEs could end up with estimates that are drastically different from one another. The PIDA-JCT and ADB-IO both use full-time equivalent (FTE) for their estimates, with PIDA specifying that the estimates are based on 40 hours and five days per week. Other models that refer to the GTAP for their employment data are more likely to use the ILO definition of employment (that is, a headcount) (SRQ-JIM and ILO-SMSD for example).

Job years, average annual job, maximum number of jobs supported

Most interventions, especially large infrastructure projects, are implemented over several years. The way in which the number of jobs is reported over this period may vary. The PIDA-JCT introduces two definitions:

> **Job years (the number of jobs per year x project duration in years):** Project job years estimate the employment impact of an investment at different points in time to provide a measure of how many job years will be created over the life of the project. For example, if an infrastructure investment creates an additional 10,000 jobs in 2017 and is expected to last for 20 years, the project has the potential to create 200,000 job years.
>
> **Average annual jobs:** Job estimates are also provided on an average annual basis. The PIDA-JCT also provides the average annual job estimates for three different phases of the project: project preparation, construction, and operations & maintenance. The ADB also uses a similar concept called "annualized estimates".

The EU Results Framework introduces a slightly different concept than average annual jobs, which makes the estimation more complicated:

> **Maximum number of jobs supported (in a given year):** The EU Results Framework requires the reporting of the maximum number of jobs (only direct jobs for now) during the project implementation. For example, when an EU intervention provided business development support and access to credit to SMEs over the period 2016-2018, and the intervention implementer collected information reported by the SMEs on the number of FTE jobs at the end of each reporting period—19 for 2016, 22 for 2017, and 15 for 2018—then the number of 22 FTEs should be reported.

Job quality concerns

Many of the models can provide some breakdowns related to qualitative dimension of jobs, such as by gender, age, employment formality, skills, and occupation. The breakdowns by skills and occupation are also built-in features of the GTAP employment data. The breakdowns by gender (male and female), age ("between 15-24" and "25 and over") and

[16] The ILO STRENGTHEN2 project is looking at how to improve the underlying employment statistics for use in employment impact assessment (Miao and Chen 2024, forthcoming).

employment formality (formal and informal employment) are estimated using employment data from ILOSTAT. However, the sectoral coverages are different: the SRQ-JIM and PIDA-JCT break down into 14 sectors, while ILO-SMSD explicitly breaks down into GTAP 64 sectors, using the additional data available in ILOSTAT.

5. Further Considerations

The question of co-financing

An increasing proportion of development finance is co-financed with many different institutions and partners (e.g. blending operations), sometimes with different levels of risk involved. The question is whether the employment impact should be divided into the proportion of the contribution from each of these agencies, or if it should be evaluated as a single project. The ADB report has limited the employment impact to the proportion of its own financial contribution. The JIM also takes the same pragmatic approach to this attribution question and applies prorating.

How big is an economic shock: total project expenditure or purchase of capital goods?

Not everyone agrees on the size of an economic shock. Some analyses treat the capital expenditure of the project cost as the shock, while others treat the total project cost as the positive shock to the macroeconomy. However, in an IO framework, at least from a theoretical point of view, it should be the changes in final demand (and the capital expenditure is part of the final demand) that drive the economy-wide reaction through the supply chain and the income effects.

“Gross” vs “net” increases in employment

The CGE-type models can account to some extent for market constraints such as limited production capacity or labour market constraints, but most macroeconomic models are not designed to capture "net" job creation: when new firms enter the market, they create new jobs, but they may also displace their competitors, affecting overall job creation and employment levels. In countries with large informal sectors, job creation in the formal sector may draw workers from the informal sector into the formal sector. The truth is that no model can take everything into account—therefore it is impossible to estimate these net effects.

A different way of looking at 'net' employment gains has been developed in the SRQ-JIM portfolio assessment, which aims to evaluate the change in impact of an outstanding portfolio over time (i.e. employment impact due to the change in the portfolio between year 1 and year 2). In other words, it doesn't just measure the number of jobs supported in Year 1 and Year 2, but the 'additional' jobs supported as a result of the changes in the portfolio. It therefore shows the net impact on employment in the host countries.

Perceiving job increases as “jobs supported” or “jobs created”

There is a terminological debate about whether an investment is said to “support” jobs or “create” jobs. Some avoid using the term “jobs created” because they believe that, in a developing economy, most people are already employed, whether formally or informally. In this view, a new investment does not “create” jobs, but it simply replaces the existing informal jobs with formal jobs, or within the formal sector replaces a not-so-good job with a better one. This is also connected to the debate over whether an investment is “additional” or simply “substitutes for something else”.

Guarantees

Guarantees can be used to enable investment in large, risky projects; they can also be used to facilitate access to finance for MSMEs. However, it can be difficult to assess the employment impact of guarantee projects when it comes to lending to MSMEs. The SQR-JIM and ILO-SMSD explored the feasibility of conducting an employment impact assessment. SQR-JIM estimates the additional capital formation of the firms that receive the loans and applies an asset turnover ratio adjusted for firm size to estimate additional output. ILO-SMSD suggested a methodology that bridges the gap in employment impact assessments between blending operations and guarantees by obtaining leverage ratios and enterprise surveys (Miao 2024).

Grants and loans

The macroeconomic frameworks we reviewed rarely considered the nature of the investment, i.e., whether or not blending operations have a loan component and, if so, whether or not they are concessional (long-term and at below-market interest rates) or non-concessional. Almost all interventions consider investment as “windfalls”, with the exception of the JRC-CGE model, which treats investment as a scarce resource distributed in different regions and to be paid back later. Whether or not this is the case may not have an immediate impact on job creation, especially in terms of short-term effects or direct and non-direct job creation, but it will make a difference in the longer term. The JRC-CGE is one of the few studies to model the economic and employment effects of loans and repayments.

Employment linkages through trade

Most of the models only consider the impact of investment on domestic production—the effect of investment on non-domestic production through international trade has been largely ignored. The reality is that in an interconnected global economy, investment is rarely confined within one country—additional domestic demand could have created demand in other countries through imports. The JRC-CGE model has constructed a production function that takes into account the impact of trade.

Productivity gains

The question of labour productivity gains is not easily addressed within the framework of IO tables, because the models make the underlying assumption of constant returns to scale—for each additional output, the ratio of labour to intermediate inputs is fixed. To answer the productivity question, it is usually necessary to rely on other available information that is not already included in the IO framework. For example, among the five long-term growth categories identified by the JRC-CGE model, three are related to productivity: productivity growth through skilled labour, increased business productivity through capital investment, and the growth of total factor productivity. Meanwhile, the ILO-SMSD addresses the productivity question using Incremental Capital Output Ratio.

Can models measure business success in the long term?

One question that is often asked is what the long-term employment impact is of companies that have received additional financing. A hypothetical example is that a company receives a loan of 5 million, which creates 20 additional jobs in the first year, but the same company may create 100 more jobs over the next 10 years due to this financing being available. Can this long-term impact on businesses be captured? The answer is yes (using microeconomic approaches such as quasi-experiment), but the IO technique may not be the right tool for it.

Should indirect jobs be estimated at the project level?

In the IO multiplier approach, estimating non-direct jobs based on a portfolio, or estimating non-direct jobs on a project-by-project basis within the same portfolio yields the same results. However, this is not true for a CGE-type approach because it takes into account the crowding-out effect that takes place within a country through competition and price changes of all projects in a portfolio, each of which contributes to reductions in the non-direct jobs created by the portfolio.

Other factors potentially affecting estimates

There are other decisions a modeller needs to make during an employment impact analysis, such as exchange rate conversion parameters, the price deflators to convert expenditures to the base year prices (i.e. all project values should be deflated to match the base-year GTAP data).

Policy recommendation: employment should not be the only target

PIDA-JCT includes an option to hypothesize job maximization scenarios to test how different projects and project inputs change the number of estimated jobs. Policy recommendations based on job maximization could therefore direct investment to the sector with the lowest labour productivity, which according to the model is where most jobs will be created. This works in the short-run, but will not necessarily be the optimal solution to help countries develop their production capacity, productivity and economic growth in the long run.

6. Conclusion

The need to understand the employment impact and other socio-economic impacts of investment projects has propelled the development of macroeconomic modelling tools using input-output approaches in recent years. The models have been developed separately by different institutions with different objectives in mind, such as PIDA's ex-ante analyses to provide guidance for budget allocation and the JIM to meet the requirements of reporting standards and guidelines set by the EC legislation or by development finance institutions themselves.

As a result, the models are built differently from one another, with almost every single element of the model—such as data, definitions of data, definitions of indicators, methodologies, and assumptions in the models—being different. The recent hypothetical case study conducted by the EIB, using the imaginary example of a 100-million-euro investment in a wind farm in Benin, showed that the employment impact could differ by as much as 200-fold depending on the reporting institution (Weiers 2024, forthcoming).

The ***Let's Work*** initiative (2013-2016), representing a global partnership of private sector, international finance institutions and donors and coordinated by the IFC, aimed at helping the development community to develop knowledge and practical approaches to implementing the jobs agenda, in particular, in the private sector. To a certain extent, the JIM is one of the products that results from the long-term collaborations of international finance institutions.

The legacy of *Let's Work* may not be as influential as initially hoped—simply because setting common standards for employment impact assessment is a daunting task. As part of the ILO STRENGTHEN2 mandate, the annual discussion with various international financial institutions has taken some initial steps towards the goal of harmonizing approaches to Employment Impact Assessment by highlighting where differences exist in methodologies, assumptions and definitions used by various institutions. International organizations should continuously play a leading role in promoting harmonized definitions, common data, and common practices to ensure that the analyses carried out are broadly comparable, through promoting best practices in the coming years, thereby enhancing the credibility and usability of Employment Impact Assessment as a tool to promote more and better jobs in Africa and beyond.

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Contact details

International Labour Organization
Route des Morillons 4
CH-1211 Geneva 22
Switzerland

T: +41227998671
E: miao@ilo.org
E: STRENGTHEN2@ilo.org

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