DEVELOPMENT IMPACT MEASUREMENT OF GLOBAL SEAPORTS

Project Reference No.: 1208146

Technical Note and Manual

Income rows	Expenditure columns							
	Activities C1	Commodities C2	Factors C3	Households C4	Government C5	Savings and investment C6	Rest of world C7	Total
Activities R1		Domestic supply						Activity income
Commodities R2	Intermediate demand			Consumption spending (C)	Recurrent spending (G)	Investment demand (I)	Export earnings (E)	Total demand
Factors R3	Value-added							Total factor income
Households R4			Factor payments to households		Social transfers		Foreign remittances	Total household income
Government R5		Sales taxes and import tariffs		Direct taxes			Foreign grants and loans	Government income
Savings and investment R6				Private savings	Fiscal surplus		Current account balance	Total savings
Rest of world R7		Import payments (M)						Foreign exchange outflow
Total	Gross output	Total supply	Total factor spending	Total household spending	Government expenditure	Total investment spending	Foreign exchange inflow	

HPC Hamburg Port Consulting GmbH **Hamburgisches WeltWirtschaftsInstitut gGmbH**

April 2017

Project Reference No.: 1208146

Technical Note and Manual

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Cover picture from Breisinger C., M. Thomas, and J. Thurlow (2010), Social Accounting Matrices and Multiplier Analysis, IFPRI, Washington DC.

03/04/2017

Development Impact Measurement of Global Seaports. Technical Note and Manual.

Commissioned by IFC to HPC Hamburg Port Consulting GmbH and funded by the Let's Work Partnership.

Redacted Version

1. The Executive Summary and report of the Evaluation entitled *'Development Impact Measurement of Global Seaports'* has now been redacted for public disclosure in accordance with IFC's 2012 Access to Information Policy, following the Procedure for Development, Management and Disclosure of IFC Evaluations effective on January 20, 2016.

2. The attached redacted version reflects the following adjustments:

- Redaction of sensitive or confidential information related to financial and proprietary information of IFC clients from projects documentation shared by and used with the consent of IFC clients (e.g. project specific investment costs and traffic volumes). This information was originally used in the estimations of economic effects of specific investments.

3. The redacted version was reviewed by HPC Hamburg Port Consulting GmbH to ensure that their views, estimations, and assessment are adequately reflected as originally intended.

4. The redacted version will be disclosed to the public in March, 2017. The document will be available on www.ifc.org.

5. Questions on this document should be addressed to Evgenia Shumilkina (eshumilkina@ifc.org) and Hayat Abdulahi Abdo (habdo@ifc.org).

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Navaid Qureshi (Chief Industry Specialist, IFC) and Juan Samos Tie (Principal Industry Specialist, IFC) provided valuable inputs and guidance during the development and testing of the tool.

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1. INTRODUCTION AND OVERVIEW

1.1 Background

The World Bank Group considers infrastructure development to be critical to achieving economic growth, reducing poverty and addressing broader development objectives, such as access to basic services, improved country competitiveness and broad-based inclusion of the poor and marginalized.

Within this context, support to infrastructure development is a key strategic priority to the International Finance Corporation (IFC). Specifically for the significant seaports sector, IFC’s active projects comprise 52 projects in 20 countries with a total commitment of USD 2.2 billion in own account financing.

Seaport developments[1] (greenfield developments or port expansions) may improve connectivity, increase port productivity, and add traffic capacities. As such, the projects may have an economic impact not only through the direct development and operation of the port, but may have second order effects such as allowing for increased traffic volumes and also cheaper and faster transport.

Against this background, IFC and the Let's Work Global Partnership engaged HPC Hamburg Port Consulting GmbH (HPC) with support from Hamburg Institute of International Economics (HWWI) to develop a model and tool for the ex-ante assessment of the economic impact of IFC’s seaport projects in terms of GDP and job creation.

1.2 Methodology

In line with the requirements for the project set out by IFC, the Consultants propose a methodology built on the Input Output (IO) / Social Accounting Matrix (SAM) framework.[2]

[1] The term *development* (of a new port or a port expansion) shall generally refer to all aspects of the development, including planning, construction, and procurement of equipment.

[2] Input Output (IO) / Social Accounting Matrix (SAM) is a framework to assess direct, indirect and induced effects of investments or other exogenous final demand shocks to an economy. *Direct effects* include output generated to satisfy shocks in final demand for goods or services, as well as the value added and income generated in the production of such output. *Indirect effects* comprise all additional effects (output, value added, or income etc.) that are generated by the direct output effect along the supply chain of an economy. *Induced effects* further comprise all additional effects (output, value added, or income etc.) that emerge when households use the additional income, generated by direct and indirect effects, for consumption.

As such, the model presented here is designed to quantify the following impacts of the new development or expansion of a seaport:

- Direct, indirect, induced effects of the development and operation of the port;
- Second order growth effects: improved connectivity, increased port productivity, and higher traffic capacities may lead to increased cargo volumes and reductions in transport cost and time.
    - Increased cargo volumes may have a demand effect*:* goods that are exported or shipped domestically may have an impact in terms of direct, indirect and induced effects.
    - Increased cargo volumes may have a supply effect*:* imports or domestic goods may be used for consumption and as intermediate inputs for production activities – thus enabling economic output to increase.
    - Increased cargo volumes may further have an impact in terms of associated hinterland transport to/from the port, with corresponding direct, indirect and induced effects.
    - Reductions in transport cost may benefit firms and households etc. in the local economy, through lower import prices as well as lower cost for land and water transport. Reductions in transport time may similarly benefit firms and households as they decrease inventory costs and other costs associated with the transport time.

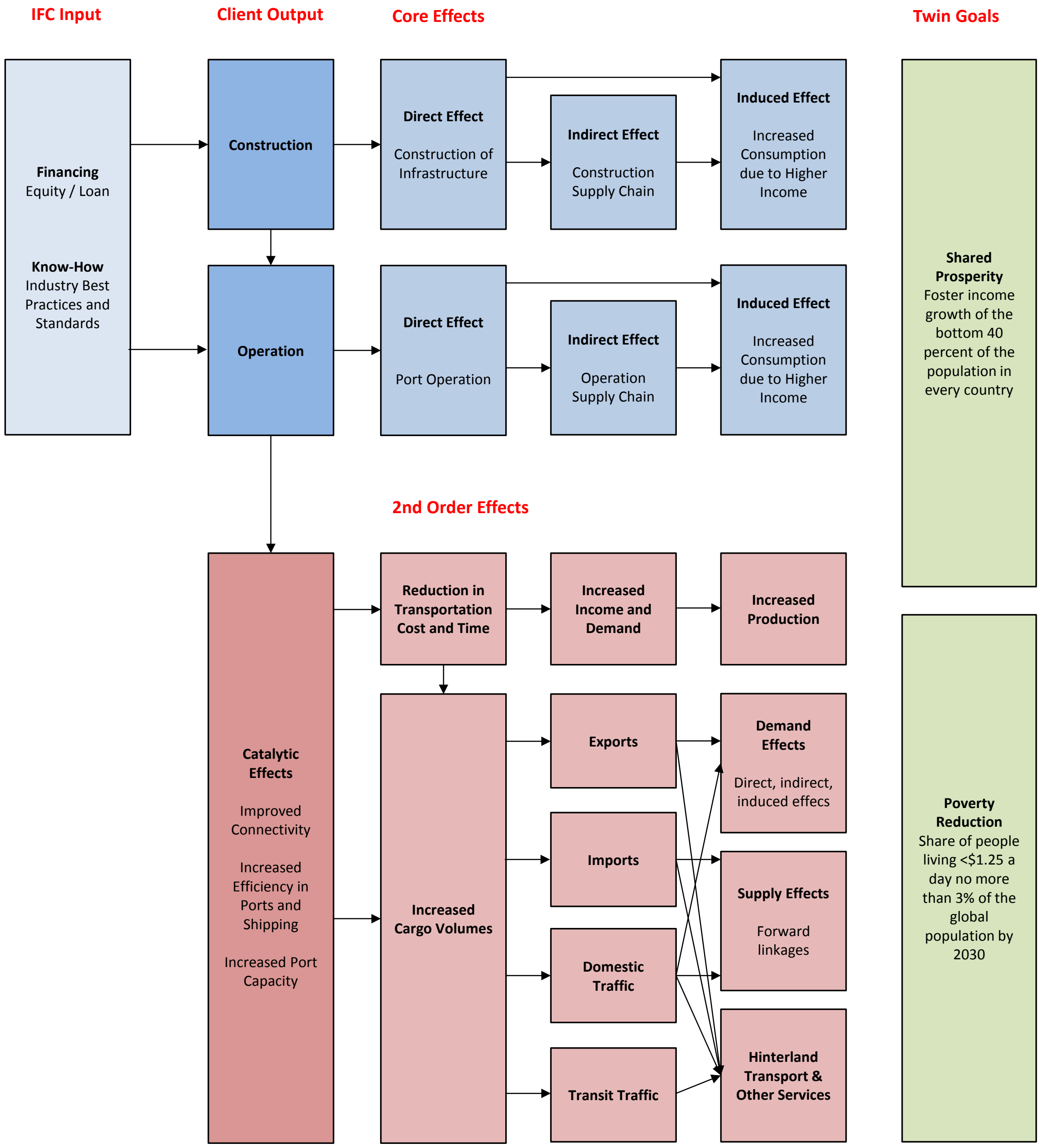
In order to be able to account for IFC's recent and present seaport developments in 20 countries[3] and also any kind of future development, the model covers a comprehensive range of seaports for cargo handling.[4] As such, different types of traffic (imports/exports, domestic traffic, transit traffic, transhipment) and cargo (containers, break bulk, project cargo, dry bulk, liquid bulk, RoRo) can be accounted for and are distinguished in terms of their economic impact.

The *Theory of Change* overleaf summarises the aforementioned impacts and highlights their impact on the World Bank's *Twin Goals*.

[3] The list of 20 countries has been selected based on IFC's investment portfolio and pipeline: Argentina, Brazil, Colombia, Côte d'Ivoire, Dominican Republic, Egypt, Ghana, Guatemala, India, Indonesia, Iran, Kenya, Mexico, Nigeria, Pakistan, Peru, Togo, Turkey, Ukraine, Vietnam.

[4] In accordance with IFC, the focus of the model lies on ports for cargo traffic. Passenger or cruise traffic is not modelled explicitly.

Figure 1: Theory of Change – IFC Seaport Investments



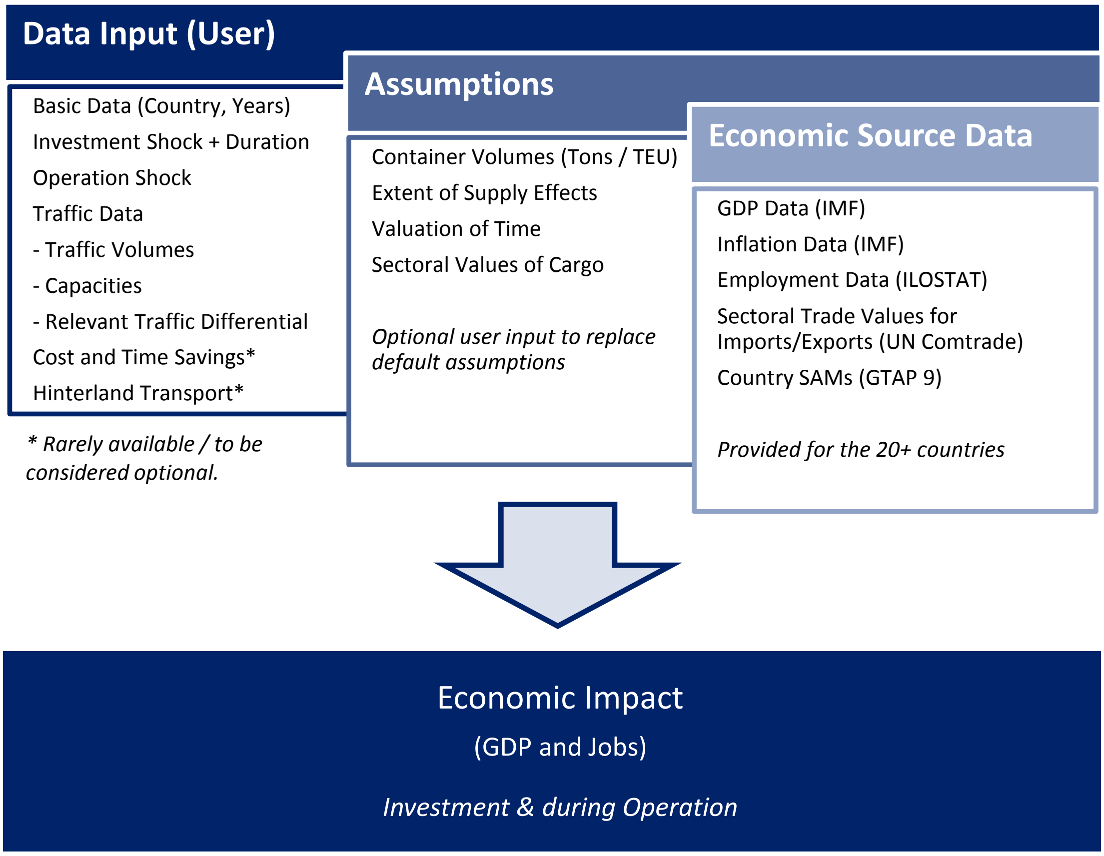
Source: HPC 2016

1.3 Data Requirements and Tool

For reasons of practicality and as required by IFC, the model restricts to data from public data sources as well as certain minimum data that may typically be expected to be available in IFC's project documentations. Although it is recommended to fully specify the model with regard to all relevant effects described above, the user may abstain from consideration of certain effects, such as cost and time reductions and hinterland traffic, subject to data availability.

The model has been implemented as a tool in MS Excel (**PEIA - Model.xlsx**) with supporting programming in Visual Basic for Applications (VBA). The user has access to overall 21 worksheets: data input (1), assumptions (1), output (8), calculations (6), economic source data (5). The tool is further accompanied by auxiliary files for data extraction purposes.[5]

Figure 2: Overview of Data Requirements for the Tool



Source: HPC 2016

1.4 Assumptions and Limitations

With the given scope and the requirement to be based on relatively minimal data requirements, the model relies on a variety of assumptions and partly – where an analytical approach is not feasible – applies heuristic approaches. As such, the basic assumptions for the IO/SAM framework comprise: fixed prices, constant returns to scale, fixed input structure, no capacity constraints. It may be assumed that these assumptions

[5] The auxiliary files comprise the following files (cf. Annex 2): (i) for analysis of trade values, the MS Excel file **PEIA - Unit Trade Value Analysis.xlsx**; (ii) for extraction of a SAM from GTAP 9, the aggregation scheme **PEIA - SAM Extraction.agg** and the MS Excel file **PEIA - SAM Conversion.xlsx**.

should typically be satisfied to sufficient degree whenever the considered shocks are not too large.

One particular issue may be the simultaneous analysis of different effects, such as demand effects and supply effects, within the IO/SAM framework: some of the assumptions for the measurement of these effects are technically not fully consistent. As a related issue, there may be a potential double counting of effects when considering supply effects – the model here relies on a conservative heuristic approach to avoid such double counting.[6]

Specifically in the port sector, cases where the IO/SAM framework may not produce sensible results include those where a port has such a structural impact on the economy that the SAM does not sufficiently represent the economy after development of the port. As an idealized case, this could refer to the development of a port on an island that would otherwise have no foreign trade at all.

1.5 Examples and Interpretation of Results

The impact assessment was tested for four of IFC's seaport projects, which have been selected jointly by the Consultants and IFC in order to test the tool for different geographic regions and different cargo and traffic types:

- Greenfield development of *Terminal de Contenedores de Buenaventura (TCBuen)* in Colombia, a dedicated container terminal mainly for exports and imports;
- Greenfield development of *Asyaport* in Turkey, a container terminal focusing on transhipment cargo destined for the Black Sea;
- Greenfield development of *Pakistan International Bulk Terminal (PIBT)* in Pakistan, planned to handle coal imports and exports of cement and clinker;
- Expansion of *Jakarta International Container Terminal (JICT)* in Indonesia, one of four container ports in Indonesia that handle international cargo and serve as hubs for redistribution of the cargo with domestic ships.

[6] An extension of the model to full blown CGE modelling could be suitable to overcome the issue of double counting, as then all impacts (demand effects, supply effects, cost/time effects) could be estimated simultaneously and more consistently. However a model based on CGE entails substantially increased data and computational requirements.

As an illustration for an analysis and results, the following bullet points summarize the case of TCBuen in Buenaventura, Colombia:

- Assessment of impacts is conducted for the total investment in the two investment phases (reference year 2009) and full operation when the terminal reaches capacity (2019).
- The expected traffic consists of exports and imports that represent the larger share of the traffic, and transhipment. As the incumbent terminal in Buenaventura is congested, it is assumed that half of the exports and imports actually depend on the development of TCBuen whereas the other half might be diverted, in case that TCBuen were not to be developed, via Caribbean ports.
- The impact of the average annual investment, for each year during the in total four years of investment phases, amounts to 0.04% of GDP and 6,000 jobs (reference year 2009).
- The total impact during operation in 2019 - including the impact of the operation and second order growth effects – amounts to 1.23% of GDP and 327,800 jobs. As such, the economic impact of TCBuen is significant. Supply and demand effects account for the lion's share of the impact during operation, reflecting the relevance of TCBuen as a catalyst for external trade.

The following should be noted as a general disclaimer for the interpretation of results:

- Impacts are aggregate (direct / indirect / induced) and do not necessarily materialise within the year of the corresponding stimulus but may materialise over time.
- The impact of the investment is the impact for the average investment per year during the investment phase(s). The impact is not sustained but is an average one-off effect for each year of investment.
- Impacts during operation (including second order growth effects) are sustained as the operation is recurring each year, yet possibly subject to a dynamic development.

Regarding the relevance of effects, it may be observed – in line with general intuition – that the second order growth effects related to imports and exports typically have the most significant impact. Such impacts depend directly on the extent to which the provided capacities of a port are relevant, in the sense that traffic may not be expected to divert to competitors. Cost and time effects may be expected to be more moderate. Transhipment traffic, on the other hand, is not even necessarily associated with any second order growth effect but may have an impact only in terms of the corresponding operation of the port.

1.6 Structure of the Note

This *Technical Note and Manual* sets out the methodology for the general model for 20+ countries and provides a step-by-step guide for the application of the tool.[7]

The note is structured as follows. Chapter 2 presents the theoretical framework for economic impact assessment with IO/SAM as well as a review of relevant existing port impact studies. Chapter 3 presents the methodological approach for the economic impact assessment of seaports – in addition to the core methodology laid out in Section 3.2, it is suggested the reader put particular emphasis on the study of assumptions and limitations in Section 3.3. Chapter 4 provides a detailed step-by-step guide for the use of the tool. Chapter 5 illustrates the impact assessment for four of IFC's seaport projects.

The Annex contains additional information. Annex 1 presents an overview of alternative modelling approaches and a review of miscellaneous literature related to transportation impacts. Annex 2 provides a manual for the addition of macro-economic source data (GDP, Inflation, Employment, Trade Values, SAMs) for other countries to the model. Annex 3 presents the concordances between different data classifications used for the model.

[7] Intermediate reports in this project comprised the following successive notes: the *Methodology Note* submitted on April 6, 2016, the *Revised Methodology and Exemplary Model Note* submitted on June 2, 2016, and the *General Model Note* submitted on July 1, 2016. The *Final Report* was submitted on August 4, partly refining the previous notes, with further revisions submitted November 23 and December 20. The present *Technical Note and Manual* constitutes the latest report in the project.

2. METHODOLOGY AND LITERATURE OVERVIEW

This chapter provides the theoretical framework for economic impact assessment with Input Output (IO) / Social Accounting Matrix (SAM) models as well as an overview of existing port impact studies. Annex 1 provides an additional discussion of alternative model types and miscellaneous literature.

2.1 Input Output / Social Accounting Matrix Models

There are three general types of theoretically founded economic models to estimate the (economic) impact of shocks. These are Input Output (IO) / Social Accounting Matrix (SAM) models, Computable General Equilibrium (CGE) models, and Econometric System Models. These three classes are not methodologically isolated from each other but can be combined in mixed approaches, as it has been the case in recent applications. Moreover, for specific cases, modellers sometimes build heuristic frameworks, which do not follow a general economic theory and are only designed for the considered case.

This section gives an introduction to the basic IO/SAM methodology, which is the principle methodological framework underlying the later economic impact assessment of seaports. The other model types are discussed in Annex 1.

IO/SAM analysis is a framework to assess direct, indirect and induced effects of investments or other exogenous final demand shocks to an economy.

- *Direct effects* include the output generated to satisfy shocks in final demand for goods or services, as well as the value added and income generated in the production of this output.
- *Indirect effects* comprise all additional effects (output, value added, or income etc.) that are generated by the direct output effect along the supply chain of an economy.
- *Induced effects* further comprise all additional effects (output, value added, or income etc.) that emerge when households use the additional income, generated by direct and indirect effects, for consumption.

In 1973 Wassily Leontief was awarded the Nobel Prize in economics for the development of the IO methodology and its application for economic impact assessment.

This methodology relies on either an IO table or a Social Accounting Matrix (SAM). An IO table describes (the value of) intermediate deliveries between all sectors of an economy under consideration in a certain period of time (usually one year). In addition, it includes rows for imported inputs and non-intermediate domestic inputs (e.g. value added such as land & natural resources, labour, capital) for each sector as well as columns for non-intermediate domestic uses (e.g. domestic final demand such as private consumption, government consumption, and savings/investment) and for exports of sectoral output. A SAM is an extension of the IO table, which typically treats households as an account in the sense that their income and expenditures are fully specified. The figure below presents the basic structure of a SAM (however without distinction of domestic and imported commodities).[8]

Figure 3: Basic Structure of a Social Accounting Matrix

Income rows	Expenditure columns							
	Activities C1	**Commodities C2**	**Factors C3**	**Households C4**	**Government C5**	**Savings and investment C6**	**Rest of world C7**	**Total**
Activities R1		Domestic supply						Activity income
Commodities R2	Intermediate demand			Consumption spending (C)	Recurrent spending (G)	Investment demand (I)	Export earnings (E)	Total demand
Factors R3	Value-added							Total factor income
Households R4			Factor payments to households		Social transfers		Foreign remittances	Total household income
Government R5		Sales taxes and import tariffs		Direct taxes			Foreign grants and loans	Government income
Savings and investment R6				Private savings	Fiscal surplus		Current account balance	Total savings
Rest of world R7		Import payments (M)						Foreign exchange outflow
Total	Gross output	Total supply	Total factor spending	Total household spending	Government expenditure	Total investment spending	Foreign exchange inflow	

Source: *Breisinger et al. (2010), Social Accounting Matrices and Multiplier Analysis, IFPRI, Washington DC*.

In a consistent IO table, row and column sums of the sectoral activities are equal to the respective sectoral output, as it is assumed that producing a given amount of output value requires the same total amount of input value. For a SAM this extends to the requirement of equal row and column sums for all accounts, meaning that income equals expenditure for all accounts.

[8] The disaggregation of the economy into sectors usually either follows certain internationally accepted classifications like the CPC and ISIC (United Nations) or is based on own definitions, such as the GSC (GTAP). These different classifications may have slightly different approaches with regard to the allocation of certain economic activities (ISIC) or products (CPC) to a certain sector. In the absence of high-resolution data, it is sometimes necessary to aggregate the set of sectors in the IO table. Unfortunately, the results of IO analysis can be sensitive to the way sectors are aggregated and therefore, aggregation of the originally given sectors should be done with care, or even avoided if possible (e.g. Flegg and Tohmo, 2013). The reason for this is that, due to the sector aggregation, originally heterogeneous sectoral goods are treated as homogenous.

The basic IO or SAM model is then set up based on the coefficient matrix A, which is the IO table or SAM with normalized columns (i.e. rescaled such that each column totals 1).[9] An output change dx relates to a final demand change dy (or in the following way:

$$dx = A \cdot dx + dy.$$

Denoting I as the identity matrix, the above formula can be rewritten as

$$dx = (I - A)^{-1} \cdot dy.$$

The matrix $(I - A)^{-1}$ is called the *Leontief inverse*. It can be shown that it always exists if all IO or SAM coefficients are less than one, which is typically the case as the coefficients represent shares. The Leontief inverse has nonnegative entries and the values on the diagonal are greater than or equal to 1.

Depending on the type of effect that shall be computed, certain accounts are treated as exogenous and the respective columns of matrix A are set to 0. Exogenous accounts typically comprise the government sector, private investment and exports to the rest of the world as well as, possibly, private households:

- Calculation of *direct and indirect effects*: private households, government, investment and rest of the world are treated as exogenous.
- Calculation of *direct, indirect and induced effects*: government, investment and rest of the world are treated as exogenous. The difference to the approach above is hence that consumption of private households is endogenous.

To gain a better understanding of the relationship expressed by the above equation, one may decompose the Leontief inverse and, denoting $A^0 = I$, write:

$$dx = \sum_{n=0}^{\infty} A^n \cdot dy = dy + A \cdot dy + A^2 \cdot dy + \cdots.$$

Using this decomposition, an output change dx resulting from a demand change dy can be interpreted as a chain of effects.

[9] Different types of IO models can be distinguished based on their economic interpretation of the coefficients as well as on assumptions concerning the coefficients' stability. One line of distinction is whether changes in production value are to be interpreted as quantity or as price changes. Another distinction is whether a sector's input or output mix is assumed to remain fixed in the course of model simulations. The standard approach used in most applications is the demand-driven Leontief quantity model, which interprets value changes as changes in output quantities and postulates fixed input coefficients. This interpretation is followed here. Alternative representations are discussed in Annex 1.

As such, the *direct effect* is the initial final demand change dy. The indirect or induced effects capture all other effects $A \cdot dy + A^2 \cdot dy + \cdots$:

- In the case with exogenous private households, $A \cdot dy + A^2 \cdot dy + \cdots$ is the *indirect effect*. This captures all effects along the supply chain, as every sector needs a given amount of intermediate goods or services from other sectors for its own production (*backward production linkages*). In the first round ($A \cdot dy$), the production affects the direct suppliers of the initially affected sector(s). In the second round ($A^2 \cdot dy$), these suppliers adjust their own demand for intermediate inputs and so on.
- In the case with endogenous private households, $A \cdot dy + A^2 \cdot dy + \cdots$ corresponds to the *indirect and induced effect*, now also capturing the impact of increased household income and the associated additional consumption of private households.

It should be noted that the IO or SAM model does not provide an indication regarding the time frame for the realisation of the above chain of effects. One should therefore remain cautious in assigning outcomes of indirect and induced effects to particular years. Instead, it is recommended to interpret the direct, indirect and induced effects only in an aggregate way.[10]

The Leontief Inverse can then be used to calculate sectoral *multipliers*.

- A sectoral *output multiplier* is defined as the aggregate output change resulting from a unit demand shock to the respective sector.
- A sectoral *value added (GDP) multiplier* is defined as the aggregate change in value added from a unit demand shock to the respective sector.
- A sectoral *income multiplier* is defined as the aggregate change in private household income from a unit demand shock to the respective sector.

Multipliers which include only direct and indirect effects are called *type I multipliers*. If also the induced effect is included, they are called *type II multipliers* (West, 1995).

[10] This can be explained by the static nature of IO or SAM models: they merely allow for a comparison of two alternative equilibrium states of the economy (prior to a shock and after the shock). No information is given at what speed the economy might converge to the new equilibrium. For this reason, it is neither possible to assign a sensible timeline to the single rounds of effects. In many applications, adjustment is assumed to be completed within the period of one year, mainly because the underlying data from Input-Output tables corresponds to a one-year time horizon. However, there is no reason to believe that this should generally be the case. Hence, one should remain cautious in assigning outcomes of indirect and induced effects to particular years. In particular, splitting up demand shocks over a range of time periods (e.g. to simulate the impact of repeated or delayed effects) and conducting separate Input-Output analyses for each period will likely yield misleading estimates, as each shock is assumed to hit an already fully adjusted economy. For this reason, the present model will simulate the impact of port investments on an aggregate basis.

The IO/SAM model as described above makes several basic assumptions. The sectoral production functions are assumed to satisfy the following properties:

- Constant returns to scale: the sectoral production functions are assumed to be homogenous of degree 1, meaning that the optimal ratio between output and inputs is constant irrespective of the level of production.
- Fixed input structure: the mix of inputs in production is always assumed to be fixed in the way this is represented in the IO table or SAM. There is no substitutability of inputs, in particular not between domestic and imported intermediates.

The sectoral production functions are called *Leontief production functions* or, more generally, *linear limitational production functions*.

In addition, the following assumptions are made in the standard IO/SAM model:

- No capacity constraints: the basic analysis of the impact of exogenous demand shocks assumes that production inputs are unrestricted.
- Fixed prices: all prices in the economy are assumed to be constant, irrespective of changes in demand.[11]
- Static economy: the IO/SAM coefficients are assumed to be constant over time, representing a static economy.

The validity of the above assumptions should be sufficient if the analysed final demand shocks are not too large. Also, the time of the shock should not be too distant from the time for which the IO/SAM is constructed.

In addition to the standard analysis of the effects of exogenous demand shocks, IO/SAM models may be adapted to investigate certain *second order growth effects* such as the relaxation of supply constraints or cost changes.

- *Supply effects (relaxation of supply constraints)*:

  Constraint supply of a commodity may constitute a constraint for the production in sectors that require the given commodity as an intermediate input for production. Releasing the supply constraint, it may then be assumed that the additional supply is used as input for all other production activities – to the full extent and with the same distribution between sectors as represented in the IO table or SAM (forward

[11] Because of the Leontief production function, the output (value) is determined by the fixed mix of input (values). As there is no possibility to substitute one input type for another, input demand is completely price insensitive. As capacity constraints in the provision of inputs are assumed to be inexistent, supply fully adjusts to any change on the demand side without repercussions on market prices.

production linkages, cf. Drejer, 2002). Accordingly, the output of all sectors expands in a manner proportional to the additional supply.

Based on an idea of Lahr (2013), IFC's model for the assessment of the economic impact of power projects (IFC, 2015) applies this approach to quantify the forward effects of additional power supply.

In the case of seaport developments, the same mechanics can be applied for an increase in import volumes or domestic cargo volumes. Assuming that imports/domestic cargo previously constituted a supply constraint for production activities, additional port capacity may release the supply constraint and thus enable economic output to increase.

It should be noted that the full supply effect as described above requires the aforementioned assumptions of fixed input structure of production functions (in particular: non-substitutability between imports and domestic intermediates). In addition, sectors other than the ones for which additional supply is provided must be unconstrained.

For the particular case of imports, however, the described supply effect may not be realised to full extent. In particular due to the fact that imports may to some extent substitute for domestic inputs in production, the extent of the supply effect may be less than 100%. Marwah and Tavakoli (2004, cf. Annex 1) indicate a supply effect for imports in the ranges of between 22.6% and 42.8%.

- *Effects of changes in transportation cost and time*:

  Reductions in transportation cost and time may be one of the main benefits for port developments. However, while the monetary implication and sector correspondence of cost savings is typically clear, the valuation of time savings is less obvious. Blauwens and van de Voorde (1988, cf. Annex 1) determine the valuation of time as approximately 0.2% of the cargo value per day – accounting for capital costs (interest on the cargo) and other aspects of transport time such as deterioration, costs of shortage of stock, fines for delay, etc., but also a general time preference of the shipper. Monetized time savings then require an attribution to sectors (as cost savings) in order to assess their impact in the framework of SAM.

  Cost changes due to either changes of prices or input requirements can generally be incorporated into the SAM, adapting input or final demand coefficients to represent a post-shock world. Other changes, e.g. subsequent reactions of the production sectors or final demand accounts may be considered as well. The resulting SAM then needs to be balanced such that expenditure equals income for each account (one possibility to achieve this is through application of the RAS algorithm[12]). Effects of the cost changes can then be analysed by comparison between the original and the adapted SAM.[13,14]

In the case of seaport developments, a reduction of transport cost and time for imports and domestic cargoes may be analysed in this fashion – possible reductions for transport cost and time include shipping as well as the port stay and hinterland transport.[15]

2.2 Other Port Impact Studies

There are plenty of studies addressing the economic impact of ports. Those studies investigating the economic impact beyond the boundaries of the port sector (direct impact) typically apply IO analysis. The IO approaches differ in the type of data used for model calibration. Some make use of micro-level, (mostly) survey-based data (bottom-up approach) others resort to data from national accounts (top-down approach) or a combination of both. In this context, choosing a bottom-up or a top-down approach is to a large part a matter of practicability. In general, project-specific micro data can be assumed to reflect local demand and supply linkages more closely than general national account statistics. On the other hand, the use of public statistics better complies with the requirements of transparency and traceability, a point that should not be underestimated especially in large-scale evaluation projects. If micro data can be easily drawn from existing surveys or the conduction of surveys is an integral part of the general evaluation project, making use of these data for IO analysis may be appropriate. However, if this is

[12] For a technical description of the RAS algorithm, see for instance J.C. Parra and Q. Wodon, *SimSIP SAM: A Tool for the Analysis of Input-Output Tables and Social Accounting Matrices*, The World Bank, 2010.

[13] If available, manipulation of the SAM should ideally take into account additional information such as price-elasticities or substitution effects between intermediates (e.g. Sandu, 2007; Steward Redqueen, 2015). Such information would need to be derived from own econometric analysis or previous empirical work. Considering the scope of the model and available data, however, no analysis with price-elasticities or substitution effects seems possible. Instead, a more elementary manipulation of the SAM will be conducted, accounting for one-off adaptations of transport cost, demand, and then production.

[14] One disadvantage compared to actual CGE analysis is that potential repercussions of demand and supply changes on prices are ignored. Linkages between prices and quantities remain one-sided. However, in certain applications, this limitation might be justifiable. In the context of port expansions, this could be reasoned for the effect of a price reduction for imported goods. If a port development or expansion causes overall transport costs to decline, the net price of imported goods could shrink from the perspective of domestic customers, entailing a certain demand response. If domestic demand only makes up a small part of worldwide demand, the impact of this demand response on world market prices could be considered negligible.

[15] For exports, the effect of cost and time savings is not immediately clear. A reduction in transportation cost may benefit the exporter in terms of a higher margin or, alternatively, in terms of a higher export volume (if selling at a more competitive price). For the former effect, it is technically not directly clear how to account for higher margin for exports in the SAM. The latter effect is accounted for through the assessment of the demand effect for export volumes. As a consequence the model does not account for cost and time savings for exports.

(as often) not the case, the use of transparent national statistics should be considered a superior option compared to the exploitation of non-project specific surveys.

Despite existing methodological drawbacks of IO analysis, such as the assumption of linear, constant input output ratios and the lack of a price mechanism (see previous section), IO analysis represents an appropriate tool for measuring potential impacts of the economic activity in one sector or for the economy as a whole. Given an existing IO table, economic impact analysis can be conducted with a relatively small amount of information. Overall, the methodology is straightforward and yields impact measures on output and employment in different industries as well as on private households' incomes and tax revenues.

Due to a large variety of adopted approaches, the comparability of existing case-study results is very limited. In a meta-analysis of 33 different studies on the economic impact of ports, Dooms et al. (2015) identify major methodological differences regarding the following aspects:

- the economic indicator regarded (i.e. employment, value added, etc.),
- the effects captured (direct, indirect, induced),
- the geographical boundaries (port perimeter, region, nation),
- the sectoral boundaries (specific activities, industry classification),
- the type of data applied (firm-level, national accounts),
- the general approach (survey based, IO-analysis, combination of both).

None of the studies investigated the effects of forward linkages through supply changes or the effects of reductions in transportation cost or time.

As the suggested methodology in the present project is based on IO analysis, the following presentation of existing impact assessments of the economic effects of ports is based on a choice of different case studies applying IO analysis in different ways. Table 1 provides an overview of the methodology applied in four selected case-studies on the economic impact of ports. There are plenty of other case studies applying the IO-methodology not considered explicitly in this review. However, the selection of presented studies provides a reasonable overview of the most common approaches.

The first study (Long Beach) estimates the impact of the port of Long Beach on job creation, wages/salaries and business sales within the city area as well as at the regional and national level. For this purpose, regional and national Input-Output-Tables were adopted and a new table for the city area was constructed. To determine the cargo-related expenditures of the shipping companies, an extensive survey among local port industry firms was carried out. This data was then used to estimate the positive income and job effects emanating from these expenditures through backward linkages. In this context, products were disaggregated into more than 1000 different commodities. The analysis of supply-side effects was limited to cargo handling and wholesale/warehouse facilities. Apart from this, forward linkages resulting from an increased availability of imported inputs as well as second-order growth effects of infrastructure capacity were not investigated.

The second study (Colombia) quantifies the wider economic impact of an expansion program for the port of Cartagena in Colombia. It distinguishes between a reference expansion scenario and two counterfactual scenarios, where expansion is either assumed to proceed with other financing options or not at all. By using a national Input-Output-Table, it assesses the demand effect of the expected increase in port revenue on national value added, employment, household income as well as tax revenues by means of the classical Input-Output approach outlined above. After the calculation of national effects, they are distributed between the different regions within the country based on observed patterns of interregional cargo transport. These are derived from an origin-destination matrix for cargo flowing through the city of Cartagena. In this study, supply-induced forward linkages and growth effects are ignored.

The third study (Italy) estimates the economic value of the port system of the Friuli Venezia Giulia Region in Italy by means of IO analysis. It simulates output and related indicators for counterfactual scenarios in which port services are either imported from abroad or substituted by other modes of transport. This is achieved by cancelling some of the Input-Output-links of the port sector to other domestic sectors and computing the resulting output changes. In this way, the approach accounts for both backward and forward linkages, but only for those related to the transport service, not for the linkages associated with the exported and imported goods themselves. The extent of port-related activities was estimated based on survey data: direct employment, output and value added of the firms authorized to enter the port perimeter were attained through interviews and an analysis of the firms' financial accounts. Another special feature of the model used is that it is bi-regional: it distinguishes (and links) input-output-relations within the region considered and relations within the rest of the country.

Finally, the fourth study considered (Antwerp) attempts to assess the economic impact of the port of Antwerp for the port perimeter as well as for the rest of the economy. Instead of limiting the view to the port area as a spatial boundary, the port sector is defined as the sum of all port actors. Port actors are in a subsequent step divided into different categories according to the type of maritime service offered. Then, by computing Leontief as well as Ghosh multipliers, the extent of backward as well as forward linkages among the different categories of actors within the port perimeter are quantified. The relevant data on output and input consumption stem from the NBB Central Balance Sheet Office and the Value Added taxes supplier's listing. Equivalent multipliers are calculated to describe backward and forward linkages of the port actors in relation to the rest of the economy. Forward linkages are only considered in so far as they relate to the transport service, not to the flow of ex- and imported goods.[16]

Table 1: Comparison of Port Impact Assessments

Case Study	Long Beach	Colombia	Italy	Antwerp
Methodology	Input-Output	Input-Output	Input-Output	Input-Output
Economic Indicators	Jobs, wages/salaries, business sales	Value-added, employment, household incomes, tax revenue	Value-added	Value-added
Regional Scale	Several regional levels: city, county, five-county, state, nation	Country level (impact is subdevided into regions afterwards)	Two-regions: local (aggregated system of regional ports), rest of country	Two regions: port perimeter, rest of country
Boundaries of the Port Sector	Firms related to port activities inside and outside the port perimeter	Port only	Firms authorized to work in port perimeter	Not restricted to port area
Modelling Approach and Data	Port-related activities estimated from survey data (inside and outside the port perimeter)	Annual port revenue (included as output change in the water transport sector of the national IO-table)	Survey data from firms authorized to work in port perimeter (assigned to different sectors in bi-regional IO-table)	Port-related activities based on firm-level data from different sources (applied IO-table distinguishes firms in- and outside the port perimeter and firms related and not related to port activities)
Impact Assessment - Port Development and Operation	Direct, indirect (backward linkages), induced	Direct, indirect (backward linkages), induced	Direct, indirect (backward linkages), induced, effect of transport supply (forward linkages)	Direct, indirect (backward linkages), induced, effect of transport supply (forward linkages)
Impact Assessment - Second Order Growth Effects	Limited to cargo handling and wholesale/warehouse facilities	Not captured	Impact of imports / exports not considered explicitly	Impact of imports / exports not considered explicitly

Source: HWWI/HPC 2016

To summarise, the Colombian case-study is most closely related to the intended methodology of the present project both in terms of the modelling approach and the type of data applied. In the Colombian study the direct impact is measured by annual revenues of the respective ports in Colombia. By contrast, the case-studies on the ports in Long Beach, the Friuli Venezia Giulia Region (Italy) and Antwerp are based on firm-level data (bottom-up approach) that are mostly obtained by surveys. The so defined direct impact of the port sector is simulated by means of spatially differentiated IO-tables.

All four of the studies calculate direct, indirect and induced effects of the port development and operation. However, impacts emanating from supply changes (forward linkages) are only regarded in the cases of Italy and Antwerp. Forward linkages considered in these analyses originate from changes in the supply of port activities. None

[16] In addition, given their use of the Ghosh framework for modelling forward linkages, the important caveats against the Ghosh model outlined in Annex 1 apply.

of the studies contains an explicit assessment of the impact of imports, exports or other traffic, nor the effects of reductions in transportation cost or time. In this respect, the explicit assessment of the impact of cargo traffic and the effects of reductions in transportation cost or time as suggested by the consultants in this Project differs from previous studies and seems to be unique in economic impact assessments of ports.

The only known study considering the impact of import supply on the local economy is purely survey based. Grobar et al. (2009) analyse the supply effect originating from the import of selected raw materials and semi-finished goods through the port of Long Beach on domestic manufacturing employment.

2.3 References

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3. PORT IMPACT ASSESSMENT WITH IO/SAM

This chapter presents the methodological approach for the assessment of the economic impact of seaport developments in the framework of IO/SAM.

3.1 Preliminaries

This section quickly introduces basic concepts: the sectors to be used for the model and the structure of the SAM, as well as the traffic types and cargo types to be considered.

3.1.1 Sector Classification and SAM

The economic impact model is based on the following *sector classification*. Considering the importance of cargo trade and transportation, the proposed classification disaggregates manufactured goods and different types of transportation.

Table 2: Sector Classification

Number	Sector
01	Agriculture
02	Mining and Oil/Gas
03	Manufacturing – Food & Tobacco
04	Manufacturing – Textiles
05	Manufacturing – Wood, Paper, Printing
06	Manufacturing – Chemicals, Minerals, Metals
07	Manufacturing – Machinery, Equipment, Electronics
08	Manufacturing – Other
09	Utilities
10	Construction
11	Trade
12	Transportation – Land
13	Transportation – Water
14	Transportation – Air
15	Communication
16	Finance & Insurance
17	Other Services
18	Public Services

Source: HPC 2016

The first eight sectors constitute the commodity sectors. Agriculture is the sector for all raw agricultural products. Mining and Oil/Gas is the sector for mining of raw coal and metals as well as extraction of crude oil and gas. The different manufacturing sectors correspond with processed goods of various kinds.

The remaining ten sectors correspond with utilities and services and are therefore not related to cargoes handled in ports.

Transportation is disaggregated into land, water, and air transport.[17] As such, land transport comprises road, rail, and pipelines as well as auxiliary services such as warehousing. Water transport comprises maritime transport and ports but also inland water transport.

Data for the *Social Accounting Matrix* is provided by the GTAP 9 database.[18] With the given sector classification, the SAM has the following 61 accounts: 18 accounts for production activities of the different sectors; 18 accounts for domestic supply of the different sectors; 18 accounts for supply of imports of the different sectors; three accounts for factor inputs (land and natural resources, labour, capital); four final demand accounts: private households, government, savings & investment, and rest of the world. The following figure gives an impression of the structure and size of the SAM.

Figure 4: Social Accounting Matrix (Colombia 2011)

	a_Agriculture	a_Mining&Oil&Gas	a_Food&Tobacco	a_Textiles	a_Wood&Paper&Printing	a_Chemicals&Minerals&Metals	a_Machinery&Equipment&Electronics	a_OtherManufacturing	a_Utilities	a_Construction	a_Trade	a_Transport_Land	a_Transport_Water	a_Transport_Air	a_Communication	a_Finance&Insurance	a_OtherServices	a_PublicServices	d_Agriculture	d_Mining&Oil&Gas	d_Food&Tobacco	d_Textiles	d_Wood&Paper&Printing	d_Chemicals&Minerals&Metals	d_Machinery&Equipment&Electronics	d_OtherManufacturing	d_Utilities	d_Construction	d_Trade	d_Transport_Land	d_Transport_Water	d_Transport_Air	d_Communication	d_Finance&Insurance	d_OtherServices	d_PublicServices	m_Agriculture	m_Mining&Oil&Gas	m_Food&Tobacco	m_Textiles	m_Wood&Paper&Printing	m_Chemicals&Minerals&Metals	m_Machinery&Equipment&Electronics	m_OtherManufacturing	m_Utilities	m_Construction	m_Trade	m_Transport_Land	m_Transport_Water	m_Transport_Air	m_Communication	m_Finance&Insurance	m_OtherServices	m_PublicServices	Land&NatRes	Labor	Capital	PrivHouseholds	Government	Savings&Investment	ROW	*Total*
a_Agriculture																			32,337																																											*32,337*
a_Mining&Oil&Gas																				38,470																																										*38,470*
a_Food&Tobacco																					38,522																																									*38,522*
a_Textiles																						12,463																																								*12,463*
a_Wood&Paper&Printing																							9,494																																							*9,494*
a_Chemicals&Minerals&Metals																								53,177																																						*53,177*
a_Machinery&Equipment&Electronics																									11,073																																					*11,073*
a_OtherManufacturing																										5,746																																				*5,746*
a_Utilities																											8,508																																			*8,508*
a_Construction																												54,001																																		*54,001*
a_Trade																													72,982																																	*72,982*
a_Transport_Land																														27,682																																*27,682*
a_Transport_Water																															844																															*844*
a_Transport_Air																																3,224																														*3,224*
a_Communication																																	14,499																													*14,499*
a_Finance&Insurance																																		18,804																												*18,804*
a_OtherServices																																			75,854																											*75,854*
a_PublicServices																																				71,549																										*71,549*
d_Agriculture	3,699	0	11,232	156	254	61	1	44	19	310	1,750	2	0	0	1	0	169	84																																								7,532	5	1,865	5,153	*32,337*
d_Mining&Oil&Gas	1	188	83	51	32	11,066	55	16	355	964	21	1	0	0	0	0	29	0																																								5	0	0	25,614	*38,481*
d_Food&Tobacco	1,605	0	3,829	224	25	215	1	11	1	0	4,734	5	0	2	6	9	118	266																																								25,000	148	0	2,324	*38,522*
d_Textiles	61	53	7	2,179	131	66	20	193	2	34	277	12	0	2	58	8	171	255																																								7,415	32	0	1,485	*12,461*
d_Wood&Paper&Printing	117	58	582	106	1,203	606	152	374	19	1,001	1,068	30	0	9	374	204	727	491																																								1,468	0	1	901	*9,493*
d_Chemicals&Minerals&Metals	1,892	192	1,527	346	432	6,779	1,464	464	279	11,159	1,207	4,139	161	403	42	53	584	1,250																																								7,479	1,025	404	11,881	*53,163*
d_Machinery&Equipment&Electronics	37	62	99	38	37	236	605	36	60	780	371	172	31	5	132	5	114	897																																								2,550	0	3,077	1,727	*11,071*
d_OtherManufacturing	2	20	31	32	173	443	92	156	2	501	25	1	0	0	4	9	193	150																																								1,444	0	2,104	364	*5,746*
d_Utilities	196	12	357	141	189	1,049	29	10	234	26	548	160	0	4	160	99	224	523																																								3,855	0	0	692	*8,508*
d_Construction	102	354	11	5	9	29	5	26	285	617	115	126	1	3	72	120	925	1,923																																								0	0	49,256	17	*54,001*
d_Trade	1,177	505	1,994	423	702	2,282	948	288	81	2,877	4,333	2,779	16	130	369	166	1,354	2,211																																								44,151	1,275	4,451	470	*72,982*
d_Transport_Land	512	2,955	1,328	332	354	1,897	333	191	229	1,284	2,331	1,290	26	251	314	42	954	433																																								11,528	10	109	980	*27,682*
d_Transport_Water	4	0	0	0	0	42	0	0	0	0	27	41	61	0	0	0	4	114																																								188	0	0	361	*844*
d_Transport_Air	16	2	22	10	10	41	9	7	5	16	554	42	0	68	90	156	163	227																																								665	0	0	1,120	*3,224*
d_Communication	44	6	72	43	43	107	27	49	37	48	1,185	231	1	18	1,057	330	917	756																																								9,155	0	0	372	*14,499*
d_Finance&Insurance	200	222	283	135	111	421	92	78	249	574	698	606	6	32	620	1,909	1,880	2,506																																								8,007	0	1	174	*18,804*
d_OtherServices	309	273	1,999	1,730	1,095	3,465	821	513	609	3,253	7,608	891	15	157	2,330	2,549	6,038	5,731																																								34,113	56	1,436	863	*75,854*
d_PublicServices	16	5	37	24	12	58	7	10	16	29	192	20	0	1	40	45	191	5,281																																								15,492	49,737	0	336	*71,549*
m_Agriculture	203	0	1,909	151	1	13	0	2	1	0	165	0	0	0	0	0	33	2																																								619	0	3		*3,101*
m_Mining&Oil&Gas	0	0	5	0	2	98	3	2	0	89	2	0	0	0	0	0	2	0																																								0	0	0		*203*
m_Food&Tobacco	169	0	1,314	15	19	208	1	7	1	0	290	1	0	0	0	0	29	40																																								1,004	0	0		*3,098*
m_Textiles	83	0	4	1,164	46	40	13	47	1	8	67	0	0	0	1	0	19	0																																								1,653	0	0		*3,146*
m_Wood&Paper&Printing	5	7	45	6	506	62	19	83	2	255	67	1	0	0	78	13	138	53																																								234	0	0		*1,575*
m_Chemicals&Minerals&Metals	1,038	153	698	383	288	5,788	761	282	132	2,940	589	1,376	36	86	9	25	390	785																																								2,649	1	84		*18,490*
m_Machinery&Equipment&Electronics	57	87	113	64	54	263	1,863	61	29	890	1,501	351	34	92	142	64	217	899																																								1,921	0	14,677		*23,378*
m_OtherManufacturing	0	0	4	4	30	87	8	47	0	27	3	0	0	0	0	0	22	17																																								428	0	28		*706*
m_Utilities	1	0	3	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0																																								2	1	0		*9*
m_Construction	0	2	0	0	0	0	0	0	0	2	0	0	0	0	0	0	6	1																																								0	0	19		*31*
m_Trade	0	0	0	0	0	0	5	0	0	0	12	103	0	518	14	0	10	1																																								35	5	0		*706*
m_Transport_Land	0	0	0	0	0	0	0	0	0	0	0	95	40	300	0	4	46	84																																								1	0	0		*571*
m_Transport_Water	9	0	0	0	0	0	0	0	0	0	1	9	121	0	0	0	0	0																																								4	0	0		*144*
m_Transport_Air	21	0	20	13	13	53	12	4	5	19	254	50	0	45	0	208	198	275																																								0	0	0		*1,191*
m_Communication	1	0	0	0	0	0	0	0	0	2	1	0	0	0	11	0	16	3																																								290	0	0		*324*
m_Finance&Insurance	11	9	19	12	9	31	7	7	7	30	43	99	0	2	79	89	82	176																																								0	0	0		*713*
m_OtherServices	51	17	85	55	45	129	33	17	34	73	230	29	1	7	85	92	317	275																																								90	0	0		*1,664*
m_PublicServices	2	2	2	1	1	3	0	0	0	0	16	2	0	0	13	5	34	167																																								34	139	0		*421*
Land&NatRes	5,629	9,819																																																												*15,448*
Labor	9,294	2,656	4,585	2,646	1,582	5,195	1,738	1,032	1,035	7,689	20,254	4,446	74	323	2,464	4,889	18,016	35,653																																												*123,569*
Capital	5,503	20,465	5,843	1,780	1,962	11,540	1,661	1,624	4,515	17,564	21,623	9,141	163	623	5,660	7,393	41,019	8,922																																												*166,999*
PrivHouseholds																																																							14,307	122,861	106,544		43,583			*287,294*
Government	269	346	382	190	127	804	285	66	262	940	816	1,429	59	146	273	316	507	1,097		11		-2	0	-14	-2												194	7	230	262	81	703	1,490	74											1,141	708	12,334	69,179		1,303		*96,016*
Savings&Investment																																																									48,121	29,102			1,595	*78,819*
ROW																																					2,908	196	2,869	2,884	1,494	17,786	21,888	632	9	31	706	571	144	1,191	324	713	1,664	421								*56,429*
Total	*32,337*	*38,470*	*38,522*	*12,463*	*9,494*	*53,177*	*11,073*	*5,746*	*8,508*	*54,001*	*72,982*	*27,682*	*844*	*3,224*	*14,499*	*18,804*	*75,854*	*71,549*	*32,337*	*38,481*	*38,522*	*12,461*	*9,493*	*53,163*	*11,071*	*5,746*	*8,508*	*54,001*	*72,982*	*27,682*	*844*	*3,224*	*14,499*	*18,804*	*75,854*	*71,549*	*3,101*	*203*	*3,098*	*3,146*	*1,575*	*18,490*	*23,378*	*706*	*9*	*31*	*706*	*571*	*144*	*1,191*	*324*	*713*	*1,664*	*421*	*15,448*	*123,569*	*166,999*	*287,294*	*96,016*	*78,819*	*56,429*	*1,982,497*

Source: GTAP, HPC 2016

[17] The GTAP database, which is the source for SAM data, does not allow for a more detailed disaggregation.

[18] The classification as shown in Table 2 has been defined as an aggregation of the GSC 2 classification, which is the classification used by the GTAP 9 database for the SAM data. The sector classification is suitable for the economic impact model as it can also be obtained from the ISIC Rev. 3.1/4 classifications of level 2 (employment data from ILOSTAT) and from the Harmonized System with 6-Digits (trade data from UN Comtrade). Annex 2 presents concordances for all relevant source data classifications.

3.1.2 Traffic Types

In order to assess the economic impact of a port in particular with regard to the handled cargo traffic, it is crucial to properly identify the types of traffic that are being handled. Besides international traffic (imports and exports), there are the following types of traffic that should be distinguished: domestic traffic, transit traffic, and transhipment.

All traffic types differ with respect to their economic impact and hence are accounted for by the model in a different way (cf. the discussion in Section 3.2.1).

The following table provides a classification of these different traffic types in terms of origin/destination and mode of arrival/departure.

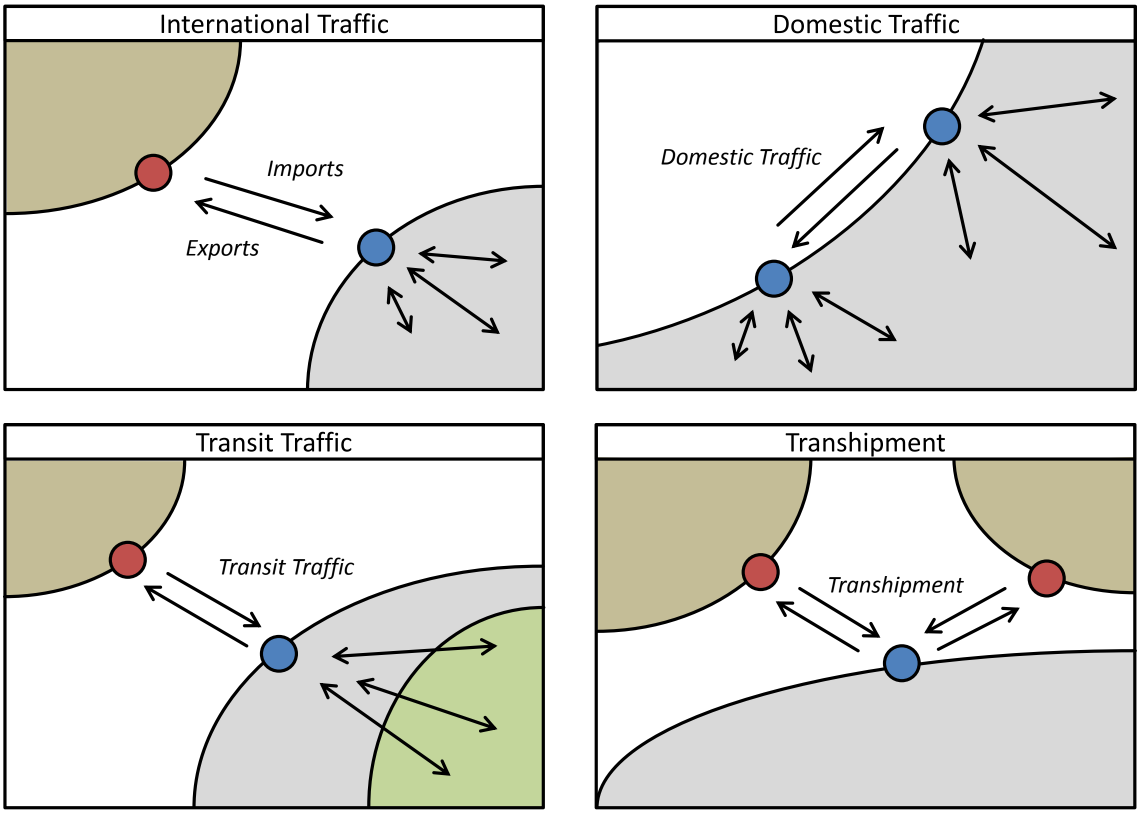
Table 3: Traffic Types

Traffic Type		Origin / Arrival	Destination / Departure
International Traffic	Imports	Port of origin in another country, arriving by ship.	Destination in the port's country, outgoing transport by truck / rail / pipeline / barge.
	Exports	Origin in the port's country, incoming transport by truck / rail / pipeline / barge.	Port of destination in another country, departing by ship.
Domestic Traffic	Inbound	Port of origin in the same country, arriving by ship.	Destination in the port's country, outgoing transport by truck / rail / pipeline / barge.
	Outbound	Origin in the port's country, incoming transport by truck / rail / pipeline / barge.	Port of destination in the same country, departing by ship.
Transit Traffic	Inbound	Port of origin in another country, arriving by ship.	Destination in hinterland country, outgoing transport by truck / rail / pipeline / barge.
	Outbound	Origin in hinterland country, outgoing transport by truck / rail / barge.	Port of destination in another country, departing by ship.
Transhipment		Port of origin not specified, arriving by ship.	Port of destination not specified, departing by ship.

Source: HPC 2016

Figure 5 overleaf provides a schematic depiction of the four traffic types.

Figure 5: Traffic Types



Note: To be interpreted from the perspective of the blue port(s) in the grey country.

Source: HPC 2016

3.1.3 Cargo Types

Ports may generally handle a variety of different cargo types, which may all be accounted for in the model: containers, break bulk, project cargo, dry bulk, liquid bulk, and RoRo. In accordance with IFC, transportation of passengers is omitted from the analysis.

Traffic data for ports is typically given in terms of these different cargo types – in some cases, such as for dry bulk and liquid bulk, additional information about specific commodities may be available.

For the assessment of the impact of imports, exports and domestic traffic, however, the model will have to convert the respective cargo volumes (in TEU or tons) into trade values (in USD) for the eight different commodity sectors: agriculture, mining and oil/gas, and the six manufacturing sectors.

The following table provides an overview of the different cargo types and typically related commodities and sectors. The exact correspondence between cargo types and sectors typically depends on the very specific characteristics of a project at hand.

Table 4: Cargo Types

Cargo Type	Description	Sectors / Commodities
Containers	Containerized cargo (in dry, reefer or tank containers)	Principally all sectors and commodities – however less often typical dry or liquid bulk cargoes.
Break Bulk (General Cargo)	Unitized or palletized cargo	Principally all sectors and commodities – however less often typical dry or liquid bulk cargoes.
Project Cargo	Single, large cargo	Manufacturing - Machinery, Equipment, Electronics: heavy machinery or parts thereof.
Dry Bulk	Unpackaged solid cargo in large volumes	Typical sectors and commodities: • Agriculture: grains • Mining and Oil/Gas: e.g. coal, metal ores • Manufacturing - Chemicals, Minerals, Metals: e.g. cement, fertilizers, refined ores or minerals, dry chemicals Less often: • Agriculture: fruits, vegetables • Manufacturing - Food & Tobacco: e.g. sugar, soymeal, flour
Liquid Bulk	Unpackaged liquid or gaseous cargo in large volumes	Typical sectors and commodities: • Mining and Oil/Gas: crude oil or gas • Manufacturing – Chemicals, Minerals, Metals: petroleum products, liquid chemicals Less often: • Manufacturing - Food & Tobacco: liquid foodstuff, molasses
RoRo*	Wheeled cargo, such as cars, trucks, semi-trailer trucks, trailers, and railroad cars	Manufacturing - Machinery, Equipment, Electronics: vehicles (cars etc.)

Note: * RoRo may also refer to trucks or other vehicles on a RoRo vessel which themselves are used for transporting cargo (containers, break bulk, or also dry or liquid bulk). Such cargo is not treated as an extra cargo type but should be accounted for as general cargo.

Source: HPC 2016

It is not generally expected that the project documentations will provide sufficient information regarding the sectoral composition and value of imports, exports and domestic traffic.

Based on the above correspondences between cargo types and commodity sectors, the Consultants have defined a *typical sector correspondence* for each cargo type, given by *sector weights* for all commodity sectors (Figure 6). Generally, a higher sector weight indicates a stronger correspondence between sector and cargo type. As such, a weight of 1.0 indicates a full correspondence and 0.0 or no weight indicates no correspondence.

As a default option when there is no better information available, the sector weights may be used to convert cargo volumes of a given cargo type into sectoral trade values.[19] To do this, the model will first calculate the actual sectoral distribution of exports/imports/domestic traffic in terms of volume.[20] In a second step, the derived sectoral distributions will be weighted with the specified sector weights of the given cargo type, resulting in sectoral distributions (in terms of volume) of exports/imports/domestic traffic of the given cargo type. Finally, the sectoral distributions in terms of volume will be converted into sectoral trade values for exports/imports/domestic traffic.

Figure 6: Typical Sector Correspondence of Cargo Types

Sector	Containers sector weight	Break Bulk sector weight	Project Cargo sector weight	Dry Bulk sector weight	Liquid Bulk sector weight	RoRo sector weight
Agriculture	0.5	0.5	0.0	1.0	0.0	0.0
Mining and Oil/Gas	0.0	0.0	0.0	1.0	1.0	0.0
Food & Tobacco	1.0	1.0	0.0	0.0	0.0	0.0
Textiles	1.0	1.0	0.0	0.0	0.0	0.0
Wood, Paper, Printing	1.0	1.0	0.0	0.0	0.0	0.0
Chemicals, Minerals, Metals	0.5	0.5	0.0	1.0	1.0	0.0
Machinery, Equipment, Electronics	1.0	1.0	1.0	0.0	0.0	1.0
Other Manufacturing	1.0	1.0	0.0	0.0	0.0	0.0

Note: For containers and break bulk, sector weights for *agriculture* and *chemicals, minerals, metals* have been reduced to 0.5 as to reflect that these commodities are, typically and to a large extent, transported as dry bulk or liquid bulk. Similarly, the sector weight for *mining and oil/gas* is set to 0 as respective volumes are, typically, relatively negligible for containers and break bulk.

Source: HPC 2016

[19] The assumption of made that the share of each sector in containerized cargo is identical to the share of each sector in general cargo.

[20] This calculation will be done based on the exports/imports/domestic supply represented in the SAM (in USD) as well as the sectoral unit trade values (USD per ton) from UN Comtrade.

3.2 Assessment of Impacts

This section provides an overview of the different types of impacts to be assessed, discusses the determination of the *relevant traffic differential*, and details specific methodologies for the assessment of the various impacts.

3.2.1 Types of Impacts

In principle, there are different types of impacts of a port that may be relevant. As such the model is designed to assess the following impacts of the development or expansion of a seaport:

- Direct, indirect, induced effects of the development and operation of the port;
- Second order growth effects: improved connectivity, increased port productivity, and higher traffic capacities may lead to increased cargo volumes and reductions in transport cost and time.

The following paragraphs provide an overview of the different types of impacts. Details on the specific methodology for the assessment of the different impact types in the framework of IO/SAM are laid out in Section 3.2.3.

Development and Operation of the Port

The *port development* and *port operation* have a direct effect on the economy but also correspond with indirect effects (suppliers to the development/operation) and induced effects (consumption effects associated with the income generated by direct and indirect effects).

Second Order Growth Effects – Overview

Seaport developments may improve connectivity, efficiency of port operations and shipping, and lift congestion, and may thus have an impact on *cargo traffic volumes* (imports/exports, domestic traffic, transit traffic, transhipment) but also on *transportation cost and time*.

It should be noted that the latter effects – additional traffic and a reduction in transport costs and time – are, in principle, subject to interdependencies:

- A reduction of transport costs and transport time may increase the demand for transportation of cargo.
- Conversely, increasing demand for cargo transport may negatively affect transportation cost and transportation times.

Within the framework of the present model, however, no real dynamic interaction between the two types of effects is considered. Instead, both additional traffic volumes and also reductions in transportation cost (and time) are taken as exogenous input to the model. As such, it is expected that the traffic forecast elaborated for the project is consistent with the associated reductions in transportation cost and time.

Second Order Growth Effects – Traffic Volumes

The following briefly discusses the impacts generated by different traffic types (cf. the definitions in Section 3.1.2):

- *Exports*: exports have a *demand effect* – the production of the exports has a direct effect and also indirect effects (suppliers to the production of exported goods) and induced effects (consumption effects associated with the income generated by direct and indirect effects).
- *Imports*: imports have a *supply effect* – they are used for consumption and as intermediate inputs for production activities (forward linkages). The latter may be relevant assuming that – without a project – there is constraint capacity for imports that are required as intermediate inputs for production. In this case, additional port capacity may release the constraint supply of imports and thus enable economic output to increase.
- *Domestic traffic*: the domestic cargoes shipped as domestic traffic may have a dual impact – in terms of a *demand effect* (production of the domestic cargo and backward linkages) as well as a *supply effect* (enabling additional economic output through forward linkages). For domestic cargoes, it may be assumed that the supply effect has full extent.

Transit traffic and *transhipment* – unlike exports, imports and domestic traffic – are not subject to a demand or supply effect related to the actual cargo volumes.

In addition to the demand or supply effects induced by the actual cargo volumes, all traffic may further impact the economy through *demand for traffic-related services* such as hinterland transport through the country (road, rail, pipeline, or inland waterways).

Reflecting the role of ports as catalysts for external trade, second order growth effects in terms of exports and imports are likely the main impact for most port developments.

Second Order Growth Effects – Transportation Cost and Time

The model allows for the assessment of a reduction for *transportation cost and time* for *imports* and *domestic traffic*.[21]

Generally, transportation cost and time should be understood as the overall transportation cost and time from origin to destination, thus including seaborne shipping, port handling, and hinterland transport (road, rail, barge, or pipeline) as shown in Table 5. Ports may in principle affect all relevant cost and time components: on the one hand, the port's location determines the overall route to be taken. On the other hand, port layout and operations determine the cargo types that may be handled as well as the possibilities for seaborne shipping (in particular through the naval accessibility and cargo handling equipment) and also hinterland transport (intermodal connections).

[21] For exports, the effect of cost and time savings is not immediately clear. A reduction in transportation cost may benefit the exporter in terms of a higher margin or, alternatively, in terms of a higher export volume (if selling at a more competitive price). For the former effect, it is technically not directly clear how to account for higher margin for exports in the SAM. The latter effect is accounted for through the assessment of the demand effect for export volumes. As a consequence the model does not account for cost and time savings for exports.

Table 5: Cost and Time Components of Transport and Relevant Determinants

Transport Component	Cost and Time Components	Relevant Determinants of Cost and Time affected by Port
Seaborne Shipping	• Shipping cost / time • Demurrage cost / time	• Distance to origin/destination • Vessel type and size • Utilisation • Vessel waiting time in port
Port	• Cargo handling cost / time • Cargo storage cost / time • Customs cost / time	• Port infrastructure • Port equipment • Port operations • Customs procedures
Hinterland Transport	• Inland transport cost / time	• Transport mode (road/rail/barge/pipeline) • Vehicle/vessel type and size • Utilisation • Distance to destination/origin

Source: HPC 2016

Reductions in *shipping cost* as well as *port costs* and *hinterland transport demand* may be assumed to benefit firms and households etc. in the local economy, through lower import prices as well as lower cost for land and water transport. Cost savings may then be assumed to translate into higher margins (production accounts) or be used for consumption of other commodities or services (final demand accounts) – with however a possibly adverse impact on the domestic water and land transport sectors.

For *transportation time*, there are two aspects that should be considered:

- On the one hand, time has a direct impact on transportation cost: shipping cost at sea, demurrage cost of ships waiting in ports, storage cost in ports, and also inland transportation cost *ceteris paribus* increase with the respective time needed.
- On the other hand, there is a *valuation of time* that does not directly correspond with transportation cost but accounts for capital costs (interest on the cargo), deterioration, costs of shortage of stock, fines for delay, etc., and also a general time preference of the shipper. Blauwens and van de Voorde (1988, cf. Annex 1) estimate the valuation of time as 0.00848% of the cargo value per hour (= 0.2035% of the cargo value per

day). As such, the time value per se is relatively minor for most cargoes (as compared to transport costs).

The transport cost-related aspect of time is automatically accounted for when analysing effects related to transportation cost. The time value aspect, on the other hand, may be assessed through a valuation following Blauwens and van de Voorde (1988). The resulting time valuation may then be allocated as monetary savings to different sectors.[22] For the purpose of the model, a default attribution to sectors is assumed as 10% *Communication*, 20% *Finance & Insurance*, and 20% *Other Services*. As a tentative approach, 50% of the time value are not allocated to sectors – a certain proportion of the time valuation accounts just for a time preference of the shipper and may not be monetized.

[22] For this, assumptions about an allocation to sectors must be made – the revealed preference method as used by Blauwens and van de Voorde provides no specific information as to how to allocate time values to sectors. Generally, however, it should be noted that it may be reasonable not to monetize all time savings, considering that the value of time also accounts for a general non-monetary time-preference of the shipper.

Summary – Theory of Change

The following *Theory of Change* summarises the aforementioned impacts and highlights their impact on the World Bank's *Twin Goals*.

Figure 7: Theory of Change – IFC Seaport Investments

Source: HPC 2016

3.2.2 Determination of the Relevant Traffic Differential

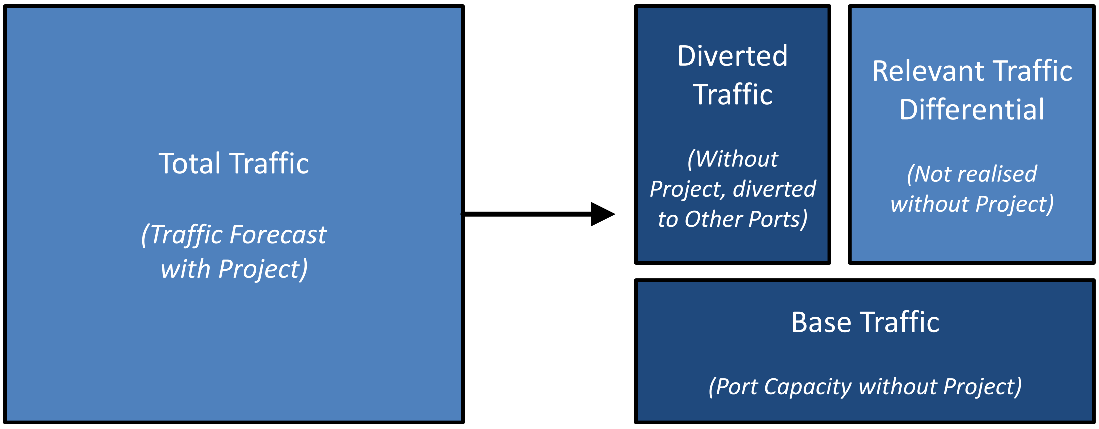
As the objective is to quantify the *net economic impact* of IFC's seaport developments, it is principally required to identify both the scenario with project as well as the *counterfactual case*, i.e. the scenario without project.

Comparison of these two scenarios is key in the determination of the *relevant traffic differential* for the various cargo types and traffic types (cf. Figure 8).

- In case of a port expansion, some *base traffic* may be handled by the port also in the scenario without project (typically as much as the port's capacity before expansion).
- The *traffic differential* for the port thus is the difference between traffic handled in the scenarios with and without project. However, the traffic differential may be variably relevant in terms of the economic impact:
  - A share of the traffic differential may actually be *diverted* to other ports in the scenario without project, provided diversion costs are not too high and potential alternative ports have sufficient capacity. This traffic may be subject to different transportation cost (cf. the discussion in Section 3.2.1) yet has no impact in terms of additional traffic volumes.
  - The residual of the traffic differential that is *not* diverted in the scenario without project is the *relevant traffic differential.* This traffic, which by definition would not be realised without the project, impacts the economy in terms of additional traffic volumes (cf. the discussion in Section 3.2.1).

The following figure illustrates the different components of traffic in a schematic way.

Figure 8: Decomposition of Traffic

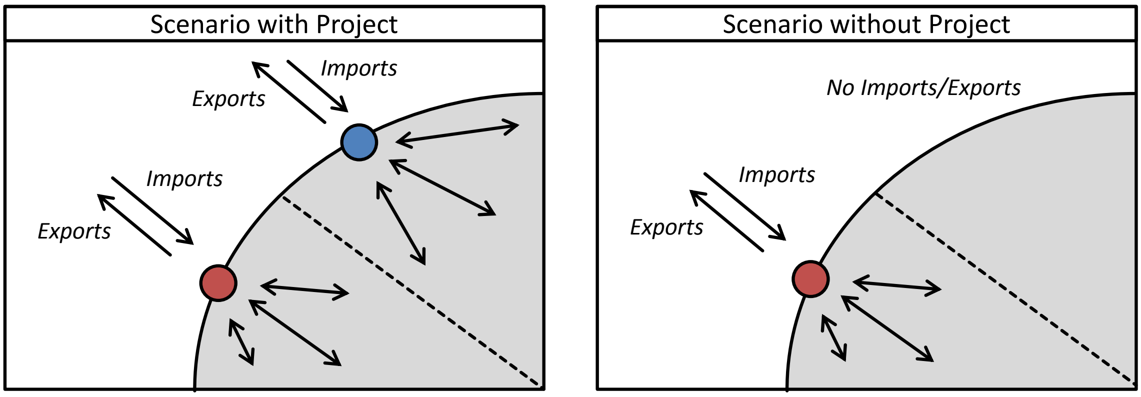


Source: HPC 2016

The economic impact in terms of traffic volumes is realised only for the relevant traffic differential. Conversely, the diverted traffic (and possibly base traffic) may be subject to reductions in transportation cost.[23]

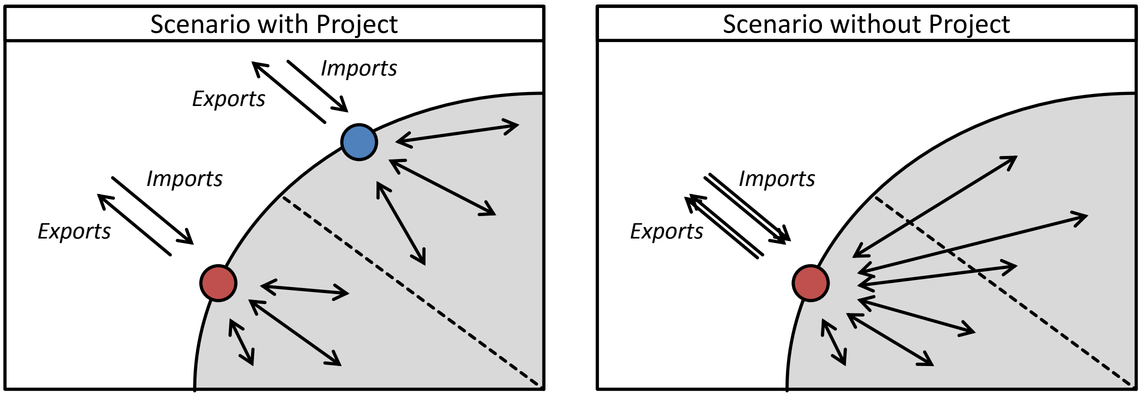
As such, the economic impact of a port may critically depend, inter alia, on its location in the country (the transport network in general), existence of competitors, as well as the elasticity of traffic demand to transport costs.

Figure 9: Maximum Impact Case (No Diversion)



Source: HPC 2016

Figure 10: Minimum Impact Case (Full Diversion)



Source: HPC 2016

Figure 9 and Figure 10 provide schematic depictions of extreme cases of the economic impact regarding imports and exports.

[23] Possible cases where cost/time reductions also apply to the base traffic include, inter alia: a lift of congestion (due to higher capacity) and corresponding reduction of vessel waiting times and related demurrage cost; more efficient port operations after expansion; better naval accessibility (e.g. deeper depth of channel and at the quay) allowing for larger ships.

- The *Maximum Impact Case* (Figure 9) shows the development of a seaport in the northern part of a country (in blue), while there is an existing port in the south (in red). Assuming that the port in the south has no excess capacity *or* foreign trade is sufficiently elastic to transport costs, the development of the new port will have maximum economic impact. In the scenario without project, imports and exports to/from the northern part of the country will not be realised.
- The *Minimum Impact Case* (Figure 10) shows the development of a seaport in the northern part of a country (in blue), while there is an existing port in the south (in red). Assuming that the port in the south has sufficient excess capacity and foreign trade is sufficiently inelastic to transport costs, the development of the new port will not have an impact on the volume of foreign trade. In the scenario without project, imports and exports to/from the northern part of the country will simply be diverted via the southern port.

For a given port project, the port's impact will be somewhere between these two idealised cases. The *relevant traffic differential* generally depends on available alternatives in the scenario without project, the additional cost for a possible diversion, and the elasticity to transport price.

Figure 11 overleaf provides a numerical example as to how the relevant traffic differential may be calculated for imports and exports. However, while an analytic determination of the relevant traffic differential is generally possible, it is typically not considered practical or possible with the available data.[24]

It should thus be left to the user whether the *relevant traffic differential* (as a share of the traffic differential) is to be derived analytically or, alternatively, be entered based on a rough analysis of the project context.

Such rough analysis should be possible and reasonable for most projects – often the project documents provide information such as, e.g., that all relevant competitor ports are congested and accordingly no excess capacity exists. It should further be expected that IFC's project team or the project's technical consultants, who are familiar with the

[24] An analytic determination in principle requires full knowledge of other ports, alternative transport routings and the implicated cost, as well as the elasticity of exports or imports (and other traffic types) to transport cost. It is expected that sufficient data for this is typically *not available* in most of the project documentations. In addition, the determination of the traffic differential may have to be conducted separately for each cargo type and traffic type. It may even be reasonable or necessary to distinguish different commodities transported under the same cargo type, if port alternatives for these commodities are different. Thus, it is not guaranteed that such an analysis can be conducted – and if it is possible, it may still be arbitrarily complex and may have to be conducted for a large number of different cases (commodities, cargo types, traffic types).

specific context of a project, can provide good judgement regarding the share of the traffic differential that shall be accounted for as the relevant traffic differential.

Figure 11: Example: Determination of the Relevant Traffic Differential

Consider the following example for calculating the diverted traffic and the relevant traffic differential for imports and exports:

- Development of a new port (*blue port*, cf. Figure 9/Figure 10).
- In the scenario with project, the traffic at the blue port is forecast as follows:
  - Imports: 100,000 tons at a CIF price of USD 1.0 billion (unit value: 10,000 USD/ton);
  - Exports: 150,000 tons at a FOB price of USD 750 million (unit value: 5,000 USD/ton).
- In the scenario without project, imports/exports could alternatively be routed via a competitor port (*red port*). Distinguish two cases:
  - *Case A*: the red port operates at capacity and has no excess capacity;
  - *Case B*: the red port has sufficient excess capacity.
- Diversion of cargo via the red port would implicate:
  - The additional overland transport for a diversion via the red port would cost USD 1,000 per ton.
  - Assume there is no difference in handling costs between blue and red port and there is no difference in shipping costs.
  - Thus the total diversion cost would be USD 1,000 per ton.
  - For imports, the diversion cost is assumed to increase the import price to be paid by the importer accordingly (+10.0% based on previous CIF price)
  - For exports, the diversion cost is assumed to decrease the revenue of the exporter (-20.0% based on previous FOB price).
- Price-elasticities for import demand and export supply are assumed to be -1.05 and 0.76, respectively.
- With constant elasticity *e* of volumes *v* to price *p*, change in volumes Δv subject to change in price Δp amounts to $\Delta v = (1+ \Delta p)^e-1$.
- Results *Case A*:
  - In the scenario without project, no diversion is possible as the red port has no excess capacity. Thus, full impact of the blue port.
  - Relevant import differential: 100,000 tons (100%);
  - Relevant export differential: 150,000 tons (100%).
- Results *Case B*:
  - In principle, diversion is possible in the scenario without project.
  - For imports, volumes are reduced by -9.5% = $(1+10.0\%)^{-1.05}$-1.
  - For exports, volumes are reduced by -15.6% = $(1-20.0\%)^{0.76}$-1.
  - Relevant import differential: 9,523 tons (9.5%); diverted imports: 90,477 tons (90.5%);
  - Relevant export differential: 23,398 tons (15.6%); diverted exports: 126,602 tons (84.4%).

Note: Price-elasticities of imports and exports are actual elasticities for Colombia (long-run elasticities incl. GE-effects) from S. Tokarick, *A Method for Calculating Export Supply and Import Demand Elasticities*, IMF Working Paper 2010.

Source: HPC 2016

3.2.3 Economic Impact Assessment for Different Impact Types

Section 3.2.1 discussed the different types of impacts to be considered in the model. The following paragraphs describe how these impacts may be assessed in the framework of IO/SAM, quantifying the impacts in terms of GDP (value added) and jobs. For a general discussion of economic impact assessment with IO/SAM, cf. Section 2.1.

Generally, it should be noted that the *port development* may be assessed with regard to the aggregate impact of the investment. All other impacts (*port operation* and *second order growth effects*) are to be assessed for an average year during the later operation, e.g. when the port has reached its full impact in terms of realised traffic.

Development and Operation of the Port

The *port development* and *port operation* may be assessed in terms of their direct, indirect, and induced effects.

- *Port development*: investment cost (CapEx) may be applied to the SAM as exogenous demand shocks. To do so, one has to correctly map investment cost to the model sectors.

  To allow for a clear interpretation of the results, the tool conducts an assessment of the *impact of the average investment per year during the investment phase(s)*.[25]

- *Port operation*: operations may be assessed in two ways:
  - Revenues may be applied to the SAM as an exogenous shock of demand for water transport.
  - Operating cost (OpEx) may be applied to the SAM as exogenous demand shocks. To do so, one has to correctly map operating cost to the model sectors.

  The approach based on revenues has the advantage that it is easier and more direct (and needs less information); in addition, it takes into account the operating margin of the port (and thus the corresponding induced effects).[26]

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[25] The impact in terms of employment may be misleading if considering the aggregate investment for an investment period of more than 1 year – corresponding employment figures should then be interpreted as “job-years”. Consideration of the average investment per year during the investment phase(s) (= total investment / duration in years) allows for a clear interpretation of employment figures as “number of jobs for one year” for, on average, each year of the investment phases.

[26] However, the revenue-approach assumes that the cost and profit structure of the port resembles that of the overall water transport sector. Thus, the cost-approach should only be preferred if (i) revenues do not correspond well with the structure of the water transport sector and (ii) the cost components can be allocated to sectors in a reasonable way.

Second Order Growth Effects – Traffic Volumes

The *second order growth effects* of additional traffic may be analysed using IO/SAM but subject to the type of traffic.

For all traffic types, it is crucial to only consider the *relevant traffic differential* (cf. Section 3.2.2). Further, it is crucial to associate the cargo volumes for imports, exports, and domestic traffic with trade values for each commodity sector (cf. Section 3.1.3).

Then, as discussed in Section 3.2.1, there are generally two types of second order growth effects related to traffic volumes: *demand effects* (for exports and domestic traffic) and *supply effects* (for imports and domestic traffic).

- *Demand effects (exports and domestic traffic)*: demand effects are assessed as exogenous demand shocks, i.e. the direct effect and the related indirect and induced effects (backward linkages);
- *Supply effects (imports and domestic traffic)*: supply effects may be relevant assuming that – without the project – there is constraint capacity for imports/domestic cargo that are required as intermediate inputs for production.

  In this case, additional port capacity may lift the supply constraint for the respective intermediates and thus enable economic output to grow. For this, it is assumed that the economy grows along the lines of the structure of the existing economy:
  - Imports/domestic intermediates are distributed among production activities and consumption and other accounts in the same way as represented in the SAM.
  - Assuming a fixed input structure (domestic and imported intermediates and factor inputs), each sector then produces additional output proportional to the additional imports/domestic intermediates.

  Essentially, the above assumptions boil down to the following: the output of all sectors may expand in a manner proportional to the additional supply of imports/domestic intermediates.

  The model however yet accounts for the following two considerations: (i) additional supply for imports/domestic cargo may be distributed uneven across sectors and (ii) in case of a violation of the above two assumptions, the extent of the supply effect may be less than proportional as compared to the increase in supply.

  (i) In case that the additional supply for imports/domestic cargo is uneven across sectors (in relative terms)[27] – which is typically the case – the model considers

[27] Relative increases are considered separately for each commodity sector. For imports, the relative increase is considered relative to the total imports of each commodity sector. For domestic cargo, the increase is considered relative to all domestic supply less exports

the overall relative increase of imports or domestic supply. Such overall relative increase is equal to the weighted average of sectoral relative increases (weights for imports: sectoral import values; weights domestic cargo: sectoral domestic supply less exports). Output may then be considered to increase proportional to the overall relative increase of imports or domestic cargo.[28]

(ii) As discussed in Section 2.1, the above two assumptions may not always hold to full extent, then resulting in a supply effect that is less than proportional. To account for this, the model further contains two scaling parameters – one for imports and one for domestic cargo – that determine the extent of the respective supply effects (if set to 0%, there is no supply effect; if set to 100%, the supply effect is considered to full extent; in between, scaling is linear). For imports, which may substitute domestic intermediates, a conservative choice of 25% is recommended as a default option for the extent of the supply effect (cf. the discussion in 2.1 and the review of Marwah and Tavakoli, 2004, in Annex 1). For domestic cargoes, no ambiguous effect may be expected as for imports. Thus, it is recommended to have the default extent of the supply effect as 100%.

For the overall supply effect, the model then considers it sufficient if the port achieves the supply effect either through additional capacities for imports or additional capacities for domestic cargoes.[29]

In addition to the above effects, the model provides the option to consider *exogenous demand shocks for hinterland transport* (land transport: road, rail, or pipeline; water transport: barge) for the relevant traffic differential.[30] Such services are then assessed in terms of their direct, indirect and induced effect.

Transit traffic and *transhipment* have no comparable demand or supply effects as exports, imports, or domestic. For transit traffic, the impact mainly lies in the required hinterland

of each commodity sector. The latter may underestimate the supply effect of domestic cargo, considering that the relative increase is not just related to total domestic cargo (which is unknown, and typically less than domestic supply excl. exports).

[28] This approach can also be motivated as follows (example illustration for imports): assume that a port provides x% additional capacity for just one sector, e.g., imports of *Chemicals&Minerals&Metals*, but no other import capacity. As such, the additional capacity in terms of overall imports, y%, is smaller than x%. Assuming that the economy will grow along the lines of the structure of the existing economy, the port thus contributes some but not all of the required imports to grow overall by x%. Assuming other import capacities are sufficiently provided by other facilities in the country, additional output then is enabled to grow overall by x%. The port at hand however only contributes a fraction of d = y/x, thus accounting for additional economic output of d * x% = y%.

[29] The aggregate supply effect of imports and domestic cargo is considered as the maximum of the two supply effects.

[30] Other traffic-related services such as, e.g., finance & insurance or communication, are not considered for the model as they are expected to have a relatively minor impact and typically no data should be available.

transport between the port and the origin / destination country (see previous paragraph). Transhipment has typically no impact other than the corresponding operation at the port.

Second Order Growth Effects – Transportation Cost and Time

The impact of a reduction of transportation cost and time for imports and domestic traffic is analysed in the following way. Note that only diverted traffic and (possibly) base traffic may be subject to reductions in transportation cost (cf. Section 3.2.2). Cost/time savings are to be entered separately for diverted traffic and, if relevant, base traffic.

Relevant input data to the model comprises *unit cost savings (USD/TEU or USD/ton)* and *time savings (days)* for seaborne shipping, port, and hinterland transport (land / water). Shipping cost savings may be differentiated for imports and domestic traffic; port and hinterland transport (land/water) cost savings are homogeneous across imports and domestic traffic.

Time savings are generally monetized as 0.2% of the cargo value per day (cf. Section 3.2.1). As such, commodities in different sectors are accounted for with different time values, with higher value cargoes being more time-sensitive.

The model then accounts for cost and (monetized) time savings with the following impacts:

- Shipping cost/time savings for imports are assumed to reduce import prices;
- All other transport cost savings are assumed to reduce domestic intermediate transport demand (land transport or water transport);
- All other time savings are assumed to reduce domestic/imported intermediate service demand (communication, finance & insurance, and other services).

In a first step, the model then automatically calculates the input data into relative cost savings for imports, domestic intermediate transport, and other (domestic/imported) intermediate services:[31]

- Savings in transportation cost and time (monetized) in seaborne shipping of imports correspond with lower import prices. Denote *m_i* as the relative reduction (%) of the import price for imports in sector *i*:

[31] Note: for land and water transport, the structure of the SAM only allows for aggregate considerations of cost savings in domestic intermediate services. The SAM does not provide sufficient information to distinguish the relative cost savings for intermediate land and water transport for each output sector. The same caveat pertains to the other intermediate services.

m_i = (total cost and (monetized) time savings in seaborne shipping for imports for commodity sector *i*) / (total import value for commodity sector *i*)

- Cost savings related to shipping of domestic traffic, the port as well as inland waterway transport correspond with a lower demand for domestic water transport services. Denote *t_w* as the relative reduction (%) in the value of intermediate domestic water transport services:

  t_w = (total savings in shipping of domestic traffic, port handling/stay as well as inland waterway transport) / (total domestic intermediate value of water transport sector)

- Cost savings related to hinterland transport (road, rail pipeline) correspond with a lower demand for domestic land transport services. Denote *t_l* as the relative reduction (%) in the value of intermediate domestic land transport services:

  t_l = (total savings in hinterland transport (road, rail pipeline)) / (total domestic intermediate value of land transport sector).

- Reductions in transportation time (except for seaborne shipping of imports) translate into lower demand for different (domestic/imported) intermediate services (cf. Section 3.2.1). The total time valuations (0.2% of the cargo values per day) are attributed to the sectors communication (10%), finance & insurance (20%), and other services (20%). The rest of 50% are tentatively considered as non-monetary (general time preference of the shipper) and are thus not attributed as monetary savings.

  Denote *s_c, s_fi, s_os* as the relative reductions (%) in the value of intermediate demand for domestic/imported communication / finance & insurance / other services, respectively:

  s_c = (total monetized time savings for communication) / (total domestic/imported intermediate value of communication sector).

  s_fi = (total monetized time savings for finance & insurance) / (total domestic/imported intermediate value of finance & insurance sector)

  s_os = (total monetized savings for other services) / (total domestic/imported intermediate value of other services sector).

In a second step, the original SAM is modified to account for the derived changes of import prices, domestic land/water transport demand, and other domestic/imported intermediate services.

- For the columns of all production sectors:
  - Decrease the intermediate input of each import commodity *i* by *m_i*.
  - Decrease the intermediate input of domestic *water transport* by *t_w* and the intermediate input of domestic *land transport* by *t_l*.

- Decrease the intermediate input of domestic and imported *communication* by *s_c*, the intermediate input of domestic and imported *finance & insurance* by *s_fi* and the intermediate input of domestic and imported *other services* by *s_os*.
- Add the total reduction in intermediate inputs proportionally to the *value added (capital)* and *taxes*.[32]

- For the columns of final demand accounts (households, government, investment), decrease the demand for each import commodity *i* by *m_i*.

- For the production sectors *water transport*, *land transport*, *communication*, *finance & insurance*, and *other services*, rescale columns such that expenditure equals income.

  For the domestic supply sectors *water transport*, *land transport*, *communication*, *finance & insurance*, and *other services*, rescale columns such that expenditure equals income.

  For the columns of import commodity sectors *i*, rescale columns such that expenditure equals income.

  For the import supply sectors *communication*, *finance & insurance*, and *other services*, rescale columns such that expenditure equals income.

- For the columns of factor inputs, rescale columns such that factor income equals factor expenditures.

- For the columns of final demand accounts (households, government, investment), reallocate total savings in imports proportionally to demand for domestic and import commodities/services.[33]

- Rescale all columns of production sectors such that income equals expenditure.

  Rescale all columns of domestic supply sectors such that income equals expenditure.

[32] This assumes that lower intermediate costs in production benefit the firms and do not per se result in higher wages.

[33] Rescaling such that total expenditure of each final demand account is unchanged serves to minimise the disturbance to be corrected by the later application of the RAS algorithm. The simple rescaling of domestic and import demand further assumes that the income that becomes available due to lower import prices increases demand for all domestic and import commodities/services in a similar way.

In a third step, the resulting SAM is balanced algorithmically with the RAS balancing algorithm.[34,35]

Finally, comparison of the new and old SAM indicates the increase in output and value added (GDP) due to lower transportation costs and time.

3.2.4 Miscellaneous Considerations

The following paragraphs briefly discuss some technical issues related to the assessment of impacts.

Aggregate Character of Impacts

It should be noted that the IO or SAM model does not provide an indication regarding the time frame for the realisation of the above chain of effects. One should therefore remain cautious in assigning outcomes of indirect and induced effects to particular years. Instead, it is recommended to interpret the direct, indirect and induced effects only in an aggregate way, being realised not necessarily in the year of the respective stimulus but being realised over time.

Simultaneous Impact Assessment and Double Counting

One technical issue lies in the potential double counting of effects when jointly analysing the different impacts.[36]

For the impact of the investment, there is no risk of double counting since investment is an exogenous account in the SAM approach.

The risk thus pertains to the operational impact and the related second order growth effects:

- The *demand effects* of exports and domestic traffic account for all indirect effects along the supply chain through backward linkages. As such, it is possible that the port operation and associated services (if such shocks are specified) are accounted for to

[34] The model applies the RAS algorithm with a maximum of 1,000 iterations, which should provide sufficient accuracy for all relevant cases. For a technical description of the RAS algorithm, see for instance J.C. Parra and Q. Wodon, *SimSIP SAM: A Tool for the Analysis of Input-Output Tables and Social Accounting Matrices*, The World Bank, 2010.

[35] RAS was also applied in the study for the Philippines power sector by Steward Redqueen (2015).

[36] An extension of the model to full blown CGE modelling could be suitable to overcome the issue of double counting, as then all impacts (demand effects, supply effects, cost/time effects) could be estimated simultaneously and more consistently (also cf. Section 3.3.1). However a model based on CGE entails substantially increased data and computational requirements.

some extent. However, the SAM unfortunately does not provide information that allows to specify the extent of the potential double counting.

- The *supply effects* of imports and domestic traffic enable the economy to grow overall, with the same economic structure as represented in the SAM. As such, these effects also account for an increase in port operations as well as additional domestic supply related to the demand effects of exports and domestic traffic.

As a rough *rule of thumb* to avoid at least heavy double counting, the model does not aggregate (a) the impacts of supply effects and (b) the impact of operations, hinterland traffic, and demand effects. For these impacts, the model considers the maximum of either (a) or (b) for each sector. After this, the impact of transport cost/time reductions is added, thus resulting in the aggregate impact for the operation of the port.

Estimation of Employment Effects

The IO/SAM approach is used to compute the impact in terms of value added (GDP) and jobs. While value added is a direct output of the standard IO/SAM approach, jobs are calculated per sector subject to each sector's *employment coefficient*, which is the number of jobs per gross output.

Assuming constant employment coefficients over time, additional output in each sector as resulting from the different impacts is converted into corresponding job figures.

It should be noted that – for all impacts such as investment, operations, demand effects and supply effects – the relative increase in terms of GDP or jobs is the same *per sector* (both are proportional to the increase in output). For the aggregated impacts across sectors, the relative change of GDP and jobs need not be the same although typically they are similar.[37,38]

[37] Both relative effects – in terms of GDP and jobs – are relatively similar *at least* whenever the impact of the supply effect is dominant, due to the fact that the supply effect impacts all sectors to the same relative degree.

[38] Also, the same may not hold for the impact of cost/time reductions, which alter the structure of the SAM (and thus change the ratio between GDP and output).

3.3 Assumptions and Limitations

This section lists and discusses all relevant assumptions required for the proposed methodology.

3.3.1 Basic Assumptions of IO/SAM

The methodology for impact assessment in the framework of IO/SAM makes a variety of relevant assumptions:

- Fixed prices: all prices in the economy are assumed to be constant, irrespective of changes in demand.
- Constant returns to scale: the sectoral production functions are assumed to be homogenous of degree 1, meaning that the optimal ratio between output and inputs is constant irrespective of the level of production.
- Fixed input structure: the mix of inputs in production is always assumed to be fixed in the way this is represented in the IO table or SAM. There is no substitutability of inputs, in particular not between domestic and imported intermediates.
- Capacity constraints:[39]
    - The basic analysis of the impact of exogenous demand shocks assumes that production inputs are unrestricted.
    - For the analysis of supply effects, however, it is assumed that the relevant imports or domestic cargo, for which capacity is added, constitute a constraint in the scenario without project.
- Static economy: the IO/SAM coefficients are assumed to be constant over time, representing a static economy.

The validity of the above assumptions should be sufficient if the analysed final demand shocks are not too large.

[39] It should be noted that there is an inconsistency between the assumptions for, on the one hand, the classical demand-side IO/SAM approach (exogenous demand with unconstrained supply) and, on the other hand, the supply-side IO/SAM approach (exogenous supply with unconstrained demand). This conflict cannot be resolved within the framework of IO/SAM if both the demand effects and supply effects are to be analysed simultaneously – a possible resolution could be using a full blown CGE framework instead of IO/SAM. For a discussion of the related double-counting issue and how this is treated in the model, cf. Section 3.2.4.

3.3.2 Discussion of General and Port-Specific Issues

The following paragraphs discuss a variety of issues arising in the application of IO/SAM, generally and in the context of seaports.

General Applicability of the SAM

Application of the IO/SAM approach requires the assumption that the economy is described by the SAM in an accurate manner (assumption of a static economy). This is typically not fully satisfied in itself:

- The SAMs are typically based on economic data from a few or several years ago. The GTAP 9 database, which is the data source for SAM data, uses the reference year 2011 – the underlying source data often is significantly older: for the 20 countries to be investigated, the source data is from between 1998 and 2007. Older data may correspond less accurately with the economic structure to be modelled.
- The ex-ante assessment of the economic impact of IFC's seaport projects will have to apply the IO/SAM approach from to the end of the respective project horizon – this typically corresponds with a time period of about 10-20 years or sometimes more. It is clear that the validity of results may be somewhat limited as the gap between IO/SAM data source year and the year of predicted impact becomes larger.

Complementary Imports

One critical issue lies in the fact that any of the considered impacts, through stimulating economic activity in general, induces *complementary demand for imports in all sectors*. Consider the following illustrative cases:

- An exogenous demand shock for the export of any given commodity, for instance, may induce demand for all commodity imports, which are used as intermediate inputs in the production processes and also for consumption.
- When analysing supply effects, an increase in the supply of imports of a single commodity is assumed to enable economic output to increase in all sectors. This then also implies – assuming an invariant economic structure – that all other imports increase by the same relative amount (cf. the discussion on uneven sectoral import capacity, particularly footnote 28, in Section 3.2.3).

It is an important assumption that such complementary imports may be realised – either through the port at hand or elsewhere (other ports or via land transport). Subject to the project context at hand, this may or may not be a critical assumption.[40]

Assessment of Transportation Cost and Time Effects

It should be noted that the methodology to assess the impact of transportation cost and time effects is a heuristic approach.

For once, the adaptation of the SAM as described in Section 3.2.3 is a one-sided and one-off reaction of demand and production to the cost changes.[41] While the described round of adjustments could, in principle, take place more than once, the one-off reaction of demand and then production can be considered as a conservative approach which tends not to overestimate the effects.

In addition, the application of a (purely mathematical) balancing algorithm such as RAS does not produce analytically derived results but should only be seen as an approximate indication. Results should be sufficiently plausible, however, when the modelled turbulences are not too large.

Validity of IO/SAM in the Context of Port Projects

In the context of seaport developments, there may be general issues with the applicability of IO/SAM.

In some cases, the port development itself may have such an impact on the economy – for instance in terms of foreign trade – that application of IO/SAM analysis may not be justified: the economic structure as shown in the SAM may not correspond well with the economic development in the scenario with project.

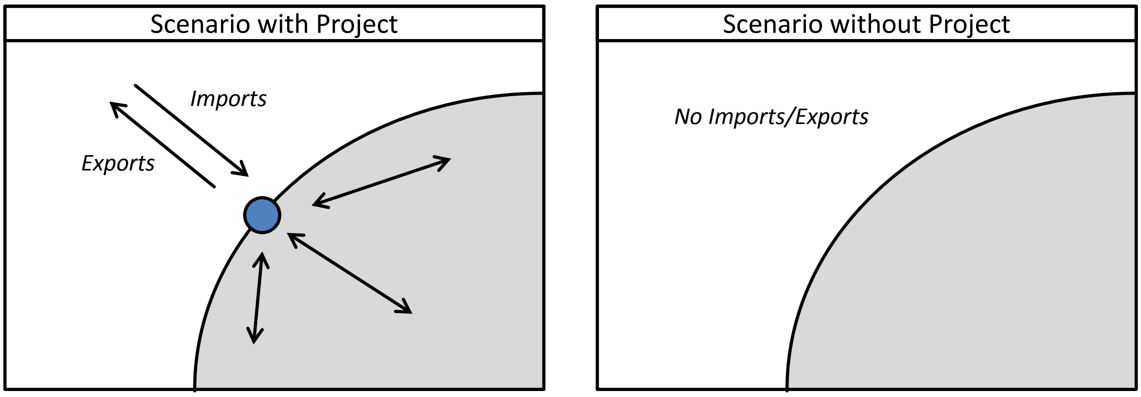
As an idealised example, consider a new port being developed in a country that – without the port – has essentially no foreign trade due to absence of alternative routings (cf. the schematic depiction in Figure 12). So the impact of the new port is effectively that it

[40] Note that the same consideration applies to IO/SAM in general and also IFC's model for the power sector. In the latter, an increase in energy supply translates into overall economic growth – and thus an increase of production in all sectors as well as additional imports.

[41] The adaptation does not take into account information about price-elasticities or substitution effects. Sandu (2007) and Steward Redqueen (2015) provide examples as how these typical features of CGE models can be accounted for in IO/SAM in a more specific context. For a general model for transportation as it is set up here, it does not seem possible to incorporate such mechanisms due to the significant complexity and corresponding substantial data requirements.

allows for foreign trade. Application of IO/SAM then is not valid as there is no representation of foreign trade in the IO/SAM table.

Figure 12: Port Development in Conflict with IO/SAM Assumptions



Source: HPC 2016

This is also related to the issue of complementary imports. Ports that create capacity only for specific import commodities also induce demand for complementary imports. The given methodology then requires that such complementary imports can be handled in other port facilities or may be transported overland. Plausibility of the results depends on the plausibility of this assumption (and thus on the larger project context).

The issue is less critical for port projects that create capacity in line with the existing structure of foreign trade.

Potential Inconsistencies between Traffic Forecasts and SAM Structure

It should further be said that inconsistencies may arise between the static structure of the SAM and the traffic forecast from the project documentation.

- Traffic forecasts often take into account – be it explicitly or implicitly – specific changes in the structure of foreign trade or in the degree of openness of the economy.
- As such, traffic forecasts may account for a more dynamic development foreign trade, or may also take into account specific information with regard to the development of particular industries (which may deviate from the overall economic development).
- As a consequence, the traffic forecast may contradict the assumption of an invariant structure of the economy as needed for IO/SAM. A more dynamic forecast of imports as compared to overall GDP may hint at an increasing share of imports as intermediates for domestic production.

The latter point may be particularly relevant for the assessment of the supply effects, see discussion above. A traffic forecast for imports that is more dynamic than the overall economic development may thus lead to an overestimation of the supply effect of imports – in these cases, it is recommended not to assess the supply effect to full extent.

General Applicability of the Port Impact Analysis

In addition to the possible difficulties with regard to the validity of assumptions and the consistency of input data and results, the following should be noted.

The economic impact assessment for seaport projects as developed here is not suited for a comparison of different development options. The model aims to provide a rough indication of the economic impact of a port development. It is not sufficiently exact or reliable to serve as a basis for the selection of a best development option.

In addition, it should be noted that the analysis is dependent on the appropriateness of the underlying traffic forecast, which is assumed to reasonably account for potential demand for cargo traffic such as imports and exports. Thus, the model may not be applied to assess an arbitrary rescaling of the project dimensions (project cost, capacities, traffic forecast) and corresponding changes in economic impact.

4. USER GUIDE FOR THE TOOL

The model has been implemented as a tool in MS Excel with algorithmic support in Excel's underlying programming language Visual Basic for Applications (VBA). This chapter presents the tool and a step-by-step guide for its application.

4.1 Overview of the Tool

The tool **PEIA - Model.xlsx** provides access to overall 21 worksheets: one worksheet for essential input data (to be filled by the user), one worksheet with economic assumptions (optional input), eight worksheets for model output, six worksheets for auxiliary calculations, and five worksheets with source data for the 20+ countries.

Table 6: List of Worksheets

Worksheet	Description
Input (Shocks and Traffic)	Input of general data as well as shocks and traffic [*mandatory input*].
Economic Assumptions	Collection of all relevant economic assumptions [*optional input*].
Impact – Summary	Summary of impacts (GDP and jobs) by impact type and sector.
Impact – Sensitivity	Sensitivity analysis for the total impact during operation.
Impact – Investment	Detailed impact: investment.
Impact – Operations	Detailed impact: operation.
Impact – Demand Effects	Detailed impact: demand effects (exports, domestic traffic).
Impact – Supply Effects	Detailed impact: supply effects (imports, domestic traffic).
Impact – Cost and Time	Detailed impact: cost/time effects (imports, domestic traffic).
Impact – Hinterland Transport	Detailed impact: hinterland transport.
Aux – Misc. Data	Various indicators derived from the SAM and input data.
Aux – Unit Shocks (Type I)	Computation of Leontief-Inverse and type-I unit shock effects.
Aux – Unit Shocks (Type II)	Computation of Leontief-Inverse and type-II unit shock effects.
Aux – Base SAM	Basic SAM (raw)
Aux – Base SAM (Balanced)	Basic SAM [*to be balanced with macro* Run Model].
Aux – Modified SAM (Balanced)	Cost/time-modified SAM [*to be balanced with macro* Run Model].
Source Data – GDP	Real GDP data for the 20+ countries.
Source Data – Inflation	Inflation data for the 20+ countries.
Source Data – Employment	Sectoral employment data for the 20+ countries.
Source Data – Trade Values	Sectoral unit trade values (exports/imports) for the 20+ countries.
Source Data – SAMs	SAM data for the 20+ countries.

Note: In addition there are six hidden worksheets containing auxiliary calculations for the cost/time adaptation of the SAM.

Source: HPC 2016

COLOUR CODING

Mandatory input (if applicable)	
Optional input	
Key results	
Notes & Comments	

The tool uses colour coding to allow for an intuitive recognition of input cells:

- Cells for mandatory user input (if applicable) are marked in light yellow.
- Optional input to replace default assumptions in the worksheet ***Economic Assumptions*** is marked in light green.
- Key results are reported with light red background.
- Explanatory notes are marked in light blue – for detailed notes, it may further be indicated that the user should rollover the respective field with the mouse.

The tool further provides two *macros*, i.e. algorithms implemented in Visual Basic for Applications (VBA) to run the model and sensitivity analysis (cf. Section 4.3.4). *It is crucial that the user runs both macros after specification of all relevant input data*.

4.2 Overview of Data Requirements and Sources

The input data in the worksheet ***Input (Shocks and Traffic)*** is *mandatory* – with the exception that some effects may not apply or may be deliberately omitted by the user. The following table provides an overview of all relevant input data.

Table 7: Input Data (Mandatory User Input)

Input Data	Data Source	Description / Comments
Project Name and Country	*Project Docs*	The country is to be chosen from a drop-down menu, which comprises countries for which a SAM is included in Worksheet ***Source Data - SAMs***.
Reference Years	*Project Docs*	For the investment, this should be the year when construction started. For operations, this should typically be a year when "full operations" are reached.
Price Years	*Project Docs*	Here the user should specify the years of the prices for monetary input data (investment, operation, cost/time savings, and hinterland transport).
Investment Shock	*Project Docs*	Investment cost, required with breakdown into different cost categories (e.g. equipment and construction). In addition: duration of investment phase(s) in years.
Operation Shock	*Project Docs*	Alternative input data: revenues or operating cost. The approach based on revenues is recommended. If operating cost are used, they are required with a breakdown into different cost categories.
Traffic Volumes	*Project Docs*	Traffic volumes including breakdown into different traffic and cargo types. *For dry and liquid bulk, information about the handled commodities should be available. It is recommended to replace the default assumptions for trade values for these cargo types (in worksheet **Economic Assumptions**).*
Capacities	*Project Docs*	*Only relevant for port expansions*. For port expansions, capacities should be entered as before the expansion.
Relevant Traffic Differential	*Project Docs*	*Typically, some (qualitative) information should be available to determine a reasonable assumption for the relevant traffic differential.*
Transportation Cost and Time Savings	*Project Docs*	*Unit cost and time savings to be determined based on a comparison of* scenarios with and without project. *Cost and time savings to be provided separately for* diverted traffic *and, if relevant,* base traffic *(cf. Section 3.2.2).* *Cost and time savings possibly may have to be assessed separately for each cargo type.*
Hinterland Transport	*Project Docs*	*If available, information on unit costs for hinterland transport for the different cargo and traffic types.*

Source: HPC 2016

All assumptions in the worksheet ***Economic Assumptions*** are provided with default values – however, the user may optionally replace assumptions where better data is available. The following table provides an overview of assumptions and default values.

Table 8: Assumptions (Optional User Input)

Assumptions	Optional Data Source	Description / Comments
Increase of real GDP		Default values are derived subject to the Reference Years and the real GDP data in worksheet ***Source Data – GDP.***
Inflation		Default values are derived subject to the Price Years and the inflation data in worksheet ***Source Data – Inflation.***
Employment		Default values are imported from the worksheet ***Source Data – Employment.***
Container Volumes (Tons per TEU)	*Project Docs*	Default values are derived based on the trade data contained in the SAM and using the sector correspondences for containers and the unit trade values (specified under *trade values* in the same worksheet). May be replaced if specific information is available.
Extent of Supply Effects	*Project Docs*	Default value for imports: 25.0%. Default value for domestic cargoes: 100.0%. The extent of the supply effect for imports may be changed if the user assumes that this effect is higher/lower, subject to the character of import commodities.
Domestic Cargo (%) in Domestic Traffic	*Project Docs*	Default value: 100.0%. This value should be lowered if there is an indication that domestic traffic contains a substantial amount of imported cargoes and not just domestically produced cargoes.
Valuation of Time		Default *value of time*: 0.2% of the cargo value per day. Default *attribution of the time value to sectors*: Communication 10.0%, Finance&Insurance 20.0%, OtherServices 20.0%.
Sectoral Trade Values (Exports, Imports, Domestic Traffic)	*Project Docs, UN Comtrade*	Sectoral trade values of exports, imports, and domestic traffic are automatically derived from the relevant traffic differential of the different cargo types. The user may overwrite any of the following steps of the calculation with optional user input): • *Sector weights determining the correspondence between cargo types and sectors*: as default value, the tool uses the sector correspondences presented in Section 3.1.3. • *Sectoral cargo distribution (based on volume):* default values are calculated automatically from other data. • *Sectoral relevant trade differentials (volume in k TEU or k tons):* default values are calculated automatically from other data. • *Sectoral unit values (USD per ton)*: default values are provided with the model (contained in worksheet ***Source Data – Trade Values***)

Source: HPC 2016

Finally there is economic source data contained in the five source data worksheets: various economic data (real GDP, inflation, sectoral employment, sectoral unit trade values) and the Social Accounting Matrices. *This data is included in the model for the 20 relevant countries.*

Table 9: Country Data – SAM and Economic Data

Data Item	Data Source	Description / Comments
GDP Data	IMF World Economic Outlook Database	GDP data: GDP in constant prices (in national currencies in Billions). *Included in the model for the relevant 20 countries.*
Inflation Data	IMF World Economic Outlook Database	Inflation data: Inflation, end of period consumer prices (index). *Included in the model for the relevant 20 countries.*
Employment Data	ILOSTAT	Data from ILOSTAT database, if available for the SAM Year 2011. In some cases, low detail of the classification requires manual allocation to model sectors based on sectoral GDP shares. *Included in the model for 19 of the relevant 20 countries (except Togo, for which no employment data is available).*
Imports/Exports: Value / Ton	UN Comtrade	Derived from UN Comtrade. In USD / ton, if available for the SAM Year 2011. *Included in the model for the relevant 20 countries.*
Country SAMs	GTAP 9	SAMs derived from GTAP 9. *Included in the model for the relevant 20 countries.*

Source: HPC 2016

Annex 2 provides a manual for the addition of country data to the model – including the extraction of SAMs from GTAP 9 and the derivation of unit trade values from UN Comtrade.

4.3 Application of the Tool

This section presents how the tool may be used, including how to enter relevant input data and modify assumptions, how to run macros, and the resulting output of the model.

Section 4.3.1 first provides a quick checklist – an overview of all relevant steps for using the tool. Then, Section 4.3.2 follows with a step-by-step description of the mandatory input required by the user in the worksheet ***Input (Shocks and Traffic)***. Section 4.3.3 provides a description of the relevant assumptions in worksheet ***Economic Assumptions*** (including default values and guidelines for their replacement). Section 4.3.4 explains how to use the two macros, which have to be run after specification of all input data. Section 4.3.5 provides an overview of the model output.

4.3.1 Quick Checklist and Relevant Considerations

This section provides a quick checklist for the application of the tool (main steps) as well as an overview of relevant considerations.

Quick Checklist for the Application of the Tool

The following checklist provides an overview of the relevant steps for using the tool.

1. Review the project documentations and collect all relevant data.

2. Enter all relevant input in worksheet ***Input (Shocks and Traffic)*** – cf. Section 4.3.2

   - Enter the basic data:
     - Specify *Project Name* and *Country*.
     - Specify the *Reference Years* for *Investment* and *Operation*.
     - Specify the *Price Years* that determine the price level of input figures.
   - Enter the *Expenditure Shocks for the Investment* (Aggregate Investment) including the *Duration of Investment Phase(s)*.
   - Enter the *Expenditure Shocks for the Operation* (Operation Reference Year).
   - Enter all relevant *Traffic Data:*
     - *Traffic Volumes* (Operation Reference Year / Scenario with Project).
     - *Capacities* (Scenario without Project) – only for port expansions.
     - The *Relevant Traffic Differential (%).*
   - If available, specify *Transport Cost and Time Savings.*
   - If available, specify *Hinterland Transport.*

3. Optionally, replace any of the default assumptions in worksheet ***Economic Assumptions*** with project-specific data – provided such specific information is available – cf. Section 4.3.3.

4. *Important*: after specification of all input data and assumptions, activate the macros *Run Model* and *Run Sensitivity Analysis* with the blue and green button in the Quick Access Toolbar – cf. Section 4.3.4. *This step has to be repeated if input data or assumptions are changed.*

5. *Results* are then provided in the worksheets ***Impact – Summary*** and ***Impact – Sensitivity Analysis*** as well as, more detailed, in the other six impact worksheets – cf. Section 4.3.5.

Relevant Considerations

The following points should be considered for the application of the tool and the interpretation of the economic impact of a port development.

- Issues regarding the input data in worksheet ***Input (Shocks and Traffic)***:
  - The user may abstain from consideration of certain effects subject to data availability. This holds in particular for cost/time reductions and hinterland transport, for which information may not always be available. Nonetheless it is generally recommended to, if possible, fully specify the model with regard to all relevant effects.
  - The choice of the *Relevant Traffic Differential (%)* is of central importance while at the same little information may be available to derive this analytically – for the general intuition of how to derive this, cf. Section 3.2.2; for practical guidelines, cf. Section 4.3.2. The sensitivity analysis of the tool serves to assess variations in this assumption.

- The additional economic output enabled by the supply effects may already account to some extent for other impacts such as operations or demand effects (cf. Section 3.2.4). As a conservative and heuristic approach to deal with possible double counting, the tool does not aggregate (a) the impacts of supply effects and (b) the impact of operations, hinterland traffic, and demand effects.

- It should be noted that the model does not provide an indication regarding the time frame for the realisation of the impacts. It is recommended to interpret impacts only in an aggregate way. The comparison of impacts with the GDP and employment of the reference years (*Investment Reference Year* and *Operation Reference Year*) does *not* imply that the impacts are realised within the respective year.
  - Due to the non-recurring character of the investment, the corresponding impact is not sustained but is an average one-off effect for each year during the investment phase(s).
  - The impact of operation and second order growth effects are sustained impacts to the extent that the operation is recurring each year, though yet possibly subject to a dynamic development.

- For a discussion of basic assumptions of IO/SAM as well as general and specific limitations of the model presented here, cf. Sections 3.3.1 and 3.3.2.

- In view of the relatively limited amount of input data yet the large scope and detail of predictions made by the model, results should generally be considered as somewhat indicative. While the model may serve well to gain an understanding of the magnitude of the impact of a port development, a too detailed and exact interpretation of results is not recommended.

4.3.2 Worksheet *Input (Shocks and Traffic)*

The input data in the worksheet ***Input (Shocks and Traffic)*** is *mandatory* – with the exception that some effects may not apply or may deliberately be omitted by the user.

Input cells in this worksheet are highlighted in light yellow, in accordance with the general colour coding. As such, the tool applies conditional formatting – input cells relating to traffic or cargo types that have zero traffic are not highlighted.

The following paragraphs provide a step-by-step guide for all relevant input data, in the same order as appearing in worksheet ***Input (Shocks and Traffic)***.

General Data

General Data		
Project Name	TCBuen I & II	
Country	Colombia	
Investment Reference Year	2009	*Rollover for Notes.*
Operation Reference Year	2019	
Price Year - Investment	2009	*Rollover for Notes.*
Price Year - Operation	2019	
Price Year - Cost/Time Savings	2009	
Price Year - Hinterland Transport	2009	

- *Project Name* as entered here is displayed in the header of each worksheet.
- *Country* is to be chosen from a drop-down-menu.[42]
- *Reference Years*:
  - The *Investment Reference Year* should typically be the year when construction started. The impact of the investment will be compared to the prevailing economic indicators (GDP or employment) of the *Investment Reference Year*. Must be 2000 or later.
  - The *Operation Reference Year* is the year during operation for which the operational impact and second order effects are analysed. Typically this should be the year when the port or terminal reaches "full operations" in terms of the maximum traffic that is being handled (i.e. the year the traffic reaches capacity or, if capacity is never reached, the final year of the forecast horizon).[43]

[42] The list of countries is defined by the countries represented in the worksheet ***Source Data - SAMs***.

[43] "Traffic reaches capacity" is to be understood as traffic being equal (or very close) to the stated capacity. Capacity calculations for ports or terminals typically account for a certain utilisation buffer, such that even when operating "at capacity" the port or terminal should still operate efficiently – thus, the user should *not* account for an additional buffer in terms of lower capacity utilisation.

- The impact of the operation and second order effects will be compared to the economic indicators (GDP or employment) of the *Operation Reference Year*. Must be 2000 or later.

- The *Price Years* determine the price level of the monetary input data for investment shock, operation shock, cost/time savings, and hinterland transport. Based on the *Price Years*, the tool automatically converts monetary figures to the SAM Base Year 2011. Must be 2000 or later.

  Specification of the price years is necessary considering that monetary input figures may be given not in current prices of the investment/operation year but may have a different price level:

  - In case of a financial analysis conducted in constant prices, investment cost or revenues are typically not in prices of the *Investment / Operation Reference Year* (but instead, e.g., in prices of the year the planning was done).
  - Information on transport cost savings or hinterland transport may typically not be given in prices of the *Operation Reference Year* (but instead, e.g., in prices of the year the planning was done).

Expenditure Shocks – Investment

Expenditure Shocks - Investment (Aggregate) *Rollover for Notes.*

Total Net Duration of Investment Phase(s) in Years [redacted]

Sector	Investment 2009 m USD	Type of Expenditure	Direct Effect 2009 m USD
Agriculture			
Mining&Oil&Gas			
Food&Tobacco			
Textiles			
Wood&Paper&Printing			
Chemicals&Minerals&Metals			
Machinery&Equipment&Electronics	[redacted]	Total	[redacted]
OtherManufacturing			
Utilities			
Construction	[redacted]	Total	[redacted]
Trade			
Transport_Land			
Transport_Water			
Transport_Air			
Communication			
Finance&Insurance			
OtherServices			
PublicServices			
Total	[redacted]		[redacted]

- The tool first requires the *Duration of the Investment Phases (in Years)* as input – in order to assess the impact of the average investment per year during the investment phase(s).[44]

- The *Investment Shocks* (first input column) should account for the total investment of the project. Shocks should be in Million USD and in prices of the *Price Year – Investment* (specified under *General Data*).
  - Investment costs such as marine and civil engineering but also land acquisition should be included under *Construction*. It is recommended to also include contingencies that are directly associated with the construction.
  - Equipment costs (also: IT) should be included under *Machinery&Equipment&Electronics*. It is recommended to also include contingencies that are directly associated with the procurement of equipment.
  - In addition, if there is evidence for a relevant domestic cost component, the user may also consider other cost items such as, e.g., financing cost (under *Finance&Insurance*) and pre-operating expenses (under *OtherServices*).

- The *Type of Expenditure* (second input column) determines for each sector whether the respective shock accounts for the *Total Expenditure* (domestic and foreign) or only the *Domestic Expenditure*. This must be specified for all sectors for which a shock is entered.
  - For shocks that are entered as domestic expenditures, the *Direct Effect* is equal to the shock. If the user has information regarding the *domestic content* of a shock, it is recommended to enter the shock in this fashion.
  - For shocks that are entered as total expenditures, the tool determines the *Direct Effect* of the shock by automatically removing the assumed foreign share of expenditure (subject to the shares of domestic and foreign supply as derived from the SAM).

- Note: the *Total Shock* (bottom of the first input column) is displayed only if all shocks are of the same type of expenditure.

[44] The impact in terms of employment may be misleading if considering the aggregate investment for an investment period of more than 1 year – corresponding employment figures should then be interpreted as “job-years”. Consideration of the average investment per year during the investment phase(s) (= total investment / duration in years) allows for a clear interpretation of employment figures as “number of jobs for one year” for, on average, each year of the investment phases.

Expenditure Shocks – Operation

Expenditure Shocks - Operation (2019)

Rollover for Notes.

Sector	Operation 2019 m USD	Type of Expenditure	Direct Effect 2019 m USD
Agriculture			
Mining&Oil&Gas			
Food&Tobacco			
Textiles			
Wood&Paper&Printing			
Chemicals&Minerals&Metals			
Machinery&Equipment&Electronics			
OtherManufacturing			
Utilities			
Construction			
Trade			
Transport_Land			
Transport_Water	[redacted]	Domestic	[redacted]
Transport_Air			
Communication			
Finance&Insurance			
OtherServices			
PublicServices			
Total	[redacted]		[redacted]

- The *Operation Shocks* (first input column) should correspond with the operations of the *Operation Reference Year*. Shocks should be in Million USD and in prices of the *Price Year – Operation* (specified under *General Data*).
- The *Type of Expenditure* (second input column) determines for each sector whether the respective shock accounts for the *Total Expenditure (domestic & foreign)* or only the *Domestic Expenditure*. This must be specified for all sectors for which a shock is entered.
  - For shocks that are entered as domestic expenditures, the *Direct Effect* is equal to the shock. If the user has information regarding the *domestic content* of a shock, it is recommended to enter the shock in this fashion.
  - For shocks that are entered as total expenditures, the tool determines the *Direct Effect* of the shock by automatically removing the assumed foreign share of expenditure (subject to the shares of domestic and foreign supply as derived from the SAM).
- Generally, there are two alternative ways to account for the operations:[45]

[45] The *revenue-approach* accounts for the full port operations assuming a cost/revenue structure as for the overall water transport sector. As such, this may be distorted to the extent that the cost/revenue structure deviates from the overall water transport sector. The *approach based on a decomposition of operating costs* requires additional user effort and creates distortions where cost items do not correspond well with any sector – the latter is the case for such items as e.g. labour cost, any fees, and taxes. Also, this omits the port's profit and may thus lead to an underestimation of the operational impact.

- *Revenue-approach (recommended)*: with this approach, the operations are accounted for by entering the revenues of the *Operation Reference Year* as a shock to the water transport sector (*Type of Expenditure: Domestic*).
- *Operating cost-approach*: alternatively, the user may allocate the operating cost of the *Operation Reference Year* to the different sectors and enter respective shocks (in this case, *Type of Expenditure* may be *Domestic* or *Total*).

• Note: the *Total Shock* (bottom of the first input column) is displayed only if all shocks are of the same type of expenditure.

Traffic – Traffic Volumes (Scenario with Project)

Traffic Volumes (Scenario with Project) *Rollover for Notes.*

Traffic Type	Containers k TEU	Break Bulk k tons	Project Cargo k tons	Dry Bulk k tons	Liquid Bulk k tons	RoRo k tons
Exports	[redacted]					
Imports						
Domestic Traffic						
Transit Traffic						
Transhipment	[redacted]					
Total		0.0	0.0	0.0	0.0	0.0

• *Traffic Volumes* should correspond with the traffic of the *Operations Reference Year*. Information on traffic volumes should be available per cargo type in the project documentations. Traffic volumes should be entered in k TEU (*containers*) or k tons (*other cargo types*).

• If only total traffic volumes are known per cargo type, the user should derive assumptions regarding the composition of traffic. Some guidelines may be:
  - For *containers*, it should be assumed that imports and exports jointly amount to 100% of container traffic whenever there is no explicit indication for domestic traffic/transit traffic/transhipment.
    The split between imports and exports should generally be assumed 50%/50% if no other information is available.
  - For *break bulk*, if no other information is available it may be assumed there are only exports and imports with a split in the same ratio as the container volumes in exports and imports (tons per TEU, as shown in cells F52:F53 in worksheet ***Economic Assumptions***).
  - For *dry bulk* and *liquid bulk*, default assumptions are not reasonable – bulk cargoes typically comprise either import or export cargo of very specific commodities. The relevant information should however be available in the project documents.
  - Also for *project cargo* and *RoRo*, no default assumptions seem reasonable. The relevant information should however be available in the project documents.

- *For the subsequent inputs in this worksheet, the tool will* un-highlight *input cells relating to traffic or cargo types that have zero traffic.*

Traffic – Capacities (Scenario without Project)

Capacities (Scenario without Project) — *Rollover for Notes.*

Traffic Type	Containers k TEU	Break Bulk k tons	Project Cargo k tons	Dry Bulk k tons	Liquid Bulk k tons	RoRo k tons
Exports						
Imports						
Domestic Traffic						
Transit Traffic						
Transhipment						
Total	0.0	0.0	0.0	0.0	0.0	0.0

- *Capacities* should be entered for the *Scenario without Project*. Capacities should be entered in k TEU (*containers*) or k tons (*other cargo types*).
  - For *greenfield ports*, this may be left blank (all capacities should be 0).
  - For *port expansions*, capacities should be entered as before the expansion. If only total capacities are known per cargo type, it is suggested to allocate them to traffic types proportionally to traffic volumes (cf. example for JICT in Section 5.5).

Traffic – Traffic Differential

Traffic Differential

Traffic Type	Containers k TEU	Break Bulk k tons	Project Cargo k tons	Dry Bulk k tons	Liquid Bulk k tons	RoRo k tons
Exports	[redacted]					
Imports						
Domestic Traffic						
Transit Traffic						
Transhipment	[redacted]					
Total		0.0	0.0	0.0	0.0	0.0

- *No input required*. The *Traffic Differential* computes automatically as the difference between *Traffic Volumes* and the *Capacities (Scenario without Project)*.

Traffic – Relevant Traffic Differential (%) and Relevant Traffic Differential

Relevant Traffic Differential (%)

Rollover for Notes.

Traffic Type	Containers %	Break Bulk %	Project Cargo %	Dry Bulk %	Liquid Bulk %	RoRo %
Exports	[redacted]					
Imports						
Domestic Traffic						
Transit Traffic						
Transhipment	0.0%					

Relevant Traffic Differential

Traffic Type	Containers k TEU	Break Bulk k tons	Project Cargo k tons	Dry Bulk k tons	Liquid Bulk k tons	RoRo k tons
Exports	[redacted]					
Imports						
Domestic Traffic						
Transit Traffic						
Transhipment	0.0					
Total	[redacted]	0.0	0.0	0.0	0.0	0.0

- The *Relevant Traffic Differential (%)* should be entered as the *Share (%) of the Traffic Differential* that would not be diverted to other ports in Scenario without Project (cf. the discussion in Section 3.2.2). To be specified for all traffic and cargo types that are considered.
- The following reference cases may serve as a guideline:
  - *No Impact Case*: if there are alternative ports or terminals that have sufficient excess capacities (in the future) and diversion cost are negligible, then set the *Relevant Traffic Differential* as 0%.
  - *Maximum Impact Case*: if there are no relevant competitors with excess capacities (in the future) *or* diversion cost are prohibitively high, then set the *Relevant Traffic Differential* as 100%.
  - If it may be expected that some but not all of the *Traffic Differential* is diverted in the future, choose a value in between these two extreme cases (default suggestion: 50%).
- *Note*: it may be reasonable or necessary to distinguish the different traffic types or cargo types with regard to the *Relevant Traffic Differential*.
- Subject to the *Traffic Differential* and the *Relevant Traffic Differential (%),* the tool then automatically calculates the *Relevant Traffic Differential* in terms of volumes.

Reduction of Transport Cost and Time

Reduction of Transport Cost and Time (2019)

Rollover for Notes.

DIVERTED TRAFFIC - Imports and Domestic Traffic - Average UNIT COST Savings (per Transport Component by Cargo Type)

Transport Component	Containers 2009 USD/TEU	Break Bulk 2009 USD/ton	Project Cargo 2009 USD/ton	Dry Bulk 2009 USD/ton	Liquid Bulk 2009 USD/ton	RoRo 2009 USD/ton
Seaborne Shipping *(Imports)*						
Seaborne Shipping *(Domestic)*						
Port						
Hinterland Transport - Land	[redacted]					
- Waterways						

DIVERTED TRAFFIC - Imports and Domestic Traffic - Average TIME Savings (per Transport Component by Cargo Type)

	Containers days	Break Bulk days	Project Cargo days	Dry Bulk days	Liquid Bulk days	RoRo days
Seaborne Shipping *(Imports)*						
Seaborne Shipping *(Domestic)*						
Port						
Hinterland Transport - Land	[redacted]					
- Waterways						

BASE TRAFFIC - Imports and Domestic Traffic - Average UNIT COST Savings (per Transport Component by Cargo Type)

Transport Component	Containers 2009 USD/TEU	Break Bulk 2009 USD/ton	Project Cargo 2009 USD/ton	Dry Bulk 2009 USD/ton	Liquid Bulk 2009 USD/ton	RoRo 2009 USD/ton
Seaborne Shipping *(Imports)*						
Seaborne Shipping *(Domestic)*						
Port						
Hinterland Transport - Land						
- Waterways						

BASE TRAFFIC - Imports and Domestic Traffic - Average TIME Savings (per Transport Component by Cargo Type)

	Containers days	Break Bulk days	Project Cargo days	Dry Bulk days	Liquid Bulk days	RoRo days
Seaborne Shipping *(Imports)*						
Seaborne Shipping *(Domestic)*						
Port						
Hinterland Transport - Land						
- Waterways						

- Input data for transportation cost and time reductions comprise *unit cost and time savings* relating to the *Operation Reference Year*.
  - Thus, cost and time savings should be subject to a comparison of the Scenario with Project and Scenario without Project in the Operation Reference Year.
  - Cost and time savings are to be provided separately for *diverted traffic* and, if relevant, *base traffic* (cf. Section 3.2.2). Diverted traffic is traffic that would be diverted to other ports without the project. Base traffic may only be relevant in case of port expansions – this is the traffic that would be handled at the port at hand also without the expansion.[46]
  - Cost savings are to be entered as unit cost savings (USD per TEU or ton) and in prices of the year specified under *General Data*.

[46] Possible cases where cost/time reductions also apply to the base traffic include, inter alia: a lift of congestion (due to higher capacity) and corresponding reduction of vessel waiting times and related demurrage cost; more efficient port operations after expansion; better naval accessibility (e.g. deeper depth of channel and at the quay) allowing for larger ships.

- Time savings are to be entered in days.
- Cost and time savings must be specified separately for the different transport components: seaborne shipping (for imports and domestic traffic), port, and hinterland transport (land and/or water transport).
- Note: in case that both land and water transport are relevant for hinterland transport of a given cargo type, the unit cost/time savings should be based on the total hinterland traffic. Example: if hinterland transport is 50% trucking and 50% barge, and cost/time savings are USD 100 (1 day) for trucking and USD 50 (2 days) for barge, then the cost/time saving input in the tool should be USD 50 (0.5 days) for land transport and USD 25 (1 day) for water transport.

• The case of TCBuen in Section 5.2 provides an example for the determination of transportation cost and time reductions (Figure 13).

Other Shocks – Hinterland Transport

Other Shocks - Hinterland Transport (2019)

Rollover for Notes.

Exports

Sector	Containers 2009 USD/TEU	Break Bulk 2009 USD/ton	Project Cargo 2009 USD/ton	Dry Bulk 2009 USD/ton	Liquid Bulk 2009 USD/ton	RoRo 2009 USD/ton	Total 2009 m USD	Type of Expenditure	Direct Effect 2009 m USD
Transport_Land	[redacted]						[redacted]	Domestic	[redacted]
Transport_Water									
Total		*0.0*	*0.0*	*0.0*	*0.0*	*0.0*			

Imports

Sector	Containers 2009 USD/TEU	Break Bulk 2009 USD/ton	Project Cargo 2009 USD/ton	Dry Bulk 2009 USD/ton	Liquid Bulk 2009 USD/ton	RoRo 2009 USD/ton	Total 2009 m USD	Type of Expenditure	Direct Effect 2009 m USD
Transport_Land	[redacted]						[redacted]	Domestic	[redacted]
Transport_Water									
Total		*0.0*	*0.0*	*0.0*	*0.0*	*0.0*			

Domestic Traffic

Sector	Containers 2009 USD/TEU	Break Bulk 2009 USD/ton	Project Cargo 2009 USD/ton	Dry Bulk 2009 USD/ton	Liquid Bulk 2009 USD/ton	RoRo 2009 USD/ton	Total 2009 m USD	Type of Expenditure	Direct Effect 2009 m USD
Transport_Land									
Transport_Water									
Total	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*			0.0

Transit Traffic

Sector	Containers 2009 USD/TEU	Break Bulk 2009 USD/ton	Project Cargo 2009 USD/ton	Dry Bulk 2009 USD/ton	Liquid Bulk 2009 USD/ton	RoRo 2009 USD/ton	Total 2009 m USD	Type of Expenditure	Direct Effect 2009 m USD
Transport_Land									
Transport_Water									
Total	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*			0.0

• *Shocks for Hinterland Transport* may account for *land transport* (road, rail, pipeline) or *water transport* (barge) between the port and the origin/destination of cargo in the port's hinterland, if such information is available.

• There is one input block for each of the four traffic types *exports, imports, domestic traffic, transit traffic*:
  - Shocks are to be entered as *Unit Shocks (USD per TEU or ton)* for the different cargo types.
  - Note: in case that both land and water transport are relevant for hinterland transport of a given cargo type, the unit shocks should be based on the total hinterland traffic. Example: if hinterland transport is 50% trucking and 50% barge, and unit cost are USD 100 for trucking and USD 50 for barge, the unit cost

input in the tool should be USD 50 for land transport and USD 25 for water transport.

- The unit shocks pertain to the *Relevant Traffic Differential* in the *Operation Reference Year*.
- Unit Shocks should be entered in prices of year specified under *General Data*.
- Based on the unit cost input data, the tool automatically calculates the total expenditures for the different service sectors.
- The *Type of Expenditure* (input column on the right of each block) determines for each sector whether the respective shock accounts for the *Total Expenditure (domestic & foreign)* or only the *Domestic Expenditure*. This must be specified for all sectors for which a shock is entered.
    - For shocks that are entered as domestic expenditures, the *Direct Effect* is equal to the shock. *This option is recommended as a default value for hinterland transport.*
    - For shocks that are entered as total expenditures, the tool determines the *Direct Effect* of the shock by automatically removing the assumed foreign share of expenditure (subject to the shares of domestic and foreign supply as derived from the SAM).

- The case of TCBuen in Section 5.2 provides an example for the determination of hinterland transport shocks.

4.3.3 Worksheet *Economic Assumptions*

The worksheet ***Economic Assumptions*** provides an overview of the underlying economic assumptions for the analysis.

The user has the possibility to – *optionally* – replace a number of these assumptions if project-specific information is available or if he/she wants to test the impact of assumptions. Generally, the value used for the model is shown on the left. Cells for optional user input are highlighted in light green. Default values are displayed in the column on the right.

The following paragraphs provide an overview of all assumptions and step-by-step guidelines as to how these may be replaced.

GDP and Inflation

GDP and Inflation

Increase of Real GDP as compared to SAM Year (2011)

		[Optional Input]	[Default Values]
Investment Reference Year (2009)	-9.8%		-9.8%
Operation Reference Year (2019)	33.9%		33.9%

Inflation as compared to SAM Year (2011)

		[Optional Input]	[Default Values]
Price Year - Investment (2009)	-6.6%		-6.6%
Price Year - Operation (2019)	33.4%		33.4%
Price Year - Cost/Time Savings (2009)	-6.6%		-6.6%
Price Year - Hinterland Transport (2009)	-6.6%		-6.6%

- *Increase of Real GDP* shows the respective growth of real GDP between the two *Reference Years (Investment and Operation)* and the *SAM Year (2011)*.

  This default values are sourced automatically from the GDP data in worksheet ***Source Data – GDP*** and subject to the *Reference Years* specified in the worksheet ***Input (Shocks and Traffic)***.[47]

- *Inflation* shows the respective inflation between the four *Price Years (Investment, Operation, Cost Savings,* and *Hinterland Transport)* and the *SAM Year (2011)*.

  This default values are sourced automatically from the inflation data in worksheet ***Source Data – Inflation*** and subject to the *Price Years* specified in the worksheet ***Input (Shocks and Traffic)***.[48]

- The user has the possibility to replace all GDP and inflation data with own input.

[47] In case the time horizon of available GDP data is shorter than the respective *Reference Year*, the tool extrapolates GDP growth geometrically with a constant growth rate equal to the last growth rate of the GDP. If the respective *Reference Year* is not specified, the increase of real GDP is assumed to be 0.

[48] In case the time horizon of available inflation data is shorter than the respective *Price Year*, the tool extrapolates inflation geometrically with at a constant rate equal to the last increase of the inflation index. If the respective *Price Year* is not specified, the inflation is assumed to be 0.

Employment Figures

Employment Figures (2011)

Sector	Jobs Thousands	[Optional Input] Jobs Thousands	[Default Values] Jobs Thousands
Agriculture	3,634		3,634
Mining&Oil&Gas	244		244
Food&Tobacco	712		712
Textiles	411		411
Wood&Paper&Printing	246		246
Chemicals&Minerals&Metals	806		806
Machinery&Equipment&Electronics	270		270
OtherManufacturing	160		160
Utilities	109		109
Construction	1,145		1,145
Trade	5,286		5,286
Transport_Land	1,010		1,010
Transport_Water	17		17
Transport_Air	73		73
Communication	560		560
Finance&Insurance	238		238
OtherServices	1,303		1,303
PublicServices	3,794		3,794
Total	20,016	0	20,016

- The default values for the *Employment Figures* (in 1000 Jobs) are sourced automatically from the worksheet ***Source Data – Employment***.
- The user has the possibility to replace the employment data with own input.

Miscellaneous Assumptions

Miscellaneous Assumptions

Rollover for Notes.

Container Volumes (Tons per TEU)

Traffic Type	Containers Tons / TEU	[Optional Input] Containers tons / TEU	[Default Values] Containers tons / TEU
Exports	5.4		5.4
Imports	10.8		10.8
Domestic Traffic	8.1		8.1

Extent of Supply Effects

Traffic Type	Extent of Supply Effect	[Optional Input] Extent of Supply Effect	[Default Values] Extent of Supply Effect
Imports	25.0%		25.0%
Domestic Cargoes	100.0%		100.0%

Share of Domestic Cargo in Domestic Traffic

		[Optional Input]	[Default Values]
Domestic Cargo in Domestic Traffic	100.0%		100.0%

Valuation of Time

		[Optional Input]	[Default Values]
Valuation as % of Cargo Value per Day	0.20%		0.20%

Monetary Attribution to Sectors:

Sector	Share of Time Value	[Optional Input] Share of Time Value	[Default Values] Share of Time Value
Communication	10.0%		10.0%
Finance&Insurance	20.0%		20.0%
OtherServices	20.0%		10.0%
Not Monetarized	50.0%		

- *Container Volumes*:
  - These assumptions specify the average volume contained in containers (Tons per TEU).
  - As default values, the tool automatically derives assumptions about the content of imports and exports (subject to various factors such as trade statistics in the SAM, unit trade values, and assuming a minimum share of 10% empty containers as well as 12 tons for each full TEU). The default value for domestic traffic is the average of exports and imports.

- *Extent of Supply Effects:*
  - The *Extent of Supply Effects* determines for imports and domestic cargoes the extent that the relevant traffic differential enables economic output to grow (cf. Section 3.2.3). 100% means full extent, 0% means no extent. Values in between represent a linear scaling of the effects.
  - For imports, a conservative default value of 25% is recommended. For domestic cargoes a default value of the full 100% is recommended.

- *Share of Domestic Cargo in Domestic Traffic:*
  - The *Share of Domestic Cargo in Domestic Traffic* determines the content share of domestic products (as compared to imports) in domestic traffic.
  - The suggested default value is 100%.
  - The user may replace the default value if there is specific information suggesting that domestic traffic also contains a substantial amount of imports. A lower share of domestic cargo decreases both the demand effect and supply effect of domestic traffic.

- *Valuation of Time:*
  - The *Valuation of Time* determines the value of time as a % of the cargo value per day. The *Monetary Attribution to Sectors* specifies the allocation of the monetized time savings as cost savings to the domestic service sectors (cf. Section 3.2.3). A certain proportion of the time valuation however may be considered immaterial and is hence not attributed to sectors.
  - The default time value is set to 0.20%. The default sector attributions are set to *Communication* (10%), *Finance&Insurance* (20%), and *OtherServices* (20%).

Trade Values – Exports, Imports, and Domestic Traffic

Trade Values - Exports (2019)

Rollover for Notes.

Sector Correspondence of Cargo Types

Sector	Containers sector weight	Break Bulk sector weight	Project Cargo sector weight	Dry Bulk sector weight	Liquid Bulk sector weight	RoRo sector weight
Agriculture	0.5	0.5	0.0	1.0	0.0	0.0
Mining&Oil&Gas	0.0	0.0	0.0	1.0	1.0	0.0
Food&Tobacco	1.0	1.0	0.0	0.0	0.0	0.0
Textiles	1.0	1.0	0.0	0.0	0.0	0.0
Wood&Paper&Printing	1.0	1.0	0.0	0.0	0.0	0.0
Chemicals&Minerals&Metals	0.5	0.5	0.0	1.0	1.0	0.0
Machinery&Equipment&Electronics	1.0	1.0	1.0	0.0	0.0	1.0
OtherManufacturing	1.0	1.0	0.0	0.0	0.0	0.0

Resulting Cargo Distribution by Sector (based on Volume)

Sector	Containers %	Break Bulk %	Project Cargo %	Dry Bulk %	Liquid Bulk %	RoRo %
Agriculture	21.1%	21.1%	0.0%	3.3%	0.0%	0.0%
Mining&Oil&Gas	0.0%	0.0%	0.0%	88.9%	92.0%	0.0%
Food&Tobacco	20.8%	20.8%	0.0%	0.0%	0.0%	0.0%
Textiles	1.6%	1.6%	0.0%	0.0%	0.0%	0.0%
Wood&Paper&Printing	4.5%	4.5%	0.0%	0.0%	0.0%	0.0%
Chemicals&Minerals&Metals	49.9%	49.9%	0.0%	7.8%	8.0%	0.0%
Machinery&Equipment&Electronics	2.0%	2.0%	100.0%	0.0%	0.0%	100.0%
OtherManufacturing	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Relevant Trade Differential (Volume)

Sector	Containers k TEU	Break Bulk k tons	Project Cargo k tons	Dry Bulk k tons	Liquid Bulk k tons	RoRo k tons	Total k tons
Agriculture	26.4	0.0	0.0	0.0	0.0	0.0	26.4
Mining&Oil&Gas	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Food&Tobacco	26.0	0.0	0.0	0.0	0.0	0.0	26.0
Textiles	1.9	0.0	0.0	0.0	0.0	0.0	1.9
Wood&Paper&Printing	5.6	0.0	0.0	0.0	0.0	0.0	5.6
Chemicals&Minerals&Metals	62.4	0.0	0.0	0.0	0.0	0.0	62.4
Machinery&Equipment&Electronics	2.5	0.0	0.0	0.0	0.0	0.0	2.5
OtherManufacturing	0.1	0.0	0.0	0.0	0.0	0.0	0.1
Total	125.1	0.0	0.0	0.0	0.0	0.0	125.1

Unit Values

Sector	Containers USD / ton	Break Bulk USD / ton	Project Cargo USD / ton	Dry Bulk USD / ton	Liquid Bulk USD / ton	RoRo USD / ton
Agriculture	1,490.7	1,490.7	1,490.7	1,490.7	1,490.7	1,490.7
Mining&Oil&Gas	274.5	274.5	274.5	274.5	274.5	274.5
Food&Tobacco	1,365.1	1,365.1	1,365.1	1,365.1	1,365.1	1,365.1
Textiles	11,649.7	11,649.7	11,649.7	11,649.7	11,649.7	11,649.7
Wood&Paper&Printing	2,460.5	2,460.5	2,460.5	2,460.5	2,460.5	2,460.5
Chemicals&Minerals&Metals	1,456.9	1,456.9	1,456.9	1,456.9	1,456.9	1,456.9
Machinery&Equipment&Electronics	10,546.8	10,546.8	10,546.8	10,546.8	10,546.8	10,546.8
OtherManufacturing	48,752.9	48,752.9	48,752.9	48,752.9	48,752.9	48,752.9

Value of Relevant Traffic Differential by Cargo Type and Sector

Sector	Containers m USD	Break Bulk m USD	Project Cargo m USD	Dry Bulk m USD	Liquid Bulk m USD	RoRo m USD	Total m USD
Agriculture	211.1	0.0	0.0	0.0	0.0	0.0	211.1
Mining&Oil&Gas	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Food&Tobacco	190.4	0.0	0.0	0.0	0.0	0.0	190.4
Textiles	121.6	0.0	0.0	0.0	0.0	0.0	121.6
Wood&Paper&Printing	73.8	0.0	0.0	0.0	0.0	0.0	73.8
Chemicals&Minerals&Metals	486.7	0.0	0.0	0.0	0.0	0.0	486.7
Machinery&Equipment&Electronics	141.5	0.0	0.0	0.0	0.0	0.0	141.5
OtherManufacturing	29.8	0.0	0.0	0.0	0.0	0.0	29.8
Total	1,255.0	0.0	0.0	0.0	0.0	0.0	1,255.0

[Optional Input]

Sector	Containers sector weight	Break Bulk sector weight	Project Cargo sector weight	Dry Bulk sector weight	Liquid Bulk sector weight	RoRo sector weight
Agriculture						
Mining&Oil&G						
Food&Tobacco						
Textiles						
Wood&Paper						
Chemicals&Mi						
Machinery&Eq						
OtherManufac						

[Optional Input]

Sector	Containers %	Break Bulk %	Project Cargo %	Dry Bulk %	Liquid Bulk %	RoRo %
Agriculture						
Mining&Oil&G						
Food&Tobacco						
Textiles						
Wood&Paper						
Chemicals&Mi						
Machinery&Eq						
OtherManufac						
Total	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

[Optional Input]

Sector	Containers k TEU	Break Bulk k tons	Project Cargo k tons	Dry Bulk k tons	Liquid Bulk k tons	RoRo k tons	Total k tons
Agriculture							0.0
Mining&Oil&G							0.0
Food&Tobacco							0.0
Textiles							0.0
Wood&Paper							0.0
Chemicals&Mi							0.0
Machinery&Eq							0.0
OtherManufac							0.0
Total	0.0	0.0	0.0	0.0	0.0	0.0	0.0

[Optional Input]

Sector	Containers USD / ton	Break Bulk USD / ton	Project Cargo USD / ton	Dry Bulk USD / ton	Liquid Bulk USD / ton	RoRo USD / ton
Agriculture						
Mining&Oil&G						
Food&Tobacco						
Textiles						
Wood&Paper						
Chemicals&Mi						
Machinery&Eq						
OtherManufac						

[Default Values]

Sector	Containers sector weight	Break Bulk sector weight	Project Cargo sector weight	Dry Bulk sector weight	Liquid Bulk sector weight	RoRo sector weight
Agriculture	0.5	0.5	0.0	1.0	0.0	0.0
Mining&Oil&G	0.0	0.0	0.0	1.0	1.0	0.0
Food&Tobacco	1.0	1.0	0.0	0.0	0.0	0.0
Textiles	1.0	1.0	0.0	0.0	0.0	0.0
Wood&Paper	1.0	1.0	0.0	0.0	0.0	0.0
Chemicals&Mi	0.5	0.5	0.0	1.0	1.0	0.0
Machinery&Eq	1.0	1.0	1.0	0.0	0.0	1.0
OtherManufac	1.0	1.0	0.0	0.0	0.0	0.0

[Default Values]

Sector	Containers %	Break Bulk %	Project Cargo %	Dry Bulk %	Liquid Bulk %	RoRo %
Agriculture	21.1%	21.1%	0.0%	3.3%	0.0%	0.0%
Mining&Oil&G	0.0%	0.0%	0.0%	88.9%	92.0%	0.0%
Food&Tobacco	20.8%	20.8%	0.0%	0.0%	0.0%	0.0%
Textiles	1.6%	1.6%	0.0%	0.0%	0.0%	0.0%
Wood&Paper	4.5%	4.5%	0.0%	0.0%	0.0%	0.0%
Chemicals&Mi	49.9%	49.9%	0.0%	7.8%	8.0%	0.0%
Machinery&Eq	2.0%	2.0%	100.0%	0.0%	0.0%	100.0%
OtherManufac	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

[Default Values]

Sector	Containers k TEU	Break Bulk k tons	Project Cargo k tons	Dry Bulk k tons	Liquid Bulk k tons	RoRo k tons	Total k tons
Agriculture	26.4	0.0	0.0	0.0	0.0	0.0	26.4
Mining&Oil&G	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Food&Tobacco	26.0	0.0	0.0	0.0	0.0	0.0	26.0
Textiles	1.9	0.0	0.0	0.0	0.0	0.0	1.9
Wood&Paper	5.6	0.0	0.0	0.0	0.0	0.0	5.6
Chemicals&Mi	62.4	0.0	0.0	0.0	0.0	0.0	62.4
Machinery&Eq	2.5	0.0	0.0	0.0	0.0	0.0	2.5
OtherManufac	0.1	0.0	0.0	0.0	0.0	0.0	0.1
Total	125.1	0.0	0.0	0.0	0.0	0.0	125.1

[Default Values]

Sector	Containers USD / ton	Break Bulk USD / ton	Project Cargo USD / ton	Dry Bulk USD / ton	Liquid Bulk USD / ton	RoRo USD / ton
Agriculture	1,490.7	1,490.7	1,490.7	1,490.7	1,490.7	1,490.7
Mining&Oil&G	274.5	274.5	274.5	274.5	274.5	274.5
Food&Tobacco	1,365.1	1,365.1	1,365.1	1,365.1	1,365.1	1,365.1
Textiles	11,649.7	11,649.7	11,649.7	11,649.7	11,649.7	11,649.7
Wood&Paper	2,460.5	2,460.5	2,460.5	2,460.5	2,460.5	2,460.5
Chemicals&Mi	1,456.9	1,456.9	1,456.9	1,456.9	1,456.9	1,456.9
Machinery&Eq	10,546.8	10,546.8	10,546.8	10,546.8	10,546.8	10,546.8
OtherManufac	48,752.9	48,752.9	48,752.9	48,752.9	48,752.9	48,752.9

- These three assumption blocks serve to determine the sectoral trade values for exports, imports, and domestic traffic.

- The following steps of the calculation may be overwritten with optional user input.
  - *Sector weights determining the correspondence between cargo types and sectors*: as default value, the tool uses the standard sector correspondences of cargo types presented in Section 3.1.3.

  - *Cargo distribution by sector (based on volume):* the suggested default values are calculated automatically from other data (SAM trade data, sector weights, and sectoral unit trade values) as described in Section 3.1.3.
  - *Relevant trade differentials* of sectors (volume in k TEU or k tons): default values are calculated subject to the relevant traffic differentials and the cargo distribution by sector.
  - *Sectoral unit values (USD per ton)*: default values are provided with the model (sourced from worksheet ***Source Data – Trade Values***).[49]

  An assumption replaced with individual input will be considered for all subsequent calculation steps.

  The final result, subject to the previous assumptions, is the *Value of Relevant Traffic Differential by Cargo Type and Sector* (no optional user input possible).

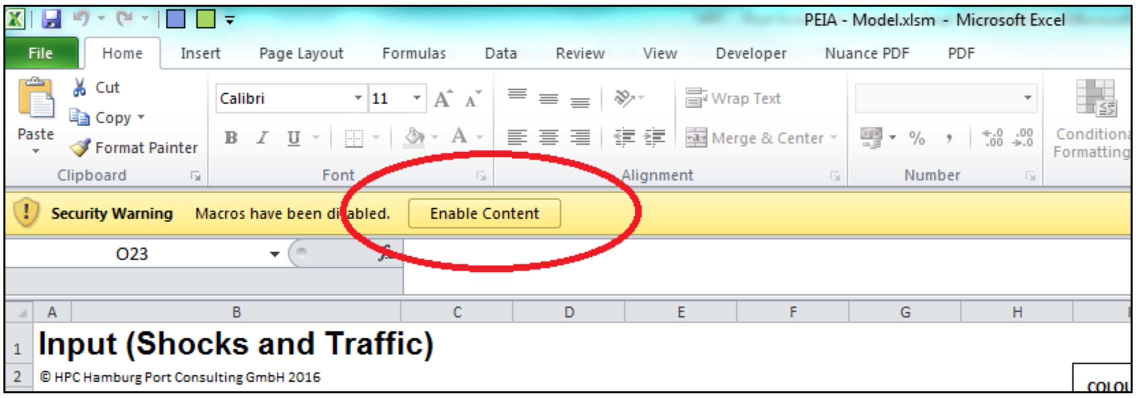
- *Additional user input is recommended for dry and liquid bulk*. For these cargo types, which typically comprise very specific commodities, it is suggested to specify the *sector correspondence* (alternatively: the *cargo distribution by sector*) as well as the respective *unit trade values*. The case of PIBT in Section 5.4 provides an example. Annex 2 provides a manual for the analysis of trade values.

[49] In case a country's sectoral unit trade values are not specified in worksheet ***Source Data – Trade Values***, an average of the other country's unit trade values are chosen.

4.3.4 Macros

In addition to the worksheets, the tool provides two *macros*, i.e. algorithms implemented in VBA to support the model: *Run Model* and *Run Sensitivity Analysis.*

In order to use the macros, macros must be enabled *when starting the workbook*:



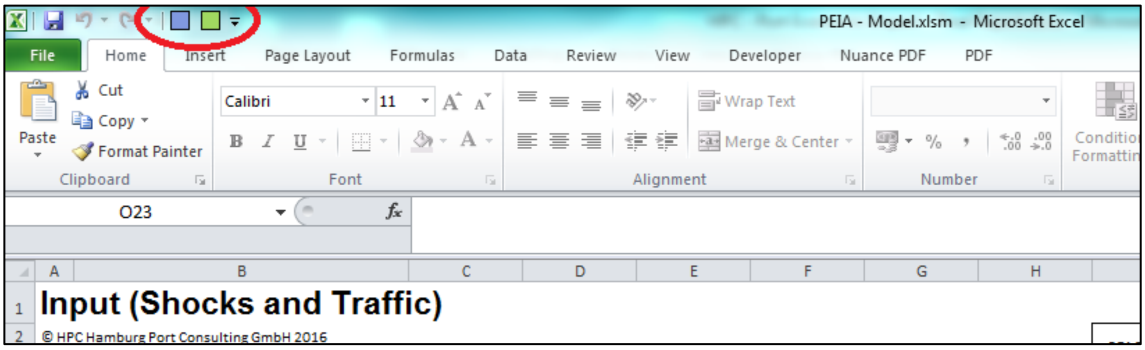
Once macros have been enabled, they may be activated with the blue and green square in the Quick Access Toolbar (see picture below):

- *Blue square*: the macro *Run Model* serves to balance both the basic SAM[50] and the cost/time-modified SAM (cf. Section 3.2.3) with the RAS algorithm. The then balanced SAMs appear in the worksheets ***Aux - Base SAM (Balanced)*** and ***Aux - Modified SAM (Balanced)***.

  The macro Run Model must be activated after specification of all relevant input data.

- *Green square*: the macro *Run Sensitivity Analysis* conducts a sensitivity analysis of the total impact during operation with regard to the *relevant traffic differential* and the *extent of supply effects (imports)* (cf. Section 3.2.3). The results of the sensitivity analysis appear in the worksheet ***Impact - Sensitivity***.

[50] This is necessary to avoid disturbances in case that the input SAM is not perfectly balanced, which is typically the case for SAM data from GTAP 9.



4.3.5 Model Output

After specification of all relevant input data, the user should run both macros *(Run Model and Run Sensitivity Analysis, cf. Section 4.3.4) in order to initialise cost/time effects and conduct the sensitivity analysis.*

The model output then comprises eight worksheets that present the impact of the port.

It should be noted that the model/tool does not provide an indication regarding the time frame for the realisation of the impacts. It is therefore recommended to interpret the impacts only in an aggregate way. The comparison of impacts with the GDP and employment of the reference years (Investment Reference Year *and* Operation Reference Year) *does* **not** *imply that the impacts are realised within the respective year.*

Impact – Summary provides a summary of the total impact in terms of *GDP (Value Added)* and *Employment* (in 1000 jobs) both for the investment as well as for the operation phase (including second order growth effects).

- The impacts of the investment are provided with a distinction for sectors and as a total. In addition, the impacts are expressed as a % of the respective base indicator (GDP or employment) in the *Investment Reference Year*.

  Note: The impact of the investment is measured as the *aggregate impact of the average investment per year during the investment phase(s)*. Aggregate impacts do not necessarily materialise within the year of the corresponding stimulus but may materialise over time. Due to the non-recurring character of the investment, the corresponding impact is not sustained but is an average one-off effect for each year during the investment phase(s).

- Impacts for the operation phase are provided both for the different types of effects (operation, hinterland transport, traffic demand effects, traffic supply effects, and traffic cost/time effects) as well as with a distinction for sectors and as a total. The aggregate impact is subject to the considerations regarding double counting (cf.

discussion in Section 3.2.4). Total impacts are further expressed as a % of the respective base indicator (GDP or employment) in the *Operation Reference Year*.

Note: The impacts of the operations and second order growth effects are measured as aggregate impacts of the port (expansion) in the *Operation Reference Year*. Aggregate impacts do not necessarily materialise within the operation reference year but may materialise over time. Such impacts are sustained impacts to the extent that the operation is recurring each year, though yet possibly subject to a dynamic development.

- The worksheet also provides an overview of whether the tool uses default assumptions or individual assumptions specified by the user.

Note: for all impacts such as investment, operations, demand effects and supply effects, the relative increase in terms of GDP or jobs is the same *per sector* (both are proportional to the increase in output). For the aggregated impacts across sectors, the relative change of GDP and jobs need not be the same although typically they are similar.[51,52]

Impact – Sensitivity provides a sensitivity analysis of the total impact during operation (including second order growth effects) with regard to two central parameters: the *relevant traffic differential* (as one homogeneous percentage over all traffic and cargo types) as well as the *extent of the supply effect of imports*.

- For the relevant traffic differential, the analysis is conducted for the values 0%, 25%, 50%, 75%, and 100%.
- For the supply effect for imports, the analysis is conducted for the default value of 25% as well as two values to the left (0%, 10%) and two values to the right (50%, 100%).
- The sensitivity is tested both for GDP (Value Added) as well as Employment. The results are further expressed as a % of the respective base indicator (GDP or employment) in the *Operation Reference Year*.

The remaining six output worksheets present detailed results for the different types of effects. Impacts are reported in terms of Output, GDP (Value Added), Labour Income, and Employment.

[51] Both relative effects – in terms of GDP and jobs – are relatively similar *at least* whenever the impact of the supply effect is dominant, due to the fact that the supply effect impacts all sectors to the same relative degree.

[52] Also, the same may not hold for the impact of cost/time reductions, which alter the structure of the SAM (and thus change the ratio between GDP and output).

5. EXAMPLES OF IMPACT ASSESSMENTS

This chapter presents examples of impact assessments of four port investments of IFC to illustrate input data requirements and the management of assumptions as well as the interpretation of results. The four examples have been selected jointly by the Consultants and IFC to cover different geographic regions and to account for different cargo types as well as economic impacts.

5.1 Overview

The following chapter presents examples of impact assessments of four port investments of IFC.

The four examples have been selected jointly by the Consultants and IFC to cover different geographic regions and to account for different cargo types as well as economic impacts.

- Greenfield development of *Terminal de Contenedores de Buenaventura (TCBuen)* in Colombia, a dedicated container terminal mainly for exports and imports;
- Greenfield development of *Asyaport* in Turkey, a container terminal focusing on transhipment cargo destined for the Black Sea;
- Greenfield development of *Pakistan International Bulk Terminal (PIBT)* in Pakistan, planned to handle coal imports and exports of cement and clinker;
- Expansion of *Jakarta International Container Terminal (JICT)* in Indonesia, one of four container ports in Indonesia that handle international cargo and serve as hubs for redistribution of the cargo with domestic ships.

The examples are presented to illustrate input data requirements and the management of assumptions as well as the interpretation of results.

5.2 Terminal de Contenedores de Buenaventura (Colombia)

The Terminal de Contenedores de Buenaventura (TCBuen) in Buenaventura, Colombia, is a dedicated container terminal forecast to handle mainly imports and exports, as well as minor transhipment volumes. The terminal has been a greenfield development implemented in two phases (*TCBuen I* and *TCBuen II*), which both received funding from IFC.

Information for the analysis has been derived from the project documentations for the two phases (IFC's *Investment Review Memoranda*). The analysis is conducted as a joint analysis for the overall development. The aggregate investment of both phases (overall duration 4 years) is considered with the *Investment Reference Year* 2009. Operation is considered for the year when the terminal reaches capacity (*Operation Reference Year* 2019). The following paragraphs provide an overview of the most relevant input data.

Model Input

The table overleaf presents the shocks related to the investment and operation as derived from the financial data in the project documentations.

The investment is considered aggregate for both phases (price year: 2009, type of expenditure: total):

- Total cost for equipment[53] are accounted for as a shock to *Machinery&Equipment&Electronics.*
- Total cost for civil works and dredging[54] are accounted for as a shock to *Construction.*
- Other cost (E&S, pre-operating expenses, financing cost) and a general contingency are not included as a shock.

The operation is accounted for using the revenues of the *Operation Reference Year* as a shock to the water transport sector (price year: 2019, type of expenditure: domestic).

[53] It is assumed that this includes specific contingencies and overhead such as design and supervision.

[54] It is assumed that this includes specific contingencies and overhead such as design and supervision.

Table 10: TCBuen I & II – Investment and Operation Shocks

Item	Sector	Value	Unit
Investment (4 Years)	*Machinery&Equipment&Electronics*	[redacted]	Million USD (2009)
	Construction		Million USD (2009)
	Total Investment		Million USD (2009)
Operation	*Transport_Water*		Million USD (2019)
	Total Operation		Million USD (2019)

Source: IFC *Investment Review Memorandum: TCBuen* 2009, IFC *Investment Review Memorandum: TCBuen II* 2012, HPC 2016

The following table presents relevant input figures for traffic. Relevant notes on the data are presented overleaf.

Table 11: TCBuen I & II – Traffic Data

Item	Data	Value	Unit
Traffic (Containers)	Exports	[redacted]	k TEU
	Imports		k TEU
	Transhipment		k TEU
	Total Traffic		k TEU
Capacity for Containers (without Project)		0.0	k TEU
Relevant Traffic Differential	Exports	50.0%	
	Imports	50.0%	
Reductions of Transportation Cost and Time (Imports)	Seaborne Shipping	-	USD / TEU (2009)
	Port	-	USD / TEU (2009)
	Hinterland Transport - Land	[redacted]	USD / TEU (2009)
	Hinterland Transport - Waterways	-	USD / TEU (2009)
	Time Savings	[redacted]	hours
Hinterland Transport (Imports and Exports)	Hinterland Transport - Land		USD / TEU (2009)

Source: IFC *Investment Review Memorandum: TCBuen* 2009, IFC *Investment Review Memorandum: TCBuen II* 2012, HPC 2016

Relevant notes:

- The traffic figures have been derived from the project's traffic forecast for 2019. Export and import represent the majority of the traffic.
- The capacity without project is zero, considering TCBuen is a greenfield port.
- The relevant traffic differential has been assumed to amount to 50% for imports and exports, reflecting the fact that the only competitor of TCBuen in Buenaventura is congested, and containers are diverted to ports on the Caribbean coast of Colombia. (The relevant traffic differential for transhipment has no impact as no services associated with transhipment are accounted for.)
- Reductions of transportation cost and time (for the diverted traffic) and the hinterland transportation cost (for the relevant traffic differential) have been derived from the project documentations (cf. Figure 13 overleaf). Prices are entered as 2009 USD.

- For reductions of transportation cost and time, it is assumed that the avoided diversion through the Caribbean (Cartagena) saves USD 216 per TEU and 15 hours trucking time. For other cost components (shipping or port), no information is available.
- Hinterland transport is considered with USD 540 per TEU for imports/exports.

For economic assumptions, the suggested default values have been used:

- In particular, the automatic default values for container volumes are 5.4 tons / TEU for exports and 10.8 tons / TEU for imports.
- The supply effect for imports is used with the standard default value of 25%.

Figure 13: TCBuen I & II – Transportation Cost/Time Assumptions

- Project documents (IRM for TCBuen I) provide the information for trucking rates (imports) from Buenaventura and competitor ports to the main population centres.
- Traffic to and from the capital and largest city Bogotá is chosen as the reference case. (Note: as a more sophisticated approach, different destinations could be considered, then averaging the cost and time savings).
- *Reductions of transportation cost and time* (pertains to imports; diverted traffic only):
  - It is assumed that diverted containers would be routed via Buenaventura's main competitor Cartagena. (Note: as a more sophisticated approach, different ports of diversion could be considered, then averaging the cost and time savings).
  - Diversion cost then would be approx. USD [redacted] USD per ton (USD [redacted] per ton for Cartagena as compared to USD [redacted] per ton for Buenaventura), or USD [redacted] per TEU for a full import container (12 tons per TEU).
  - Empty import containers are assumed to be subject to the same trucking rate.
  - Time savings: as per *Google Maps*, Buenaventura is approx. 600 km closer to Bogotá than Cartagena (500 km as compared to 1,100 km). Assuming an average truck speed of 40 km/h, an avoided diversion corresponds with a transport time saving of approximately 15 hours.
- *Hinterland transport (land transport)* (pertains to imports and exports; relevant traffic differential only):
  - Trucking cost to Bogotá is USD [redacted] per ton. For a full import container (12 tons per TEU), this amounts to USD [redacted] per TEU.
  - Full export containers and empty containers (import/export) are assumed to be subject to the same trucking rate.
- Note: prices are assumed to be in 2009 USD (publication year of the IRM for TCBuen I).

Source: IFC *Investment Review Memorandum: TCBuen* 2009, Google 2016, HPC 2016

Summary of Economic Impacts

The table below provides a summary of impacts (GDP and employment) of investment and operation for TCBuen. In addition, the summary shows the total impacts as a % of the respective base indicator (GDP or employment) in the given reference year.

The summary shows that the impact of the average annual investment, for each year during the in total 4 years of investment phases, amounts to 0.04% of GDP and 6,000 jobs (reference year 2009).[55]

In contrast, the total impact during operation in 2019 – including the impact of the operation and second order growth effects – amounts to 1.23% of GDP and 327,800 jobs.[56] As such, the economic impact of TCBuen is significant. Supply and demand effects account for the lion's share of the impact during operation, reflecting the relevance of TCBuen as a catalyst for external trade.

Table 12: TCBuen I & II – Impact Summary

Impact	**GDP (2011 m USD)**		**Employment ('000 Jobs)**	
Average Annual Investment *over 4 Years* (Reference Year 2009)				
Investment	102.8	*0.04 %*	6.0	*0.02 %*
Operation & 2nd Order Effects (Reference Year 2019)				
Operation	106.6		7.0	
Traffic – Demand Effects	1,777.9		134.7	
Traffic – Supply Effects	4,984.4		326.0	
Traffic – Cost/Time	21.5		-0.7	
Hinterland Transport	204.8		14.4	
Total Impact*	5,040.4	*1.23 %*	327.8	*1.22 %*

Note: The % refer to the respective base indicator (GDP or employment) in the given reference year. Total impact during operation is subject to considerations for double counting (cf. Section 3.2.4).

[55] The impact of the investment is measured as the *aggregate impact of the average investment per year during the investment phase(s)*. Aggregate impacts do not necessarily materialise within the year of the corresponding stimulus but may materialise over time. Due to the non-recurring character of the investment, the corresponding impact is not sustained but is an average one-off effect for each year during the investment phase(s).

[56] The impacts of the operations and second order growth effects are measured as aggregate impacts of the port (expansion) in the *Operation Reference Year*. Aggregate impacts do not necessarily materialise within the operation reference year but may materialise over time. Such impacts are sustained impacts to the extent that the operation is recurring each year, though yet possibly subject to a dynamic development.

Source: HPC 2016

A sensitivity analysis with regard to the *relevant traffic differential* and the *extent of the supply effect (imports)* indicates that, given the most optimistic assumptions for these two parameters, the impact during operation could amount to up to 9.73% of GDP and 2.6 million jobs (reference year 2019).

Detailed Economic Impacts

The following pages illustrate the impacts in more detail and provide a sensitivity analysis of the impact during operation.

The following figure summarises the aggregate impact of the average annual investment, for each year during the 4 years of investment phases, at TCBuen.[57]

Table 13: TCBuen I & II – Impacts of the Investment

Sector	GDP (Value Added) 2011 m USD	% of 2009	Employment '000 Jobs	% of 2009
Agriculture	4.3	0.02%	0.8	0.02%
Mining&Oil&Gas	5.4	0.02%	0.0	0.02%
Food&Tobacco	2.7	0.03%	0.2	0.03%
Textiles	1.0	0.03%	0.1	0.03%
Wood&Paper&Printing	1.3	0.04%	0.1	0.04%
Chemicals&Minerals&Metals	7.4	0.05%	0.4	0.05%
Machinery&Equipment&Electronics	2.6	0.09%	0.2	0.09%
OtherManufacturing	0.7	0.03%	0.0	0.03%
Utilities	1.5	0.03%	0.0	0.03%
Construction	31.7	0.14%	1.4	0.14%
Trade	12.5	0.03%	1.6	0.03%
Transport_Land	4.3	0.03%	0.3	0.03%
Transport_Water	0.0	0.01%	0.0	0.01%
Transport_Air	0.2	0.02%	0.0	0.02%
Communication	2.2	0.03%	0.1	0.03%
Finance&Insurance	3.5	0.03%	0.1	0.03%
OtherServices	18.4	0.03%	0.4	0.03%
PublicServices	3.0	0.01%	0.3	0.01%
Total	**102.8**	**0.04%**	**6.0**	**0.03%**

Note: The stated impacts are aggregate impacts of the average investment per year during the investment phase(s). The % refer to the respective base indicator (GDP or employment) in the given reference year.

Source: HPC 2016

[57] The impact of the investment is measured as the *aggregate impact of the average investment per year during the investment phase(s)*. Aggregate impacts do not necessarily materialise within the year of the corresponding stimulus but may materialise over time. Due to the non-recurring character of the investment, the corresponding impact is not sustained but is an average one-off effect for each year during the investment phase(s).

For the operation (including second order growth effects), TCBuen has the following impact in terms of GDP (Value Added) and employment.[58] With the given assumptions, the supply effect for imports is the dominant effect for TCBuen.

Table 14: TCBuen I & II – Impacts during Operation (GDP)

Sector	Operation 2011 m USD	Traffic Demand Effects 2011 m USD	Traffic Supply Effects 2011 m USD	Traffic Cost/Time Effects 2011 m USD	Hinterland Transport 2011 m USD	Total Impact 2011 m USD	% of 2019
Agriculture	4.1	274.3	332.7	1.3	8.3	334.0	1.22%
Mining&Oil&Gas	6.1	138.1	536.5	6.3	7.2	542.8	1.23%
Food&Tobacco	2.7	110.4	169.8	2.7	5.4	172.6	1.24%
Textiles	1.0	71.9	72.1	0.7	2.0	75.7	1.28%
Wood&Paper&Printing	0.8	50.6	57.7	0.8	1.5	58.5	1.23%
Chemicals&Minerals&Metals	10.5	233.7	272.6	4.0	12.1	276.6	1.23%
Machinery&Equipment&Electronics	1.8	54.1	55.4	0.7	1.1	57.7	1.27%
OtherManufacturing	0.4	23.6	43.3	0.4	0.7	43.7	1.23%
Utilities	1.6	35.2	90.4	0.6	3.4	91.0	1.23%
Construction	0.4	7.3	411.3	3.2	1.0	414.5	1.23%
Trade	12.1	215.4	682.1	5.7	28.4	687.8	1.23%
Transport_Land	5.5	80.3	221.3	-11.6	80.8	209.7	1.15%
Transport_Water	33.0	0.6	3.9	0.0	0.1	33.8	10.66%
Transport_Air	0.2	3.1	15.4	0.4	0.4	15.8	1.25%
Communication	2.2	39.5	132.3	0.7	5.0	133.1	1.22%
Finance&Insurance	3.7	60.5	200.1	0.1	8.1	200.2	1.22%
OtherServices	17.3	324.9	961.6	3.2	33.1	964.8	1.22%
PublicServices	3.1	54.4	726.0	2.1	6.1	728.2	1.22%
Total	**106.6**	**1,777.9**	**4,984.4**	**21.5**	**204.8**	**5,040.4**	**1.23%**

Note: The impacts of the operations and second order growth effects are measured as aggregate impacts of the port (expansion) in the Operation Reference Year. The total impact during operation is subject to the considerations for double counting (cf. Section 3.2.4).

Source: HPC 2016

Table 15: TCBuen I & II – Impacts during Operation (Jobs)

Sector	Operation 1000 Jobs	Traffic Demand Effects 1000 Jobs	Traffic Supply Effects 1000 Jobs	Traffic Cost/Time Effects 1000 Jobs	Hinterland Transport 1000 Jobs	Total Impact 1000 Jobs	% of 2019
Agriculture	0.7	48.8	59.2	0.1	1.5	59.3	1.22%
Mining&Oil&Gas	0.0	1.0	4.0	0.0	0.1	4.0	1.22%
Food&Tobacco	0.2	7.5	11.6	0.0	0.4	11.6	1.22%
Textiles	0.1	6.7	6.7	0.0	0.2	7.0	1.27%
Wood&Paper&Printing	0.1	3.5	4.0	0.0	0.1	4.0	1.22%
Chemicals&Minerals&Metals	0.5	11.3	13.1	0.0	0.6	13.1	1.22%
Machinery&Equipment&Electronics	0.1	4.3	4.4	0.0	0.1	4.5	1.25%
OtherManufacturing	0.0	1.4	2.6	0.0	0.0	2.6	1.22%
Utilities	0.0	0.7	1.8	0.0	0.1	1.8	1.22%
Construction	0.0	0.3	18.6	0.0	0.0	18.7	1.22%
Trade	1.5	27.2	86.1	0.1	3.6	86.2	1.22%
Transport_Land	0.4	6.0	16.4	-1.0	6.0	15.4	1.14%
Transport_Water	2.3	0.0	0.3	0.0	0.0	2.4	10.65%
Transport_Air	0.0	0.2	1.2	0.0	0.0	1.2	1.22%
Communication	0.2	2.7	9.1	0.0	0.3	9.1	1.22%
Finance&Insurance	0.1	1.2	3.9	0.0	0.2	3.9	1.22%
OtherServices	0.4	7.2	21.2	0.0	0.7	21.2	1.22%
PublicServices	0.3	4.6	61.8	0.1	0.5	61.9	1.22%
Total	**7.0**	**134.7**	**326.0**	**-0.7**	**14.4**	**327.8**	**1.22%**

Note: The impacts of the operations and second order growth effects are measured as aggregate impacts of the port (expansion) in the Operation Reference Year. The total impact during operation is subject to the considerations for double counting (cf. Section 3.2.4).

Source: HPC 2016

[58] The impacts of the operations and second order growth effects are measured as aggregate impacts of the port (expansion) in the *Operation Reference Year*. Aggregate impacts do not necessarily materialise within the operation reference year but may materialise over time. Such impacts are sustained impacts to the extent that the operation is recurring each year, though yet possibly subject to a dynamic development.

In addition, a sensitivity analysis has been conducted for the total impact during operation (incl. second order growth effects) with regard to the *relevant traffic differential* and the *extent of the supply effect (imports)*.

Table 16: TCBuen I & II – Sensitivity – Impacts during Operation

Total Impact - GDP (Valued Added) (2011 m USD)

Extent of Supply Effect for Imports	Relevant Traffic Differential (All Cargo Types) 0.0%	25.0%	50.0%	75.0%	100.0%
0.0%	152.4	1,130.3	2,110.9	3,087.5	4,072.0
10.0%	152.4	1,355.9	2,599.3	3,842.8	5,094.1
25.0%	152.4	2,559.6	5,040.4	7,517.2	10,001.9
50.0%	152.4	5,046.2	10,016.4	14,982.7	19,956.7
100.0%	152.4	10,026.8	19,977.5	29,924.3	39,879.0

% of 2019 GDP

Extent of Supply Effect for Imports	Relevant Traffic Differential (All Cargo Types) 0.0%	25.0%	50.0%	75.0%	100.0%
0.0%	0.04%	0.28%	0.52%	0.75%	0.99%
10.0%	0.04%	0.33%	0.63%	0.94%	1.24%
25.0%	0.04%	0.62%	1.23%	1.84%	2.44%
50.0%	0.04%	1.23%	2.45%	3.66%	4.87%
100.0%	0.04%	2.45%	4.88%	7.30%	9.73%

Total Impact - Employment (1000 Jobs)

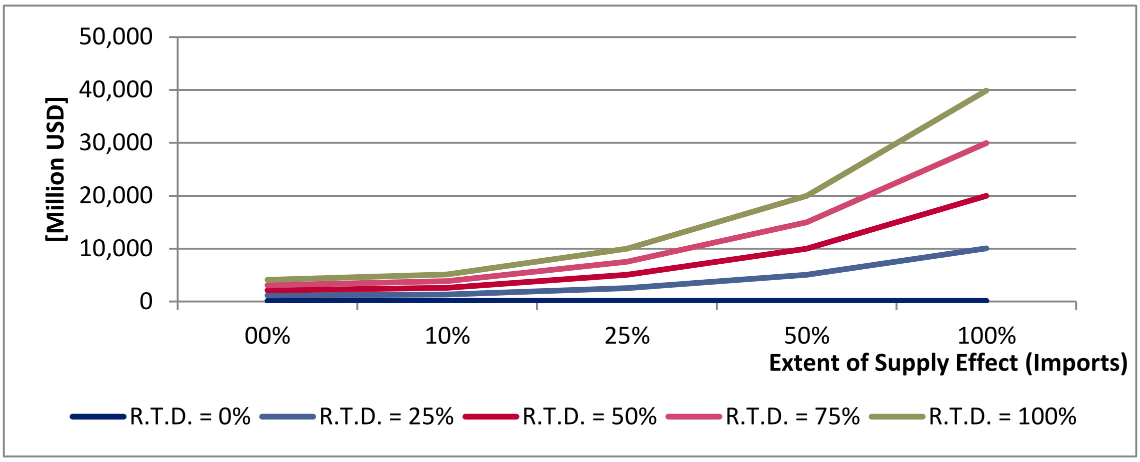
Extent of Supply Effect for Imports	Relevant Traffic Differential (All Cargo Types) 0.0%	25.0%	50.0%	75.0%	100.0%
0.0%	5.9	80.5	155.4	230.1	305.2
10.0%	5.9	94.3	185.3	276.2	367.5
25.0%	5.9	164.5	327.8	491.0	654.5
50.0%	5.9	327.0	653.2	979.1	1,305.4
100.0%	5.9	652.8	1,304.7	1,956.4	2,608.4

% of 2019 Employment

Extent of Supply Effect for Imports	Relevant Traffic Differential (All Cargo Types) 0.0%	25.0%	50.0%	75.0%	100.0%
0.0%	0.02%	0.30%	0.58%	0.86%	1.14%
10.0%	0.02%	0.35%	0.69%	1.03%	1.37%
25.0%	0.02%	0.61%	1.22%	1.83%	2.44%
50.0%	0.02%	1.22%	2.44%	3.65%	4.87%
100.0%	0.02%	2.44%	4.87%	7.30%	9.74%

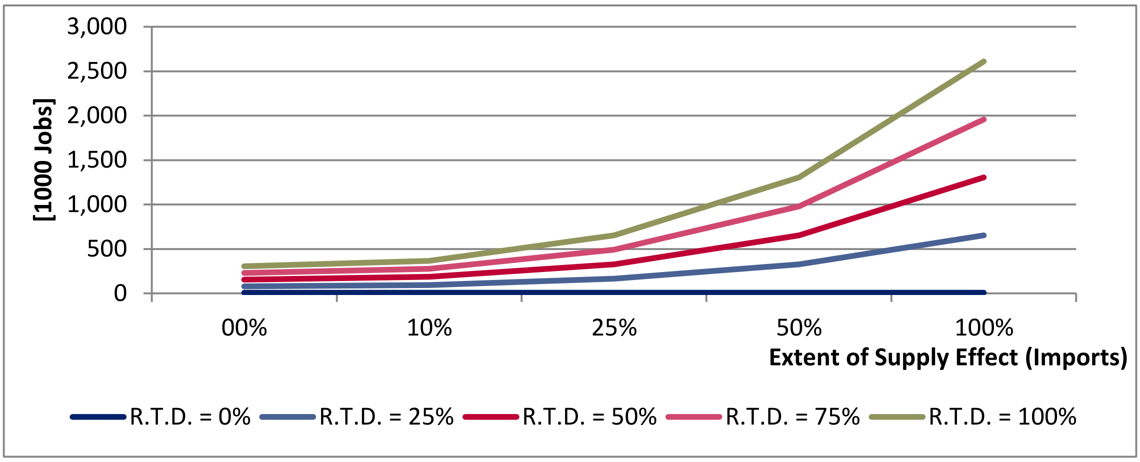
Source: HPC 2016

Figure 14: TCBuen I & II – Sensitivity – Impacts during Operation (GDP)



Source: HPC 2016

Figure 15: TCBuen I & II – Sensitivity – Impacts during Operation (Jobs)



Source: HPC 2016

5.3 Asyaport (Turkey)

Asyaport is a greenfield container terminal on the Marmara Sea near the city of Barbaros in Turkey. The terminal mainly aims for transhipment cargo destined for the Black Sea, with the Mediterranean Shipping Company (MSC) to be the main customer. As such, the project may be expected to decrease transportation cost for containers destined to the Black Sea.

Information for the analysis has been derived from the project documentation (IFC's *Investment Review Memorandum*). The analysis considers the investment during the 3 year investment phase (*Investment Reference Year* 2010) as well as the operation after full development (*Operation Reference Year* 2017). The following paragraphs provide an overview of the most relevant input data.

Model Input

The following table presents the shocks related to the investment and operation as derived from the financial data in the project documentation.

The investment is accounted for as follows (price year: 2010, type of expenditure: total):

- Total cost for equipment (incl. specific contingencies and overhead cost) are accounted for as a shock to *Machinery&Equipment&Electronics.*
- Total cost for civil engineering (incl. specific contingencies and overhead cost) are accounted for as a shock to *Construction.*
- Other cost (start-up cost, financing cost, etc.) are not included as a shock.

The operation is accounted for using the revenues as a shock to the water transport sector (price year: 2017, type of expenditure: domestic).

Table 17: Asyaport – Investment and Operation Shocks

Item	Sector	Value	Unit
Investment (3 Years)	*Machinery&Equipment&Electronics*	[redacted]	Million USD (2010)
	Construction		Million USD (2010)
	Total Investment		Million USD (2010)
Operation	*Transport_Water*		Million USD (2017)
	Total Operation		Million USD (2017)

Source: IFC *Investment Review Memorandum: Asyaport* 2013, HPC 2016

The following table presents relevant input figures for traffic.

Table 18: Asyaport – Traffic Data

Item	Data	Value	Unit
Traffic (Containers)	Exports	[redacted]	k TEU
	Imports		k TEU
	Transhipment		k TEU
	Total Traffic		k TEU
Capacity for Containers (without Project)			k TEU
Relevant Traffic Differential	Exports	0.0%	
	Imports	0.0%	

Source: IFC *Investment Review Memorandum: Asyaport* 2013, HPC 2016

Relevant notes:

- The traffic figures are as per the project's traffic forecast for 2017. The vast majority of the traffic is transhipment. The capacity without project is zero, considering Asyaport is a greenfield development.
- The relevant traffic differential is assumed to amount to 0% for imports and exports, reflecting the fact that import/export volumes are rather minor and Ambarli near Istanbul is a strong competitor approx. 140 km from Asyaport. (The relevant traffic differential for transhipment has no impact as no services associated with transhipment are accounted for.)

No information is available with regard to transportation cost reduction (diversion cost) or hinterland transportation – it should be noted that accounting for such cost would actually improve the analysis and probably increase the economic impact.

For economic assumptions, the suggested default values have been used:

- In particular, the automatic default values for container volumes are 7.7 tons / TEU for exports and 10.8 tons / TEU for imports.
- The supply effect for imports is used with the standard default value of 25%.

The following paragraphs provide an overview of the resulting economic impacts.

Summary of Economic Impacts

The table below provides a summary of impacts (GDP and employment) of investment and operation for Asyaport. In addition, the summary shows the total impacts as a % of the respective base indicator (GDP or employment) in the given reference year.

The summary shows that the impact of the average annual investment, for each year during the 3 year investment phase, amounts to 0.02% of GDP and 4,800 jobs (reference year 2010).[59]

The total impact during operation in 2017 – including the impact of the operation and second order growth effects – amounts to 0.01% of GDP and 2,900 jobs.[60] As such, the impact of Asyaport on the Turkish economy is rather limited – reflecting the fact that the terminal handles mainly transhipment cargo and economic benefits accrue to the main customer MSC and/or destination countries at the Black Sea.

[59] The impact of the investment is measured as the *aggregate impact of the average investment per year during the investment phase(s)*. Aggregate impacts do not necessarily materialise within the year of the corresponding stimulus but may materialise over time. Due to the non-recurring character of the investment, the corresponding impact is not sustained but is an average one-off effect for each year during the investment phase(s).

[60] The impacts of the operations and second order growth effects are measured as aggregate impacts of the port (expansion) in the *Operation Reference Year*. Aggregate impacts do not necessarily materialise within the operation reference year but may materialise over time. Such impacts are sustained impacts to the extent that the operation is recurring each year, though yet possibly subject to a dynamic development.

Table 19: Asyaport – Impact Summary

Impact	GDP (2011 m USD)		Employment ('000 Jobs)	
Average Annual Investment *over 3 Years* (Reference Year 2010)				
Investment	136.4	*0.02 %*	4.8	*0.02 %*
Operation & 2nd Order Effects (Reference Year 2017)				
Operation	114.3		2.9	
Traffic – Demand Effects	0.0		0.0	
Traffic – Supply Effects	0.0		0.0	
Traffic – Cost/Time	-		-	
Hinterland Transport	-		-	
Total Impact*	114.3	*0.01 %*	2.9	*0.01 %*

Note: The % refer to the respective base indicator (GDP or employment) in the given reference year. Total impact during operation is subject to considerations for double counting (cf. Section 3.2.4).

Source: HPC 2016

A sensitivity analysis with regard to the *relevant traffic differential* and the *extent of the supply effect (imports)* indicates that, given the most optimistic assumptions for these two parameters, the impact during operation could amount to up to 0.42% of GDP and 124,100 jobs (reference year 2017).

The results of the analysis for Asyaport however omit cost/time effects and the impact of the demand for hinterland transport, for which no information is available.

Detailed Economic Impacts

The following pages illustrate the impacts in more detail and provide a detailed sensitivity analysis of the impact during operation.

The following figure provides a summary of the aggregate impact of the average annual investment (for each year during the 3 year investment phase) at Asyaport.[61]

[61] The impact of the investment is measured as the *aggregate impact of the average investment per year during the investment phase(s)*. Aggregate impacts do not necessarily materialise within the year of the corresponding stimulus but may materialise over time. Due to the non-recurring character of the investment, the corresponding impact is not sustained but is an average one-off effect for each year during the investment phase(s).

Table 20: Asyaport – Impacts of the Investment

Sector	GDP (Value Added) 2011 m USD	*% of 2010*	Employment '000 Jobs	*% of 2010*
Agriculture	6.1	*0.01%*	0.8	*0.01%*
Mining&Oil&Gas	2.5	*0.03%*	0.0	*0.03%*
Food&Tobacco	3.8	*0.01%*	0.1	*0.01%*
Textiles	2.4	*0.01%*	0.1	*0.01%*
Wood&Paper&Printing	1.7	*0.02%*	0.0	*0.02%*
Chemicals&Minerals&Metals	10.1	*0.03%*	0.2	*0.03%*
Machinery&Equipment&Electronics	15.3	*0.05%*	0.4	*0.05%*
OtherManufacturing	0.4	*0.01%*	0.0	*0.01%*
Utilities	3.2	*0.02%*	0.0	*0.02%*
Construction	33.9	*0.09%*	1.5	*0.09%*
Trade	17.1	*0.02%*	0.7	*0.02%*
Transport_Land	7.4	*0.02%*	0.1	*0.02%*
Transport_Water	2.4	*0.02%*	0.0	*0.02%*
Transport_Air	0.2	*0.01%*	0.0	*0.01%*
Communication	2.1	*0.02%*	0.0	*0.02%*
Finance&Insurance	16.3	*0.02%*	0.0	*0.02%*
OtherServices	10.0	*0.02%*	0.6	*0.02%*
PublicServices	1.5	*0.00%*	0.1	*0.00%*
Total	**136.4**	***0.02%***	**4.8**	***0.02%***

Note: The stated impacts are aggregate impacts of the average investment per year during the investment phase(s). The % refer to the respective base indicator (GDP or employment) in the given reference year.

Source: HPC 2016

For the operation (including second order growth effects), Asyaport has the following impact in terms of GDP (Value Added) and employment.[62] The results of the analysis however omit cost/time effects and the impact of the demand for hinterland transport.

[62] The impacts of the operations and second order growth effects are measured as aggregate impacts of the port (expansion) in the *Operation Reference Year*. Aggregate impacts do not necessarily materialise within the operation reference year but may materialise over time. Such impacts are sustained impacts to the extent that the operation is recurring each year, though yet possibly subject to a dynamic development.

Table 21: Asyaport – Impacts during Operation (GDP)

Sector	Operation 2011 m USD	Traffic Demand Effects 2011 m USD	Traffic Supply Effects 2011 m USD	Traffic Cost/Time Effects 2011 m USD	Hinterland Transport 2011 m USD	Total Impact 2011 m USD	*% of 2017*
Agriculture	5.0					5.0	*0.01%*
Mining&Oil&Gas	0.7					0.7	*0.01%*
Food&Tobacco	3.2					3.2	*0.01%*
Textiles	2.0					2.0	*0.01%*
Wood&Paper&Printing	1.0					1.0	*0.01%*
Chemicals&Minerals&Metals	4.5					4.5	*0.01%*
Machinery&Equipment&Electronics	1.7					1.7	*0.00%*
OtherManufacturing	0.3					0.3	*0.01%*
Utilities	1.7					1.7	*0.01%*
Construction	0.2					0.2	*0.00%*
Trade	11.7					11.7	*0.01%*
Transport_Land	7.0					7.0	*0.01%*
Transport_Water	50.0					50.0	*0.26%*
Transport_Air	0.3					0.3	*0.01%*
Communication	1.8					1.8	*0.01%*
Finance&Insurance	14.0					14.0	*0.01%*
OtherServices	7.9					7.9	*0.01%*
PublicServices	1.2					1.2	*0.00%*
Total	**114.3**	**0.0**	**0.0**	**0.0**	**0.0**	**114.3**	***0.01%***

Note: The impacts of the operations and second order growth effects are measured as aggregate impacts of the port (expansion) in the Operation Reference Year. The total impact during operation is subject to the considerations for double counting (cf. Section 3.2.4).

Source: HPC 2016

Table 22: Asyaport – Impacts during Operation (Jobs)

Sector	Operation 1000 Jobs	Traffic Demand Effects 1000 Jobs	Traffic Supply Effects 1000 Jobs	Traffic Cost/Time Effects 1000 Jobs	Hinterland Transport 1000 Jobs	Total Impact 1000 Jobs	*% of 2017*
Agriculture	0.6					0.6	*0.01%*
Mining&Oil&Gas	0.0					0.0	*0.01%*
Food&Tobacco	0.1					0.1	*0.01%*
Textiles	0.1					0.1	*0.01%*
Wood&Paper&Printing	0.0					0.0	*0.01%*
Chemicals&Minerals&Metals	0.1					0.1	*0.01%*
Machinery&Equipment&Electronics	0.0					0.0	*0.00%*
OtherManufacturing	0.0					0.0	*0.01%*
Utilities	0.0					0.0	*0.01%*
Construction	0.0					0.0	*0.00%*
Trade	0.4					0.4	*0.01%*
Transport_Land	0.1					0.1	*0.01%*
Transport_Water	0.7					0.7	*0.26%*
Transport_Air	0.0					0.0	*0.01%*
Communication	0.0					0.0	*0.01%*
Finance&Insurance	0.0					0.0	*0.01%*
OtherServices	0.5					0.5	*0.01%*
PublicServices	0.1					0.1	*0.00%*
Total	**2.9**	**0.0**	**0.0**	**0.0**	**0.0**	**2.9**	***0.01%***

Note: The impacts of the operations and second order growth effects are measured as aggregate impacts of the port (expansion) in the Operation Reference Year. The total impact during operation is subject to the considerations for double counting (cf. Section 3.2.4).

Source: HPC 2016

In addition, a sensitivity analysis has been conducted for the total impact related to operation (incl. second order growth effects) with regard to the *relevant traffic differential* and the *extent of the supply effect (imports)*. The results of the analysis however omit cost/time effects and the impact of the demand for hinterland transport.

Table 23: Asyaport – Sensitivity – Impacts during Operation

Total Impact - GDP (Valued Added) (2011 m USD)

Extent of Supply Effect for Imports	Relevant Traffic Differential (All Cargo Types) 0.0%	25.0%	50.0%	75.0%	100.0%
0.0%	114.3	333.2	552.0	770.8	989.6
10.0%	114.3	343.3	573.8	804.2	1,034.7
25.0%	114.3	365.5	619.8	881.8	1,148.5
50.0%	114.3	490.2	925.0	1,360.6	1,796.2
100.0%	114.3	886.9	1,723.7	2,560.5	3,412.7

% of 2017 GDP

Extent of Supply Effect for Imports	Relevant Traffic Differential (All Cargo Types) 0.0%	25.0%	50.0%	75.0%	100.0%
0.0%	0.01%	0.04%	0.07%	0.09%	0.12%
10.0%	0.01%	0.04%	0.07%	0.10%	0.13%
25.0%	0.01%	0.05%	0.08%	0.11%	0.14%
50.0%	0.01%	0.06%	0.11%	0.17%	0.22%
100.0%	0.01%	0.11%	0.21%	0.32%	0.42%

Total Impact - Employment (1000 Jobs)

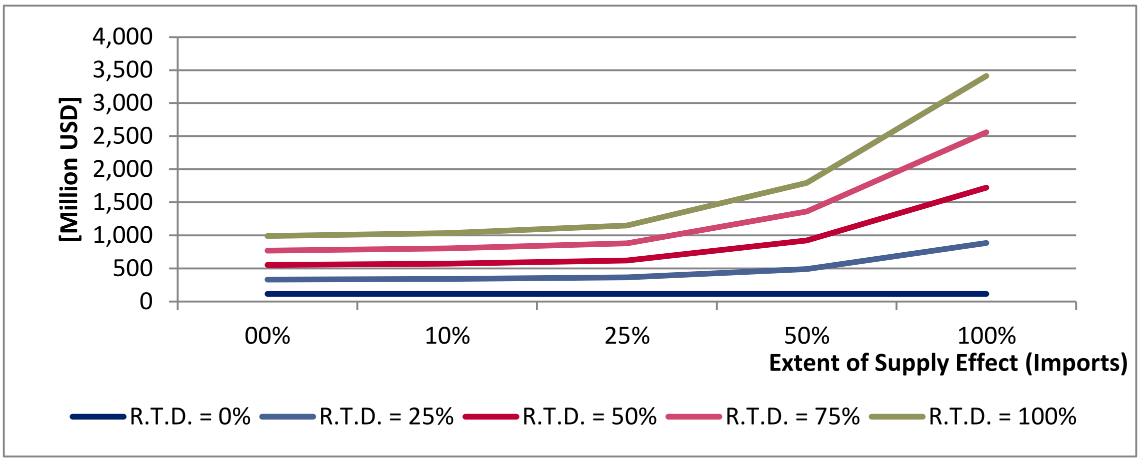
Extent of Supply Effect for Imports	Relevant Traffic Differential (All Cargo Types) 0.0%	25.0%	50.0%	75.0%	100.0%
0.0%	2.9	11.1	19.3	27.4	35.6
10.0%	2.9	11.5	20.2	28.9	37.5
25.0%	2.9	12.4	22.1	32.1	42.0
50.0%	2.9	16.9	33.0	49.0	65.0
100.0%	2.9	31.5	62.3	93.1	124.1

% of 2017 Employment

Extent of Supply Effect for Imports	Relevant Traffic Differential (All Cargo Types) 0.0%	25.0%	50.0%	75.0%	100.0%
0.0%	0.01%	0.04%	0.07%	0.09%	0.12%
10.0%	0.01%	0.04%	0.07%	0.10%	0.13%
25.0%	0.01%	0.04%	0.07%	0.11%	0.14%
50.0%	0.01%	0.06%	0.11%	0.17%	0.22%
100.0%	0.01%	0.11%	0.21%	0.32%	0.42%

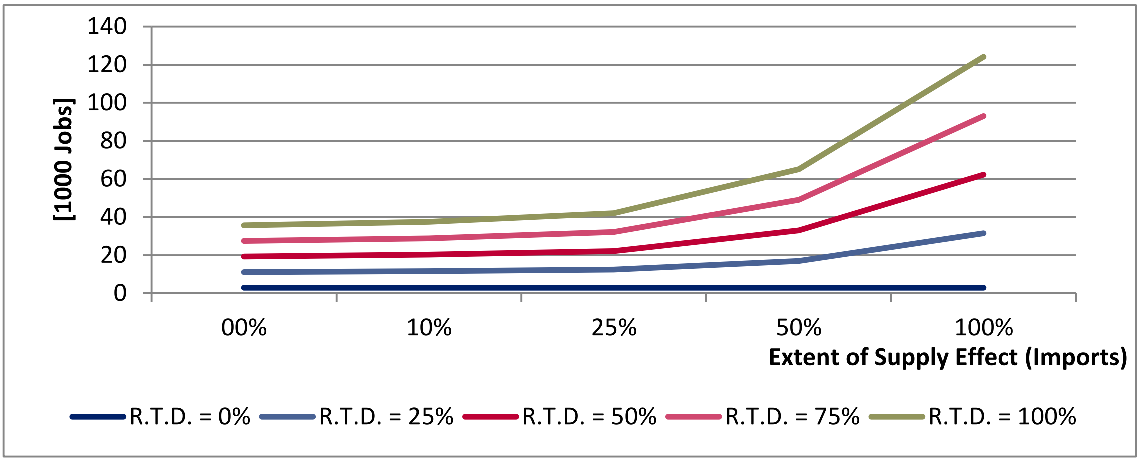
Source: HPC 2016

Figure 16: Asyaport – Sensitivity – Impacts during Operation (GDP)



Source: HPC 2016

Figure 17: Asyaport – Sensitivity – Impacts during Operation (Jobs)



Source: HPC 2016

5.4 Pakistan International Bulk Terminal (Pakistan)

Pakistan International Bulk Terminal (PIBT) is a greenfield bulk terminal at Port Mohammad Bin Qasim in Karachi, Pakistan. The terminal is planned to handle coal imports for power plants and exports of cement and clinker.

Information for the analysis has been derived from the project documentation (IFC's *Investment Review Memorandum*). The analysis considers the investment during the 3 year investment phase (*Investment Reference Year* 2012) as well as the operation in an average operational year (*Operation Reference Year* 2025). The following paragraphs provide an overview of the most relevant input data.

Model Input

The following table presents the shocks related to the investment and operation as derived from the financial data in the project documentation.

The investment is accounted for as follows (price year: 2012, type of expenditure: total):

- Total cost for equipment (incl. specific contingencies and overhead cost) are accounted for as a shock to *Machinery&Equipment&Electronics.*
- Total cost for marine and civil works (incl. specific contingencies and overhead cost) are accounted for as a shock to *Construction.*
- Other cost (miscellaneous cost, financing cost) are not included as a shock.

The operation is accounted for using the revenues as a shock to the water transport sector (price year: 2025, type of expenditure: domestic).

Table 24: PIBT – Investment and Operation Shocks

Item	Sector	Value	Unit
Investment (3 Years)	*Machinery&Equipment&Electronics*	[redacted]	Million USD (2012)
	Construction		Million USD (2012)
	Total Investment		Million USD (2012)
Operation	*Transport_Water*		Million USD (2025)
	Total Operation		Million USD (2025)

Source: IFC *Investment Review Memorandum: PIBT* 2012, HPC 2016

The following table presents relevant input figures for traffic.

Table 25: PIBT – Traffic Data

Item	Data	Value	Unit
Traffic (Dry Bulk)	Exports (Cement and Clinker)	[redacted]	million tons
	Imports (Coal)		million tons
	Total Traffic		million tons
Capacities (without Project)		0.0	million tons
Relevant Traffic Differential	Exports (Cement and Clinker)	100.0%	
	Imports (Coal)	50.0%	

Source: IFC *Investment Review Memorandum: PIBT* 2012, HPC 2016

Relevant notes:

- The traffic figures are as per the project's traffic forecast for 2025. The capacity without project is zero, considering PIBT is a greenfield development.
- The relevant traffic differential is assumed to amount to 50% for coal imports, considering there are competitors for coal handling. For cement and clinker exports, the traffic differential is assumed to be 100%, due to exclusive handling rights in Port Qasim and considering that the project is considered to make exporters more competitive.

No information is available with regard to transportation cost reduction (diversion cost) or hinterland transportation cost – it should be noted that accounting for such cost would actually improve the analysis and probably increase the economic impact.

For relevant economic assumptions, the suggested default values have partly been replaced with individual data.

- The extent of supply effects for coal imports is assumed to be the default value of 25%, as the coal is used for industrial production and energy production.
- Considering the specific nature of the handled bulk commodities, sector correspondences and unit trade values have been specified individually for imports and exports:[63]

[63] For a manual as to how analyse trade values from UN Comtrade, cf. Annex 2.

- Cement and clinker exports correspond only with the *Chemicals&Minerals&Metals* sector and are accounted for with a value of 51 USD / ton (value from UN Comtrade).

Optional input: sector correspondence (exports)

Sector	Containers sector weight	Break Bulk sector weight	Project Cargo sector weight	Dry Bulk sector weight	Liquid Bulk sector weight	RoRo sector weight
Agriculture				0.0		
Mining&Oil&G				0.0		
Food&Tobacco				0.0		
Textiles				0.0		
Wood&Paper				0.0		
Chemicals&Mi				1.0		
Machinery&Eq				0.0		
OtherManufac				0.0		

Optional input: unit trade values (exports)

Sector	Containers USD / ton	Break Bulk USD / ton	Project Cargo USD / ton	Dry Bulk USD / ton	Liquid Bulk USD / ton	RoRo USD / ton
Agriculture						
Mining&Oil&G						
Food&Tobacco						
Textiles						
Wood&Paper						
Chemicals&Mi				51.0		
Machinery&Eq						
OtherManufac						

- Coal imports correspond only with the *Mining&Oil&Gas* sector and are accounted for with a value of 139 USD / ton (value from UN Comtrade).

Optional input: sector correspondence (imports)

Sector	Containers sector weight	Break Bulk sector weight	Project Cargo sector weight	Dry Bulk sector weight	Liquid Bulk sector weight	RoRo sector weight
Agriculture				0.0		
Mining&Oil&G				1.0		
Food&Tobacco				0.0		
Textiles				0.0		
Wood&Paper				0.0		
Chemicals&Mi				0.0		
Machinery&Eq				0.0		
OtherManufac				0.0		

Optional input: unit trade values (imports)

Sector	Containers USD / ton	Break Bulk USD / ton	Project Cargo USD / ton	Dry Bulk USD / ton	Liquid Bulk USD / ton	RoRo USD / ton
Agriculture						
Mining&Oil&G				139.0		
Food&Tobacco						
Textiles						
Wood&Paper						
Chemicals&Mi						
Machinery&Eq						
OtherManufac						

The following pages provide an overview of the resulting economic impacts.

Summary of Economic Impacts

The table below provides a summary of impacts (GDP and employment) of investment and operation for PIBT. In addition, the summary shows the total impacts as a % of the respective base indicator (GDP or employment) in the given reference year.

The summary shows that the impact of the average annual investment, for each year during the 3 year investment phase, amounts to 0.04% of GDP and 21,200 jobs (reference year 2012).[64]

In contrast, the total impact during operation in 2025 – including the impact of the operation and second order growth effects – amounts to 0.17% of GDP and 155,900 jobs.[65] The impact of PIBT is significant in particular due to the supply effect of coal imports, which are used for industrial production and for the generation of electricity.

Table 26: PIBT – Impact Summary

Impact	GDP (2011 m USD)		Employment ('000 Jobs)	
Average Annual Investment *over 3 Years* (Reference Year 2012)				
Investment	86.9	*0.04 %*	21.2	*0.04 %*
Operation & 2nd Order Effects (Reference Year 2025)				
Operation	114.6		21.3	
Traffic – Demand Effects	179.0		34.3	
Traffic – Supply Effects	640.9		150.7	
Traffic – Cost/Time	-		-	
Hinterland Transport	-		-	
Total Impact*	678.2	*0.17 %*	155.9	*0.16 %*

Note: The % refer to the respective base indicator (GDP or employment) in the given reference year. Total impact during operation is subject to considerations for double counting (cf. Section 3.2.4).

Source: HPC 2016

[64] The impact of the investment is measured as the *aggregate impact of the average investment per year during the investment phase(s)*. Aggregate impacts do not necessarily materialise within the year of the corresponding stimulus but may materialise over time. Due to the non-recurring character of the investment, the corresponding impact is not sustained but is an average one-off effect for each year during the investment phase(s).

[65] The impacts of the operations and second order growth effects are measured as aggregate impacts of the port (expansion) in the *Operation Reference Year*. Aggregate impacts do not necessarily materialise within the operation reference year but may materialise over time. Such impacts are sustained impacts to the extent that the operation is recurring each year, though yet possibly subject to a dynamic development.

A sensitivity analysis with regard to the *relevant traffic differential* and the *extent of the supply effect (imports)* indicates that, given the most optimistic assumptions for these two parameters, the impact during operation could amount to up to 1.27% of GDP and 1.2 million jobs (reference year 2025).

The results of the analysis however omit cost/time effects and the impact of the demand for hinterland transport, for which no information is available.

Detailed Economic Impacts

The following pages illustrate the impacts in more detail and provide a detailed sensitivity analysis of the impact during operation.

The following figure provides a summary of the aggregate impact of the average annual investment (for each year during the 3 year investment phase) at PIBT.[66]

Table 27: PIBT – Impacts of the Investment

Sector	GDP (Value Added) 2011 m USD	% of 2012	Employment '000 Jobs	% of 2012
Agriculture	8.2	0.03%	7.2	0.03%
Mining&Oil&Gas	1.7	0.05%	0.0	0.05%
Food&Tobacco	14.1	0.03%	0.8	0.03%
Textiles	1.5	0.03%	0.5	0.03%
Wood&Paper&Printing	1.3	0.04%	0.2	0.04%
Chemicals&Minerals&Metals	2.0	0.06%	0.6	0.06%
Machinery&Equipment&Electronics	5.1	0.08%	0.7	0.08%
OtherManufacturing	0.1	0.03%	0.0	0.03%
Utilities	2.2	0.04%	0.1	0.04%
Construction	7.6	0.19%	6.0	0.19%
Trade	12.5	0.04%	0.5	0.04%
Transport_Land	15.4	0.04%	1.6	0.04%
Transport_Water	0.0	0.01%	0.0	0.01%
Transport_Air	0.3	0.02%	0.1	0.02%
Communication	0.3	0.03%	0.0	0.03%
Finance&Insurance	5.1	0.04%	0.6	0.04%
OtherServices	8.3	0.04%	1.6	0.04%
PublicServices	1.1	0.01%	0.6	0.01%
Total	**86.9**	***0.04%***	**21.2**	***0.04%***

Note: The stated impacts are aggregate impacts of the average investment per year during the investment phase(s). The % refer to the respective base indicator (GDP or employment) in the given reference year.

[66] The impact of the investment is measured as the *aggregate impact of the average investment per year during the investment phase(s)*. Aggregate impacts do not necessarily materialise within the year of the corresponding stimulus but may materialise over time. Due to the non-recurring character of the investment, the corresponding impact is not sustained but is an average one-off effect for each year during the investment phase(s).

Source: HPC 2016

For the operation (including second order growth effects), PIBT has the following impact in terms of GDP (Value Added) and employment.[67] With the given assumptions, the supply effect of coal imports is the dominant effect for PIBT.

Table 28: PIBT – Impacts during Operation (GDP)

Sector	Operation 2011 m USD	Traffic Demand Effects 2011 m USD	Traffic Supply Effects 2011 m USD	Traffic Cost/Time Effects 2011 m USD	Hinterland Transport 2011 m USD	Total Impact 2011 m USD	% of 2025
Agriculture	10.6	17.4	76.9			76.9	0.16%
Mining&Oil&Gas	1.0	7.4	10.0			10.0	0.16%
Food&Tobacco	18.3	29.5	119.6			119.6	0.16%
Textiles	2.0	3.2	16.6			16.6	0.16%
Wood&Paper&Printing	1.1	2.7	9.3			9.3	0.16%
Chemicals&Minerals&Metals	1.0	11.2	9.8			12.2	0.20%
Machinery&Equipment&Electronics	1.4	2.7	18.9			18.9	0.16%
OtherManufacturing	0.1	0.1	1.1			1.1	0.16%
Utilities	2.1	5.9	15.3			15.3	0.16%
Construction	0.2	0.4	12.1			12.1	0.16%
Trade	11.8	29.7	98.2			98.2	0.16%
Transport_Land	14.9	38.2	111.1			111.1	0.16%
Transport_Water	35.7	0.1	0.9			35.8	5.97%
Transport_Air	0.3	0.8	4.5			4.5	0.16%
Communication	0.7	0.5	2.4			2.4	0.16%
Finance&Insurance	5.4	10.8	35.6			35.6	0.16%
OtherServices	7.0	15.2	60.7			60.7	0.16%
PublicServices	1.2	3.0	37.7			37.7	0.16%
Total	**114.7**	**179.0**	**640.9**	**0.0**	**0.0**	**678.2**	**0.17%**

Note: The impacts of the operations and second order growth effects are measured as aggregate impacts of the port (expansion) in the Operation Reference Year. The total impact during operation is subject to the considerations for double counting (cf. Section 3.2.4).

Source: HPC 2016

Table 29: PIBT – Impacts during Operation (Jobs)

Sector	Operation 1000 Jobs	Traffic Demand Effects 1000 Jobs	Traffic Supply Effects 1000 Jobs	Traffic Cost/Time Effects 1000 Jobs	Hinterland Transport 1000 Jobs	Total Impact 1000 Jobs	% of 2025
Agriculture	9.2	15.2	67.4			67.4	0.16%
Mining&Oil&Gas	0.0	0.1	0.2			0.2	0.16%
Food&Tobacco	1.1	1.7	7.1			7.1	0.16%
Textiles	0.7	1.1	5.6			5.6	0.16%
Wood&Paper&Printing	0.2	0.4	1.3			1.3	0.16%
Chemicals&Minerals&Metals	0.3	3.4	3.0			3.7	0.20%
Machinery&Equipment&Electronics	0.2	0.4	2.5			2.5	0.16%
OtherManufacturing	0.0	0.0	0.2			0.2	0.16%
Utilities	0.1	0.4	1.1			1.1	0.16%
Construction	0.2	0.4	9.5			9.5	0.16%
Trade	0.5	1.2	4.1			4.1	0.16%
Transport_Land	1.6	4.0	11.7			11.7	0.16%
Transport_Water	4.6	0.0	0.1			4.6	5.97%
Transport_Air	0.1	0.2	1.0			1.0	0.16%
Communication	0.1	0.0	0.2			0.2	0.16%
Finance&Insurance	0.6	1.2	4.0			4.0	0.16%
OtherServices	1.3	2.9	11.4			11.4	0.16%
PublicServices	0.7	1.6	20.6			20.6	0.16%
Total	**21.3**	**34.3**	**150.7**	**0.0**	**0.0**	**155.9**	**0.16%**

Note: The impacts of the operations and second order growth effects are measured as aggregate impacts of the port (expansion) in the Operation Reference Year. The total impact during operation is subject to the considerations for double counting (cf. Section 3.2.4).

[67] The impacts of the operations and second order growth effects are measured as aggregate impacts of the port (expansion) in the *Operation Reference Year*. Aggregate impacts do not necessarily materialise within the operation reference year but may materialise over time. Such impacts are sustained impacts to the extent that the operation is recurring each year, though yet possibly subject to a dynamic development.

Source: HPC 2016

In addition, a sensitivity analysis has been conducted for the total impact related to operation (incl. second order growth effects) with regard to the *relevant traffic differential* and the *extent of the supply effect (imports)*. The results of the analysis however omit cost/time effects and the impact of the demand for hinterland transport.

Table 30: PIBT – Sensitivity – Impacts during Operation

Total Impact - GDP (Valued Added) (2011 m USD)

Extent of Supply Effect	Relevant Traffic Differential (All Cargo Types)				
for Imports	0.0%	25.0%	50.0%	75.0%	100.0%
0.0%	114.7	159.4	204.2	248.9	293.7
10.0%	114.7	172.2	295.1	423.8	552.5
25.0%	114.7	355.7	675.7	995.6	1,315.6
50.0%	114.7	675.6	1,315.6	1,955.5	2,595.4
100.0%	114.7	1,315.5	2,595.4	3,875.2	5,155.1

% of 2025 GDP

Extent of Supply Effect	Relevant Traffic Differential (All Cargo Types)				
for Imports	0.0%	25.0%	50.0%	75.0%	100.0%
0.0%	0.03%	0.04%	0.05%	0.06%	0.07%
10.0%	0.03%	0.04%	0.07%	0.10%	0.14%
25.0%	0.03%	0.09%	0.17%	0.25%	0.32%
50.0%	0.03%	0.17%	0.32%	0.48%	0.64%
100.0%	0.03%	0.32%	0.64%	0.96%	1.27%

Total Impact - Employment (1000 Jobs)

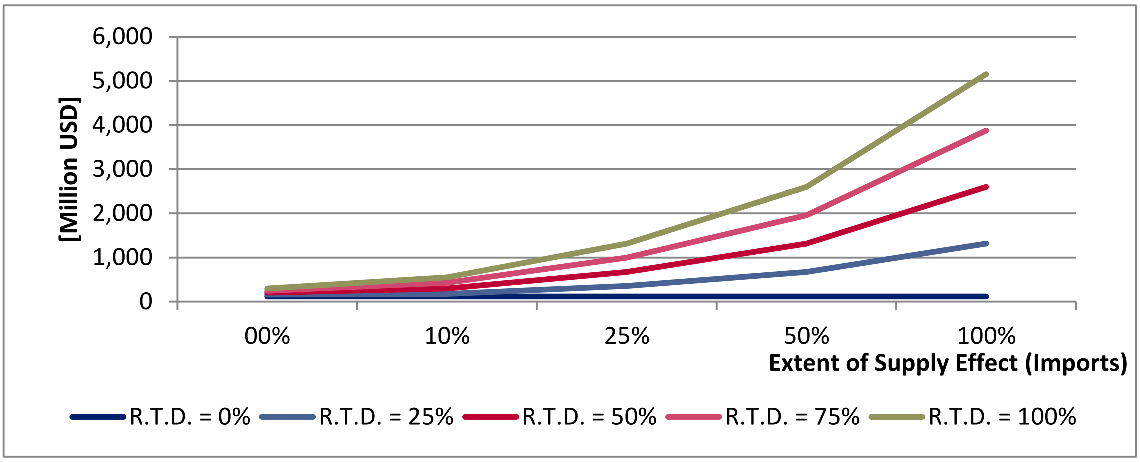
Extent of Supply Effect	Relevant Traffic Differential (All Cargo Types)				
for Imports	0.0%	25.0%	50.0%	75.0%	100.0%
0.0%	21.3	29.9	38.4	47.0	55.6
10.0%	21.3	35.8	65.7	96.0	126.4
25.0%	21.3	79.9	155.2	230.5	305.8
50.0%	21.3	155.2	305.8	456.4	607.0
100.0%	21.3	305.8	607.0	908.2	1,209.4

% of 2025 Employment

Extent of Supply Effect	Relevant Traffic Differential (All Cargo Types)				
for Imports	0.0%	25.0%	50.0%	75.0%	100.0%
0.0%	0.02%	0.03%	0.04%	0.05%	0.06%
10.0%	0.02%	0.04%	0.07%	0.10%	0.13%
25.0%	0.02%	0.08%	0.16%	0.24%	0.32%
50.0%	0.02%	0.16%	0.32%	0.48%	0.64%
100.0%	0.02%	0.32%	0.64%	0.95%	1.27%

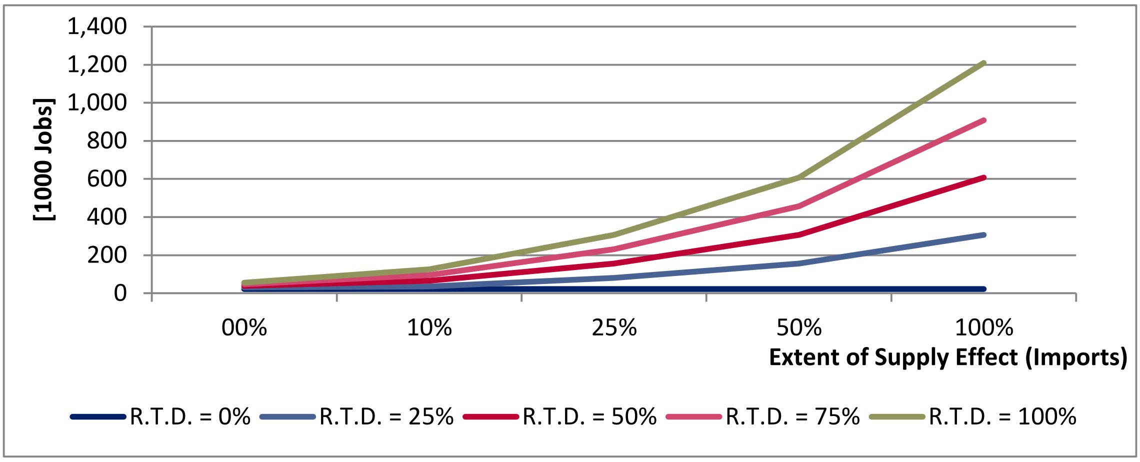
Source: HPC 2016

Figure 18: PIBT – Sensitivity – Impacts during Operation (GDP)



Source: HPC 2016

Figure 19: PIBT – Sensitivity – Impacts during Operation (Jobs)



Source: HPC 2016

5.5 Jakarta International Container Terminal (Indonesia)

Jakarta International Container Terminal (JICT) is the largest container terminal in Jakarta, Indonesia. Jakarta is one of four main ports in Indonesia that handle international cargo (imports and exports) and serves as a hub for redistribution of the cargo with domestic ships to the country's more than 6,000 inhabited islands. JICT operates under a 20 year concession awarded in 1999. IFC funded an expansion of the terminal in 2009..

Information for the analysis has been derived from the project documentation (IFC's financial model for JICT and the Moffatt & Nichol Market Study). The analysis considers the investment during the 3 year investment phase (*Investment Reference Year* 2009) as well as the full operation nearly at capacity after expansion (*Operation Reference Year* 2019). The following paragraphs provide an overview of the most relevant input data.

Model Input

The following table presents the shocks related to the investment and operation as derived from the financial data in the project documentation.

The investment for the expansion is accounted for as follows (price year: 2009, type of expenditure: total):

- Total cost for equipment and IT[68] are accounted for as a shock to *Machinery&Equipment&Electronics.*
- Total cost for civil works[69] are accounted for as a shock to *Construction.*

The operation is accounted for using the revenues as a shock to the water transport sector (price year: 2019, type of expenditure: domestic) – however only the incremental revenues are considered.

[68] It is assumed that this includes specific contingencies and overhead such as design and supervision.

[69] It is assumed that this includes specific contingencies and overhead such as design and supervision.

Table 31: JICT – Investment and Operation Shocks

Item	Sector	Value	Unit
Investment (3 Years)	*Machinery&Equipment&Electronics*	[redacted]	Million USD (2009)
	Construction		Million USD (2009)
	Total Investment		Million USD (2009)
Operation	*Transport_Water*		Million USD (2019)
	Total Operation		Million USD (2019)

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Source: IFC's Financial Model JICT 2009, Moffatt & Nichol Market Study 2009, HPC 2016

The following table presents relevant input figures for traffic. Relevant notes are presented overleaf.

Table 32: JICT – Traffic Data

Item	Data	Value	Unit
Traffic (Containers)	Exports	[redacted]	k TEU
	Imports		k TEU
	Domestic Traffic		k TEU
	Total Traffic		k TEU
Capacity for Containers (without Project)	Exports		k TEU
	Imports		k TEU
	Domestic Traffic		k TEU
	Total Traffic		k TEU
Relevant Traffic Differential	Exports	100.0%	
	Imports	100.0%	
	Domestic Traffic	100.0%	

Source: IFC's Financial Model JICT 2009, Moffatt & Nichol Market Study 2009, HPC 2016

Relevant notes:

- The traffic figures are as per the traffic forecast for 2019. Traffic has been split into exports, imports, and domestic traffic based on information from the Moffatt & Nichol Market Study.[70]
- The capacity before expansion has been allocated to traffic types proportional to the traffic shares.
- The relevant traffic differential is assumed to amount to 100% for all traffic types, reflecting the fact that other port facilities operate at capacity and there are no real diversion possibilities.

No information is available with regard to transportation cost reduction (diversion cost) or hinterland transportation cost – it should be noted that accounting for such cost might actually improve the analysis and probably increase the economic impact.

Most economic assumptions have been considered with the suggested default values – only the share of domestic cargo has been replaced with an individual assumption:

- The automatic default values for container volumes are 8.9 tons / TEU for exports, 10.8 tons / TEU for imports, and 9.9 tons / TEU for domestic traffic.
- The supply effect for imports is used with the standard default value of 25%, the supply effect for domestic cargoes with the standard default value of 100%.
- The share of domestic cargo in domestic traffic is assumed as 50%, accounting for the fact that domestic containers contain a considerable amount of transhipped international cargo (however the exact share is not known).

The following paragraphs provide an overview of the resulting economic impacts.

[70] This information contradicts the traffic composition as shown in IFC's financial model, which distinguishes local traffic (definition unclear) and transhipment. The cargo split as used here is consistent with the Consultants' knowledge of the Indonesian port sector.

Summary of Economic Impacts

The table below provides a summary of impacts (GDP and employment) of investment and operation for JICT. In addition, the summary shows the total impacts as a % of the respective base indicator (GDP or employment) in the given reference year.

The summary shows that the impact of the average annual investment, for each year during the 3 year investment phase, amounts to 0.01% of GDP and 8,400 jobs (reference year 2009).[71]

In contrast, the total impact during operation in 2019 – including the impact of the operation and second order growth effects – amounts to 0.67% of GDP and 1.2 million jobs.[72] As such, the impact of JICT is significant. Supply and demand effects account for the lion's share of the impact during operation, reflecting the relevance of JICT as a catalyst for external and internal trade.

Table 33: JICT – Impact Summary

Impact	GDP (2011 m USD)		Employment ('000 Jobs)	
Average Annual Investment *over 3 Years* (Reference Year 2009)				
Investment	65.5	*0.01 %*	8.4	*0.01 %*
Operation & 2nd Order Effects (Reference Year 2019)				
Operation	45.1		8.3	
Traffic – Demand Effects	7,007.2		1,128.8	
Traffic – Supply Effects	5,854.4		817.2	
Traffic – Cost/Time	-		-	
Hinterland Transport	-		-	
Total Impact*	8,236.8	*0.67 %*	1,243.5	*0.73 %*

Note: The % refer to the respective base indicator (GDP or employment) in the given reference year. Total impact during operation is subject to considerations for double counting (cf. Section 3.2.4).

[71] The impact of the investment is measured as the *aggregate impact of the average investment per year during the investment phase(s)*. Aggregate impacts do not necessarily materialise within the year of the corresponding stimulus but may materialise over time. Due to the non-recurring character of the investment, the corresponding impact is not sustained but is an average one-off effect for each year during the investment phase(s).

[72] The impacts of the operations and second order growth effects are measured as aggregate impacts of the port (expansion) in the *Operation Reference Year*. Aggregate impacts do not necessarily materialise within the operation reference year but may materialise over time. Such impacts are sustained impacts to the extent that the operation is recurring each year, though yet possibly subject to a dynamic development.

Source: HPC 2016

A sensitivity analysis with regard to the *relevant traffic differential* and the *extent of the supply effect (imports)* indicates that, given the most optimistic assumptions for these two parameters, the impact during operation could amount to up to 1.91% of GDP and 3.3 million jobs (reference year 2019).

The results of the analysis however omit cost/time effects and the impact of the demand for hinterland transport, for which no information is available.

Detailed Economic Impacts

The following pages illustrate the impacts in more detail and provide a detailed sensitivity analysis of the impact during operation.

The following figure provides a summary of the impact of the aggregate impact of the average annual investment (for each year during the 3 year investment phase) at JICT.[73]

Table 34: JICT – Impacts of the Investment

Sector	GDP (Value Added) 2011 m USD	*% of 2009*	Employment '000 Jobs	*% of 2009*
Agriculture	6.7	*0.01%*	2.6	*0.01%*
Mining&Oil&Gas	4.4	*0.01%*	0.1	*0.01%*
Food&Tobacco	2.5	*0.01%*	0.2	*0.01%*
Textiles	0.8	*0.00%*	0.1	*0.00%*
Wood&Paper&Printing	1.0	*0.01%*	0.1	*0.01%*
Chemicals&Minerals&Metals	7.1	*0.01%*	0.4	*0.01%*
Machinery&Equipment&Electronics	5.8	*0.02%*	0.3	*0.02%*
OtherManufacturing	0.1	*0.00%*	0.0	*0.00%*
Utilities	0.4	*0.01%*	0.0	*0.01%*
Construction	13.3	*0.02%*	1.1	*0.02%*
Trade	7.8	*0.01%*	1.6	*0.01%*
Transport_Land	1.3	*0.01%*	0.3	*0.01%*
Transport_Water	0.4	*0.01%*	0.1	*0.01%*
Transport_Air	0.1	*0.01%*	0.0	*0.01%*
Communication	1.0	*0.01%*	0.0	*0.01%*
Finance&Insurance	2.8	*0.01%*	0.1	*0.01%*
OtherServices	9.0	*0.01%*	1.0	*0.01%*
PublicServices	0.9	*0.00%*	0.1	*0.00%*
Total	**65.5**	***0.01%***	**8.4**	***0.01%***

Note: The stated impacts are aggregate impacts of the average investment per year during the investment phase(s). The % refer to the respective base indicator (GDP or employment) in the given reference year.

[73] The impact of the investment is measured as the *aggregate impact of the average investment per year during the investment phase(s)*. Aggregate impacts do not necessarily materialise within the year of the corresponding stimulus but may materialise over time. Due to the non-recurring character of the investment, the corresponding impact is not sustained but is an average one-off effect for each year during the investment phase(s).

Source: HPC 2016

For the operation (including second order growth effects), JICT has the following impact in terms of GDP (Value Added) and employment.[74] The results of the analysis however omit cost/time effects and the impact of the demand for hinterland transport.

Table 35: JICT – Impacts during Operation (GDP)

Sector	Operation 2011 m USD	Traffic Demand Effects 2011 m USD	Traffic Supply Effects 2011 m USD	Traffic Cost/Time Effects 2011 m USD	Hinterland Transport 2011 m USD	Total Impact 2011 m USD	*% of 2019*
Agriculture	6.9	1,358.5	728.0			1,365.4	*0.89%*
Mining&Oil&Gas	1.7	400.4	715.7			715.7	*0.48%*
Food&Tobacco	4.2	752.9	317.2			757.0	*1.14%*
Textiles	0.5	468.6	132.9			469.1	*1.68%*
Wood&Paper&Printing	0.3	291.8	112.8			292.2	*1.24%*
Chemicals&Minerals&Metals	3.1	772.5	536.4			775.6	*0.69%*
Machinery&Equipment&Electronics	0.8	535.6	200.7			536.4	*1.28%*
OtherManufacturing	0.0	37.1	18.1			37.1	*0.98%*
Utilities	0.3	50.6	40.8			50.9	*0.60%*
Construction	0.1	17.3	545.5			545.5	*0.48%*
Trade	6.8	751.7	689.1			758.5	*0.53%*
Transport_Land	1.3	149.4	118.7			150.7	*0.61%*
Transport_Water	9.9	46.4	28.9			56.2	*0.93%*
Transport_Air	0.1	11.3	12.4			12.4	*0.48%*
Communication	0.9	102.9	100.0			103.7	*0.49%*
Finance&Insurance	1.7	263.1	234.0			264.8	*0.54%*
OtherServices	6.0	907.9	891.4			913.9	*0.49%*
PublicServices	0.6	89.3	431.6			431.6	*0.48%*
Total	**45.1**	**7,007.2**	**5,854.4**	**0.0**	**0.0**	**8,236.8**	***0.67%***

Note: The impacts of the operations and second order growth effects are measured as aggregate impacts of the port (expansion) in the Operation Reference Year. The total impact during operation is subject to the considerations for double counting (cf. Section 3.2.4).

Source: HPC 2016

Table 36: JICT – Impacts during Operation (Jobs)

Sector	Operation 1000 Jobs	Traffic Demand Effects 1000 Jobs	Traffic Supply Effects 1000 Jobs	Traffic Cost/Time Effects 1000 Jobs	Hinterland Transport 1000 Jobs	Total Impact 1000 Jobs	*% of 2019*
Agriculture	2.7	530.4	284.2			533.1	*0.89%*
Mining&Oil&Gas	0.0	5.8	10.3			10.3	*0.48%*
Food&Tobacco	0.3	62.6	26.4			62.9	*1.14%*
Textiles	0.1	76.1	21.6			76.2	*1.68%*
Wood&Paper&Printing	0.0	18.4	7.1			18.5	*1.24%*
Chemicals&Minerals&Metals	0.2	48.2	33.5			48.4	*0.69%*
Machinery&Equipment&Electronics	0.0	30.0	11.2			30.0	*1.28%*
OtherManufacturing	0.0	17.6	8.6			17.6	*0.98%*
Utilities	0.0	2.3	1.8			2.3	*0.60%*
Construction	0.0	1.5	46.0			46.0	*0.48%*
Trade	1.4	157.1	144.0			158.5	*0.53%*
Transport_Land	0.3	32.5	25.8			32.8	*0.61%*
Transport_Water	2.2	10.5	6.5			12.7	*0.93%*
Transport_Air	0.0	3.2	3.5			3.5	*0.48%*
Communication	0.0	1.1	1.0			1.1	*0.49%*
Finance&Insurance	0.1	12.2	10.8			12.3	*0.54%*
OtherServices	0.7	104.5	102.6			105.2	*0.49%*
PublicServices	0.1	14.9	72.0			72.0	*0.48%*
Total	**8.3**	**1,128.8**	**817.2**	**0.0**	**0.0**	**1,243.5**	***0.73%***

[74] The impacts of the operations and second order growth effects are measured as aggregate impacts of the port (expansion) in the *Operation Reference Year*. Aggregate impacts do not necessarily materialise within the operation reference year but may materialise over time. Such impacts are sustained impacts to the extent that the operation is recurring each year, though yet possibly subject to a dynamic development.

Note: The impacts of the operations and second order growth effects are measured as aggregate impacts of the port (expansion) in the Operation Reference Year. The total impact during operation is subject to the considerations for double counting (cf. Section 3.2.4).

Source: HPC 2016

In addition, a sensitivity analysis has been conducted for the total impact related to operation (incl. second order growth effects) with regard to the *relevant traffic differential* and the *extent of the supply effect (imports)*. The results of the analysis however omit cost/time effects and the impact of the demand for hinterland transport.

Table 37: JICT – Sensitivity – Impacts during Operation

Total Impact - GDP (Valued Added) (2011 m USD)

Extent of Supply Effect for Imports	Relevant Traffic Differential (All Cargo Types) 0.0%	25.0%	50.0%	75.0%	100.0%
0.0%	45.1	1,820.0	3,595.1	5,370.1	7,145.1
10.0%	45.1	1,867.3	3,690.2	5,513.0	7,335.9
25.0%	45.1	2,091.2	4,139.7	6,188.3	8,236.8
50.0%	45.1	3,070.6	6,125.6	9,180.6	12,237.1
100.0%	45.1	5,854.4	11,708.7	17,563.1	23,417.4

% of 2019 GDP

Extent of Supply Effect for Imports	Relevant Traffic Differential (All Cargo Types) 0.0%	25.0%	50.0%	75.0%	100.0%
0.0%	0.00%	0.15%	0.29%	0.44%	0.58%
10.0%	0.00%	0.15%	0.30%	0.45%	0.60%
25.0%	0.00%	0.17%	0.34%	0.50%	0.67%
50.0%	0.00%	0.25%	0.50%	0.75%	1.00%
100.0%	0.00%	0.48%	0.95%	1.43%	1.91%

Total Impact - Employment (1000 Jobs)

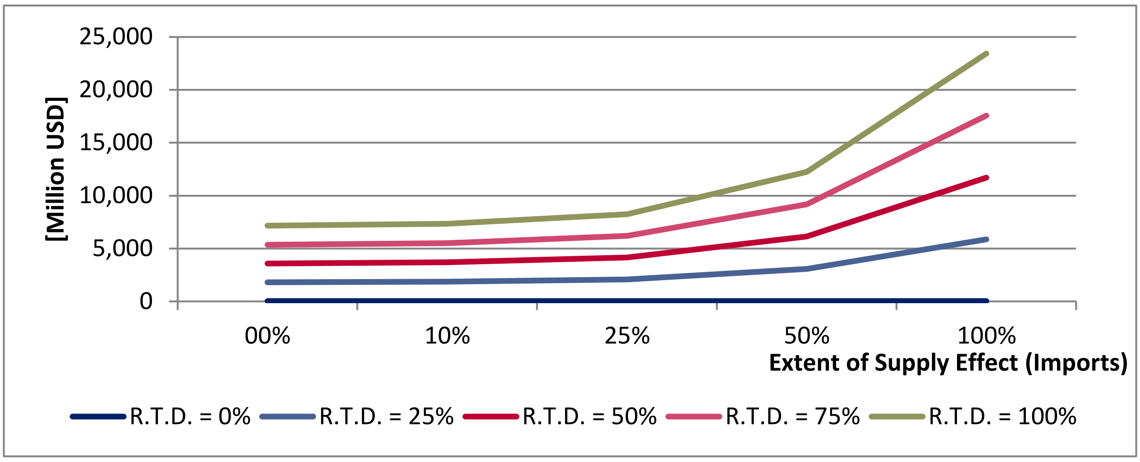
Extent of Supply Effect for Imports	Relevant Traffic Differential (All Cargo Types) 0.0%	25.0%	50.0%	75.0%	100.0%
0.0%	8.3	292.4	576.6	860.8	1,144.9
10.0%	8.3	298.1	588.0	877.9	1,167.8
25.0%	8.3	317.0	625.8	934.6	1,243.5
50.0%	8.3	424.4	846.1	1,267.8	1,689.8
100.0%	8.3	817.2	1,634.4	2,451.6	3,268.8

% of 2019 Employment

Extent of Supply Effect for Imports	Relevant Traffic Differential (All Cargo Types) 0.0%	25.0%	50.0%	75.0%	100.0%
0.0%	0.00%	0.17%	0.34%	0.50%	0.67%
10.0%	0.00%	0.17%	0.34%	0.51%	0.68%
25.0%	0.00%	0.19%	0.37%	0.55%	0.73%
50.0%	0.00%	0.25%	0.49%	0.74%	0.99%
100.0%	0.00%	0.48%	0.95%	1.43%	1.91%

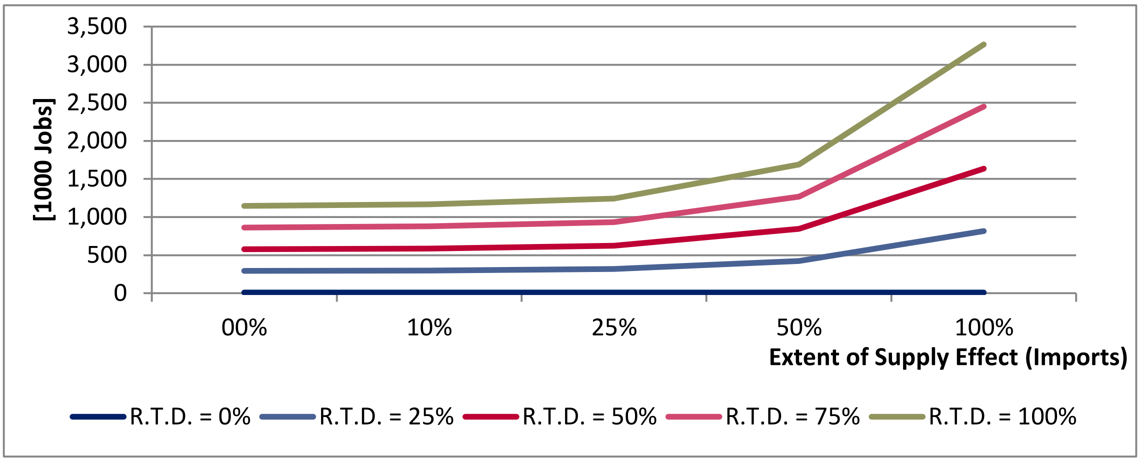
Source: HPC 2016

Figure 20: JICT – Sensitivity – Impacts during Operation (GDP)



Source: HPC 2016

Figure 21: JICT – Sensitivity – Impacts during Operation (Jobs)



Source: HPC 2016

Annex 1

ALTERNATIVE MODELLING APPROACHES AND MISCELLANEOUS LITERATURE REVIEW

Alternative Modelling Approaches: Other Representations of IO Models

Alternative representations of IO models include approaches that apply the IO methodology to an analysis of the transmission of price changes through the supply chain of an economy. In this respect, a standard approach is the Leontief price model (Miller and Blair, 2009). It shares the assumption of fixed input coefficients with the Leontief quantity model. However, instead of exogenous demand changes, the starting point is an exogenous change in the prices of primary inputs (e.g. capital, labour). As payments made to primary inputs represent household income and thus value added, this is modelled as a change in the price index of value added. Given the information on supply chains provided by the IO-table, the net effect of these price changes on sectoral price levels (in percentage terms) is derived. An implicit assumption is that each price change along the supply chain is fully passed on to the buyer, i.e. demand remains completely inflexible (Oosterhaven, 1996). Hence, while the Leontief quantity model adjusts quantities under the premise of fixed prices, the Leontief price model does the opposite. For this reason, the Leontief price model represents no useful modelling strategy for our purposes, as our prime interest is in real (i.e. output-related) effects of port investments.

A popular modelling approach for investigating supply-related shocks is the supply-driven IO model first proposed by Ghosh (1958). Instead of analysing the impact of changes in final demand, it simulates the supply chain effects of exogenous changes in sectoral value added. The underlying logic is that an increase in production values of certain sectors is associated with increased demand (in value terms) by downstream sectors, which in turn use the additional inputs to increase their own revenues made by selling their products to other production sectors or final customers. The direction of linkages is thus opposed to the Leontief quantity model, where the initial shock emanates from final demand and works its way upstream. While the Leontief quantity model thus focuses on *backward linkages* through demand pressure, the Ghosh model analyses *forward linkages* through supply pressure. Another major distinction is that in Ghosh's framework sectoral output coefficients are assumed to be fixed, while input coefficients adapt flexibly to shocks.

The economic meaningfulness of the Ghosh approach crucially hinges on its interpretation either as a quantity or as a price model. Many older applications (Giarratini, 1976; Davis and Salkin, 1984) have explicitly or implicitly interpreted the model results as changes in physical production volumes. In this formulation, the model has been subject to serious criticism. One concerns the flexibility of input coefficients towards shocks. The implicit assumption here is that no single input is absolutely essential, which in technological terms implies a very high degree of substitutability among all factors, something that is clearly unrealistic in many circumstances (Gruver, 1989). Another criticism relates to the supply-driven process as such: it requires that all downstream sectors fully adjust their production to an increase in input supply. This is only plausible in a scenario where the sector exposed to a value added shock has been limited by capacity constraints, while all other sectors in the economy have not (Oosterhaven, 1988). On the other hand, when being interpreted as a price model, Dietzenbacher (1997) has shown that results of the Ghosh model are equivalent to those of the Leontief price model. While this eliminates the criticism of Oosterhaven (1988), it also means that the model is no longer able to capture changes in production volumes and thus real income.

It should be noted again that the standard Leontief quantity model is not able to capture the impact of demand or supply changes on prices or vice versa. In case of capacity restrictions, an increase in demand may be dampened – at least to some extent – by increasing prices. This opens up an extension possibility of the classical IO methodology with its assumption of unlimited capacities and constant prices: the use of CGE models with their price-balancing mechanisms. While allowing for a high degree of modelling flexibility, their high computational requirements prevent an application in the form of a straightforward Excel sheet. We therefore limit our discussion of CGE models to the short introduction below.

Finally, there are also variants of IO models that try to explicitly incorporate supply constraints (Hallegatte, 2008, 2012). These models introduce rationing schemes (other than the price) if demand reaches the supply constraints. This, however, is sensitive to a more or less arbitrary setting of boundaries and might not be as realistic as price-based rationing.

Alternative Modelling Approaches: Computable General Equilibrium Models

The core concept of Computable General Equilibrium (CGE) models is to assume the existence of a simultaneous equilibrium on all markets of the economy (goods, labour, etc.), referred to as the “general” equilibrium. An equilibrium on a market is characterized by a price which clears the market, i.e. ensures that the amount of supplied and demanded quantities coincide. The supply and demand functions are usually determined by utility functions (households) and production functions (firms). Thereby it is assumed that households make their demand decisions by maximizing utility and that firms decide on profit maximizing input demands.

Regarding the demand and production functions, price elasticities are key parameters as they determine how strongly households and firms would react to price changes. However, these elasticities are usually not known, but need to be derived from the empirical literature, which makes the calibration of a CGE model difficult. Often, results strongly hinge upon a somewhat arbitrary choice of elasticities.

Typical for CGE models is a welfare concept. Utilities of different agents and/or of different points in time are aggregated to a welfare function. All shocks are evaluated based on the welfare function. The constituting utility levels include the physical amount of consumed goods and their prices. Depending on the way how individual utilities are aggregated to obtain the welfare function, distributional effects of shocks can also be captured. This is why CGE models are preferred to analyse policies such as taxes. Because of the assumed optimization behaviour of agents they are also suitable tool to derive optimal policies. Note that this is a difference to the IO methodology which has hardly any behavioural assumptions and – by itself – is not suited to determine an optimal policy, or optimal level of investments.

On the other hand, purely demand driven shocks cannot be captured well by CGE models, as demand is endogenous. Increased investment demand could, for example, be due to an increased savings rate of households.

In the context of seaport developments, CGE models could, in principle, be used to determine the second-order growth effects which are most likely related to price changes, such as lower transportation costs, substitution effects and specialization. However, CGE models are very data intensive and need to be solved numerically. It is expected that the data available in the project at hand would not be sufficient to calibrate the model in a way that it reflects the behaviour of real-life economies. Moreover, the high computational requirements are incompatible with the desire of having an easy-to-use MS Excel tool.

Moreover, one can briefly mention a class of related models in this context, the Land Use and Transportation Interaction Models. These models usually belong to the class of general or at least partial equilibrium models. Partial equilibrium means that some prices might be exogenous. So in principal, they have the same advantages and disadvantages as CGE models. They focus on optimal allocation of land and optimal decisions of households and firms. Their strength is that decisions on land use (location decisions) and transportation activities are modelled simultaneously, which is relevant in practice. On the downside, the additional spatial dimension renders this class of models even more data intensive and vulnerable towards arbitrary parameter choices.

Alternative Modelling Approaches: Econometric Models

Econometric models try to estimate economic impacts by considering the influence of certain (economic) variables on the variable(s) of interest. Correlations between these variables and the variable of interest are estimated and can be used to forecast. Often, econometric models are used for ex-post evaluation of single events that can be associated with a certain point in time. Then, a counterfactual scenario can be constructed by forecasting the variable of interest by the correlation structures that have been estimated from the time prior to the event to the time after the event. This path is then compared to the path of the observed variable of interest after the event. The difference can then be attributed to the occurrence of the event.

As the goal in this project is the ex-ante evaluation of investments, a classical econometric approach is not suitable. It is possible to connect econometric models to IO models, referred to as IOE models (West, 1995). However, these approaches require time series of IO tables and other variables which may not be available in the context of the project at hand.

In addition to the short-run demand stimulus created by the investment activity, port investments can also enhance economic welfare of a region in the long-run by improving capacity and quality of the port infrastructure service. For instance, a port expansion can trigger an increase in the volume of seaborne trade, which in turn generates additional local value added in merchandise and logistics. To capture these indirect trade effects in a methodological framework, a gravity analysis as the standard tool in empirical trade economics could principally be applied.

The classic version of a gravity model estimates the relationship between bilateral trade volumes of two countries or regions and a set of explanatory factors such as economic size and distance of the trading partners in the form of a log-linear regression analysis. Over the years, the literature has gradually enriched this framework by adding further explanatory factors to the analysis, including measures for trade costs and infrastructure quality (Carrere, 2006; Felbermayer and Kohler, 2010). Therefore, gravity models are suited to forecast trade based on the assumed change of GDP or trade costs or other factors that are believed to have an influence on the trade volume.

In the context of seaport development projects, gravity models could be applied to analyse trade flows in the scenarios with and without project and thus determine the amount of imports or exports that actually depend on the development of the port at hand. However, gravity models would not be suited to directly assess the economic impact in terms of GDP or employment, due to the fact that GDP is needed as an input variable.

Miscellaneous Literature Review

The following paragraphs provide brief overviews of miscellaneous papers that are concerned with impact assessment in the transport sector:

Musso et al. (2000): On the economic impact of ports: local vs. national costs and benefits

This paper qualitatively discusses the role of ports in local economies in the context of the ports' changing role in the globalized economy. As a consequence of technological change, port-related industries are no longer forced to locate in the vicinity of ports. Instead, they can move to regions where inputs are cheaper or available at better quality. Moreover, reduced transportation costs have considerably raised interregional competition among ports, implying that more and more of a port's rent is extracted by the port's users instead of remaining as profit within the region. Finally, port innovation has caused a shift between the factors of production, making port services more capital- and land-intensive and less dependent on labour. Increased space consumption implies potential negative externalities for the port region, while at the same time benefits tend to spread over a geographically wider region.

Based on these developments, the authors formulate their criticism of existing port impact studies. One is a lack of investigation concerning the question how dependent certain economic activities are on the port. Another criticism concerns the static nature of approaches as this only allows to address period-to-period changes in economic impact. As a most significant critique, the authors point to the fact that the functional role of ports is often incompletely specified.

Clark et al. (2001): Maritime Transport Costs and Port Efficiency

The scope of this article is to investigate determinants of shipping costs to the United States from different ports of the world. The article uses an econometric approach where the trade costs, as the dependent variable, are assumed to depend on marginal costs of transportation and a mark-up. Transportation costs are modelled as functions of weight, value, container share, distance, share of liners and port efficiency. The mark-up depends on price agreements and cooperation agreements with the US. The results of the econometric analysis suggest that port efficiency has a significant (negative) effect on trade costs. Regarding the measurement of port efficiency, the authors state that "Unfortunately, there is not much comparable information about port efficiency […]", which is why they use a port efficiency index from the Global Competitiveness Report and also advocate the use of the GDP per capita of the sending country as a proxy for port efficiency, as a strong correlation between GDP per capita and the quality of infrastructure is assumed. The authors believe that the time needed to clear customs could generally explain port efficiency to a certain extent.

Wilson et al. (2003): Trade Facilitation and Economic Development: A New Approach to Quantifying the Impact

The article analyses the relationship between trade facilitation and trade flows in the Asia-Pacific region. This is done by estimating a gravity model, which is based on trade data between countries from 1989 to 2000. The concept of trade facilitation is formalized through indicators, which concern port efficiency, customs environment, regulatory environment and e-business. In this aspect, the study departs from other models which capture trade facilitation through explicit parameters such as trade costs or productivity. Scenario simulations show that trade between APEC (Asia Pacific Economic Corporation) member countries could increase by 21% if below average APEC members (with regard to the indicators) would move to the average. The authors state that half of this increase would be due to improved port efficiency.

The paper shows that indicators provide an alternative to the standard approach of modelling trade facilitation through the explicit trade cost channel. However, it is always unclear how difficult it is in reality to change indicator variables, or, conversely, by how much a given project will influence a certain indicator variable.

OECD (2007): Transport infrastructure and economic productivity – Report of the 132nd round table

The OECD report on transport infrastructure and economic productivity (OECD, 2007) consists of three chapters which themselves are reports by different authors.

The first chapter summarizes three studies on the impact of highway infrastructure investments on productivity growth in the manufacturing sector. Two effects are seen as relevant. One impact channel is intermediate input relations ("indirect effects" in the terminology of the IO approach) between the manufacturing industries and "sectors involved in the production of infrastructure services" and the second is network effects. The study uses a production function approach, where the stock of transport infrastructure is assumed to be a factor of production as well as a factor determining a general productivity increase over time ("shift term"). The first channel is then addressed through IO relations in the production function and the network effects through the shift term. The conclusion of chapter 1 with regard to the analysed studies suggests that "investment in infrastructure networks does not have an effect on the pattern of economic growth" (p. 22).

The second chapter deals with the impact of paved roads on aggregate output, which is investigated by econometric techniques for several countries. The main contribution of the chapter is the use of the concept of "co-integration" of time series, which allows addressing the issue of reversed causality between infrastructure investments and economic growth. Regarding the results, the rates of return to paved road building are found to be the highest in middle-income countries.

The third and final chapter considers again an econometric approach to estimate the productivity effect of road investment for thirteen Western European countries. The fixed effects panel analysis finds a positive effect on productivity, but the contribution of road investments to that effect is small compared to other drivers of productivity.

Haezendonck et al. (2014): A new governance perspective on port-hinterland relationships: The Port Hinterland Impact (PHI) matrix

The paper is concerned with the development of what the authors call the Port Hinterland (PHI) Matrix. This matrix illustrates linkages between a port and its hinterland. One dimension considers the “geographical reach” of the port and the other the “logistics dedicatedness”, where the latter can also be described as the degree of substitutability. The entries of the matrix consider the values (or shares) of certain goods or certain cargo types with regard to the (discretized) geographic reach and substitutability. The perspective is a governance perspective; the PHI cannot be used for economic impact analysis as such, but rather for illustration of port-hinterland relations. The author states that its main purpose is “to support optimal contracting” between port authorities, port users and hinterland actors by supplying information.

Kopp (2015): GHG analysis for low-emission transport

Kopp (2015) deals with the impact of investment, pricing and regulatory policies on greenhouse gas (GHG) emissions in the transport sector. The author discusses some theoretical aspects that should be accounted for when analysing these impacts. His focus is on mode choice and route choice in the transport sector. In the author’s framework, the mode choice depends on income, monetary costs, time costs and quality of service. Transport infrastructure investments are believed to affect transport decision mainly through (decreased) travel times. Travel times, in general, are assumed to depend on congestion, which is defined as the ratio between level of usage and capacity.

Regarding concrete modelling, the author focusses on households as decision makers. Mode choice is discussed in chapter 2 and route choice in chapter 3. Chapter 4 deals with freight transport. Unlike in the previous chapters, shippers and not households are the relevant decision makers here. They take discrete decisions on vehicle technologies, shipment routes and, regarding modes, on the use of road, rail, waterways or aviation (p. 81).

World Bank (2015a): Assessing the economy-wide indirect impacts of East-West Highway investments through CGE modeling

The paper deals with the economy-wide indirect benefits of investment in the East-West Highway in Georgia (Europe). The approach is of the CGE type, where a comparative static analysis is done to estimate the medium-term effects and a comparative steady state analysis to estimate the long-term effects. The channels through which highway investments enter the model are reduced vehicle operating costs and reduced time costs. By construction, the CGE model calculates the reallocation of resources in response to the investment, and not the stimulus effect of the additional demand. This contrasts the IO approach of our project, which is suitable to study the latter effect.

World Bank (2015b): Network and Connectivity analysis of inter-island flows and Indonesia: The framework

This conceptual paper aims at developing a model that is able to link network structures and performance of infrastructure to economic development. As an example, the case of Indonesia is discussed, which relies on a maritime transport network between its islands. Key influences of the transport network on the economy are believed to be trade costs and market access. The paper lacks a consistent theoretical framework and notation due to its conceptual state, but the general idea is to use a gravity-type equation to model trade flows between provinces with interregional trade data as input. Infrastructure investments would then act on the "impedance/friction" parameters, facilitating trade. The model could help to project change in trade flows between all provinces due to investments at any part of the transport network. Relating this to our project, the availability of interregional trade data is the main limit in the application. Furthermore, trade is given as exogenous variable as part of the traffic forecast in our case, so there are already implicit assumptions on the change of trade flows through the investment projects.

Romanoff, E.; Levine, S.H. (1986): Capacity limitations, inventory, and time-phased production in the sequential input-output-model

This paper presents an extension of a sequential input-output-model. Dynamics are introduced into the typically static input-output world by defining different time phases of production and taking account of capacity limitations due to delayed provision of inputs. In this approach, time is split into several intervals. In each interval, production occurs according to the same input-output-relationship (as adopted from the static input-output table), technological change is thus not considered. However, a dynamic component is introduced by the assumption that sectors differ in their response to demand shocks. The authors distinguish between anticipatory sectors, where the decision on current production volumes is largely based on expectations of future consumption levels, and responsive sectors, whose production volumes follow actual consumption levels with some time delay (e.g. to cope with specific requirements of customers). These differences are implemented by means of leads and lags in the model equations linking supply and demand. Unlike in case of static input-output-models, production capacities cannot generally be assumed to be fully utilized. Producers will respond to anticipated demand changes by capacity expansion and/or inventory holding.

On a theoretical level, this concept represents a valuable extension of classical input-output modelling by incorporating the notion of time as a limiting factor to production increases. In principle, it allows to assess the impact a reduction of transport-related delays in input provision could have on production in the economy. However, its application to the analysis of real-world port investments is likely to face several obstacles related to data availability. The first difficulty concerns the specification of time phases. This requires knowledge on the time it takes for producers in different sectors to adjust their production plans. In order to incorporate time and delays of transport into the model, it also requires detailed information on transport time and delays by route and type of cargo (as well as its change due to port expansion). The second difficulty arises with respect to the definition of sectors as either anticipatory or responsive. It is doubtful whether in most cases sufficient micro data will be available for making such a distinction at a low level of sector aggregation. Moreover, also the degree of anticipatory or responsive behaviour (as reflected by the timing of leads and lags) will differ between sectors in real-life, something that is again unlikely to be specifiable based on existing data. Finally, information on initial inventory stocks at sector level is essential for assessing the severity of time constraints in transport. While annual inventory changes could be retrieved from input-output tables, initial inventory levels cannot. Again, restricted availability of firm-level data will likely prevent a case-specific application.

Marwah, K.; Tavakoli, A. (2004): The effect of foreign capital and imports on economic growth: further evidence from four Asian countries (1970–1998)

This paper attempts to estimate the impact of foreign direct investment and imports on national income in four Asian countries: Indonesia, Malaysia, the Philippines and Thailand. The prime objective is to gain insights into the specific role of openness for the catching-up process of these countries over the last decades. To this aim, a functional relationship between the level of output, the inflow of foreign capital and the value of imports is specified and tested for each country separately based on time series data. The theoretical background is that of a common production function framework: both foreign capital and imports are modeled as specific factors of production which (together with other inputs like domestic capital and labour) jointly determine output of the domestic economy. As specific functions, standard forms such as CES and Cobb-Douglas are chosen. In the latter case, the resulting coefficient estimates can be interpreted as production elasticities. Hence, they correspond to the percentage change in output caused by a one percent increase in the use of a certain input. Concerning the elasticities of imports, the study yields estimates ranging from 0.226 (Indonesia) to 0.428 (Thailand).

An increase in imports is, all else being equal, thus predicted to raise output in all four countries, albeit at a less than proportional level. This result fits intuition in so far as larger import volumes can trigger both beneficial and adverse impacts on domestic GDP. On the one hand, increased availability of foreign inputs can stimulate domestic production by overcoming bottlenecks through capacity increases. Considering an opposite causality, grown demand for import goods by domestic consumers might simply be a sign for a general economic upswing. On the other hand, the importation of foreign goods can also hurt the economy if they are simply used to replace domestic intermediates and consumption goods. Growth of imports might thus as well be associated with an economic downturn.

Against this background, the estimates gained by this study prove helpful for assessing the macroeconomic effects of increased import flows in the context of port expansion. Precisely, they provide some guideline for an appropriate rescaling of the supply effect of imports. The estimated elasticities mentioned above would suggest an *extent of the supply effect* of between 22.6 % and 42.8 %. Therefore, for the model, a conservative choice of 25 % is recommended as a default option for the extent of the supply effect for imports (cf. Sections 3.2.1 and 0).

Blauwens, G.; Van de Voorde, E. (1988): The valuation of time savings in commodity transport

This study seeks to quantify the benefits of time savings in the context of goods transport. By means of econometric estimation techniques, the authors assign a monetary value to a single unit of time gained. Their methodological basis is the revealed preference technique. In contrast to stated preferences, i.e. information on preferences gained through inquiries, this method deduces preferences from people's real-life behaviour. In this study, the modal choice between road haulage and inland navigation for commodity flows between Belgian regions is examined. This choice is interpreted as a function of essentially two factors of influence: the difference in required transport time and the difference in monetary transport costs between the two modes, both measured per ton of a certain commodity on a certain link. Coefficients of this functional relationship are estimated econometrically. Subsequently, they are used to derive the monetary value of time savings by asking the following question: what is the relative increase in transport costs of road haulage in relation to inland navigation that would exert the same impact on modal choice than a relative increase in transport time by one hour? This value is then interpreted as the money equivalent of one hour of transport time saved. By combining the two coefficients with the cargo value, it can easily be attained after the estimation procedure. Based on the given data, this yields a share of 0.00848 % of the cargo value as the benefits from time savings per hour, implying that the gains of reducing transport time by a whole day make up about 0.2% of the cargo value. Besides capital costs (interest on the cargo), this valuation of time accounts for all other side-aspects of transport time such as deterioration, costs of shortage of stock, fines for delay, etc., but also a general time preference of the shipper.

For the economic impact assessment of ports, the results of the study may be used to give at least a rough indication on the welfare effects of time savings in transport. As such, transport time savings may be valued as 0.2% of the cargo value per day, using information on cargo values of imports and domestic cargoes. The resulting time valuation may then be allocated as monetary savings to different sectors. For this, assumptions about an allocation to sectors must be made (cf. Sections 3.2.1 and 0) – the revealed preference method as used by Blauwens and van de Voorde provides no specific information as to how to allocate time values to sectors.[75] However, it should be noted that it may be reasonable not to monetize all time savings, considering that the value of time also accounts for a general, non-monetary time-preference of the shipper.

de Jong, G. (2014): Freight service valuation and elasticities

This article has been published as a chapter of a book providing a general guide on modelling freight transport. The article is concerned with the value of freight services and methods to determine the same, in particular the value of saved transport time. Basically, a reduction in the time needed for a certain transport procedure creates an economic benefit by allowing an earlier release of the production factors labour (workers in logistics) and capital (transport equipment) for other shipments. Part of this benefit is captured in the reduction of monetary transport costs observed. Another part of the time value cannot be captured by market transactions, such as the value of the capital employed and the general time preference of the shipper. This part is not related to the transport service provided, but to the transported good itself. The author hence defines this part as the goods component of the value of transport time.

After discussing the empirical challenges of estimating the time value based on surveys and econometric choice models, he gives an overview on recent studies that provide specific estimates of the value of one hour of transport time by road and rail. Some of them discriminate between the goods and the transport service component. Concerning the goods component, which is the relevant aspect for the modelling of time savings as presented in Section 3.2.3, estimates range between 0 and 24 Euro per transport per hour for road traffic and 0 and 0.3 Euro per ton per hour for rail traffic. The large variance is likely due to the fact that the studies consider different transported commodities as well as, for road transport, different shipping sizes (cargo volumes). Overall, the estimates

[75] Also, no other studies dealing with this issue are known to the Consultants.

presented seem to be compatible with those expressed as percentages of cargo value by Blauwens and van de Voorde (1988).

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Annex 2

MANUAL FOR THE ADDITION OF COUNTRY DATA

Overview

The model is delivered with economic source data for 20 countries: Argentina, Brazil, Colombia, Côte d'Ivoire, Dominican Republic, Egypt, Ghana, Guatemala, India, Indonesia, Iran, Kenya, Mexico, Nigeria, Pakistan, Peru, Togo, Turkey, Ukraine, Vietnam.

The economic source data (cf. Table 9) for these countries[76] is provided in the last five worksheets of the model:

- ***Source Data – GDP,***
- ***Source Data – Inflation,***
- ***Source Data – Employment,***
- ***Source Data – Trade Values,***
- ***Source Data – SAMs.***

Besides the existing data for the 20 countries listed above, the model additionally provides 20 empty slots in each source data worksheet, in order to include additional countries later on.

Note: the lists of countries in the first four source data worksheets are defined by the countries represented in ***Source Data – SAMs****. Thus, in order to add source data for a country, the user should first specify the country in the first free slot in worksheet* ***Source Data – SAMs****.*

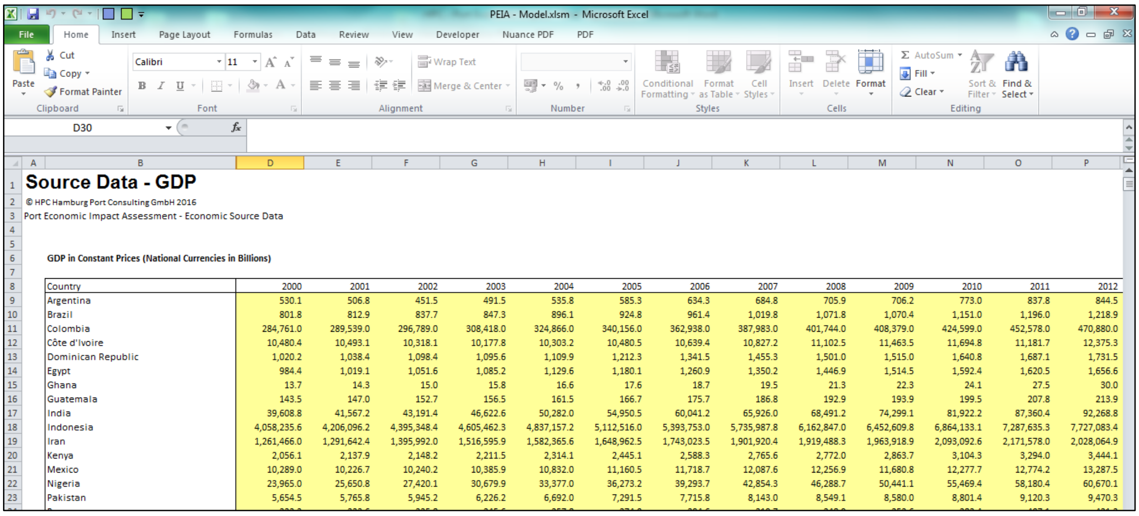
Note: the source data worksheets must be unlocked in order to include economic source data for an additional country. Afterwards, all worksheets should be locked again.

The following sections provide overviews of the five source data worksheets, including detailed manuals for the extraction of SAMs from GTAP 9 and derivation of unit trade values from UN Comtrade. For the latter two analyses, auxiliary files are provided with the model: (i) for analysis of trade values, the MS Excel file **PEIA - Unit Trade Value Analysis.xlsx**; (ii) for extraction of a SAM from GTAP 9, the aggregation scheme **PEIA - SAM Extraction.agg** and the MS Excel file **PEIA - SAM Conversion.xlsx**. The guides are presented for use with Excel 2010.

[76] With the exception of employment data for Togo, for which no employment figures could be obtained from any of the standard data sources such as ILOSTAT, LABORSTA, or World Bank.

Source Data – GDP

The worksheet ***Source Data – GDP*** contains the GDP data for the 20+ countries.



Source Data - GDP

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Port Economic Impact Assessment - Economic Source Data

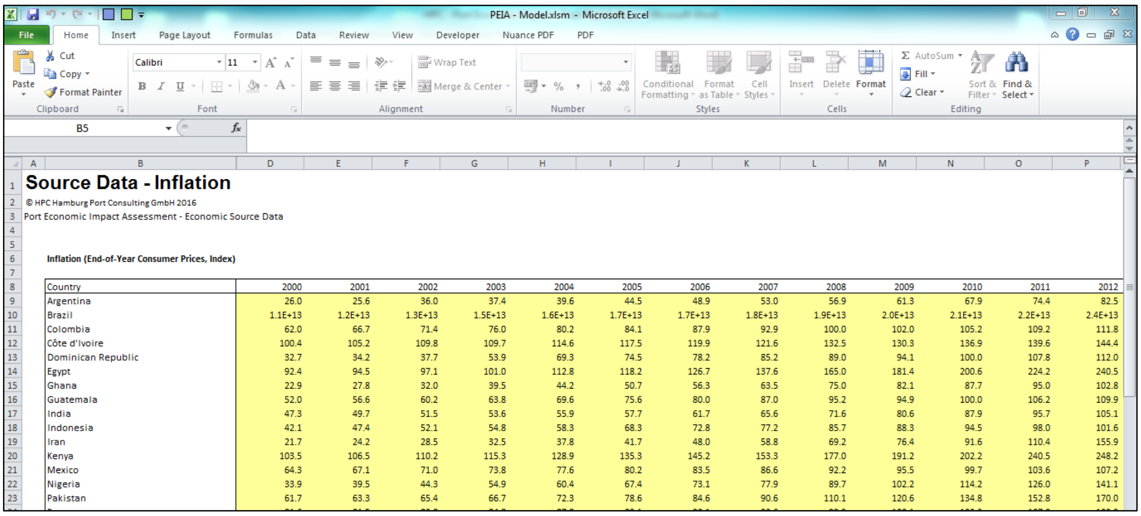
GDP in Constant Prices (National Currencies in Billions)

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Argentina	530.1	506.8	451.5	491.5	535.8	585.3	634.3	684.8	705.9	706.2	773.0	837.8	844.5
Brazil	801.8	812.9	837.7	847.3	896.1	924.8	961.4	1,019.8	1,071.8	1,070.4	1,151.0	1,196.0	1,218.9
Colombia	284,761.0	289,539.0	296,789.0	308,418.0	324,866.0	340,156.0	362,938.0	387,983.0	401,744.0	408,379.0	424,599.0	452,578.0	470,880.0
Côte d'Ivoire	10,480.4	10,493.1	10,318.1	10,177.8	10,303.2	10,480.5	10,639.4	10,827.2	11,102.5	11,463.5	11,694.8	11,181.7	12,375.3
Dominican Republic	1,020.2	1,038.4	1,098.4	1,095.6	1,109.9	1,212.3	1,341.5	1,455.3	1,501.0	1,515.0	1,640.8	1,687.1	1,731.5
Egypt	984.4	1,019.1	1,051.6	1,085.2	1,129.6	1,180.1	1,260.9	1,350.2	1,446.9	1,514.5	1,592.4	1,620.5	1,656.6
Ghana	13.7	14.3	15.0	15.8	16.6	17.6	18.7	19.5	21.3	22.3	24.1	27.5	30.0
Guatemala	143.5	147.0	152.7	156.5	161.5	166.7	175.7	186.8	192.9	193.9	199.5	207.8	213.9
India	39,608.8	41,567.2	43,191.4	46,622.6	50,282.0	54,950.5	60,041.2	65,926.0	68,491.2	74,299.1	81,922.2	87,360.4	92,268.8
Indonesia	4,058,235.6	4,206,096.2	4,395,348.4	4,605,462.3	4,837,157.2	5,112,516.0	5,393,753.0	5,735,987.8	6,162,847.0	6,452,609.8	6,864,133.1	7,287,635.3	7,727,083.4
Iran	1,261,466.0	1,291,642.4	1,395,992.0	1,516,595.9	1,582,365.6	1,648,962.5	1,743,023.5	1,901,920.4	1,919,488.3	1,963,918.9	2,093,092.6	2,171,578.0	2,028,064.9
Kenya	2,056.1	2,137.9	2,148.2	2,211.5	2,314.1	2,445.1	2,588.3	2,765.6	2,772.0	2,863.7	3,104.3	3,294.0	3,444.1
Mexico	10,289.0	10,226.7	10,240.2	10,385.9	10,832.0	11,160.5	11,718.7	12,087.6	12,256.9	11,680.8	12,277.7	12,774.2	13,287.5
Nigeria	23,965.0	25,650.8	27,420.1	30,679.9	33,377.0	36,273.2	39,293.7	42,854.3	46,288.7	50,441.1	55,469.4	58,180.4	60,670.1
Pakistan	5,654.5	5,765.8	5,945.2	6,226.2	6,692.0	7,291.5	7,715.8	8,143.0	8,549.1	8,580.0	8,801.4	9,120.3	9,470.3

The data (*GDP in Constant Prices, National Currencies in Billion*) has been taken, with no further modification, from the latest IMF World Economic Outlook Database.[77]

Source Data – Inflation

The worksheet ***Source Data – Inflation*** contains the inflation data for the 20+ countries.



Source Data - Inflation

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Port Economic Impact Assessment - Economic Source Data

Inflation (End-of-Year Consumer Prices, Index)

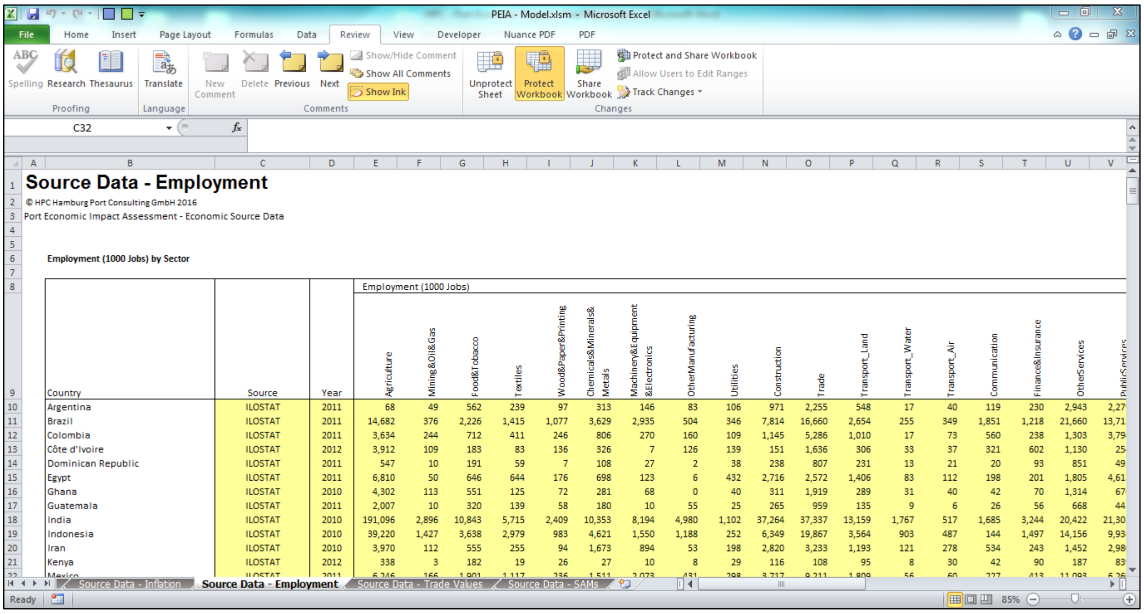
Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Argentina	26.0	25.6	36.0	37.4	39.6	44.5	48.9	53.0	56.9	61.3	67.9	74.4	82.5
Brazil	1.1E+13	1.2E+13	1.3E+13	1.5E+13	1.6E+13	1.7E+13	1.7E+13	1.8E+13	1.9E+13	2.0E+13	2.1E+13	2.2E+13	2.4E+13
Colombia	62.0	66.7	71.4	76.0	80.2	84.1	87.9	92.9	100.0	102.0	105.2	109.2	111.8
Côte d'Ivoire	100.4	105.2	109.8	109.7	114.6	117.5	119.9	121.6	132.5	130.3	136.9	139.6	144.4
Dominican Republic	32.7	34.2	37.7	53.9	69.3	74.5	78.2	85.2	89.0	94.1	100.0	107.8	112.0
Egypt	92.4	94.5	97.1	101.0	112.8	118.2	126.7	137.6	165.0	181.4	200.6	224.2	240.5
Ghana	22.9	27.8	32.0	39.5	44.2	50.7	56.3	63.5	75.0	82.1	87.7	95.0	102.8
Guatemala	52.0	56.6	60.2	63.8	69.6	75.6	80.0	87.0	95.2	94.9	100.0	106.2	109.9
India	47.3	49.7	51.5	53.6	55.9	57.7	61.7	65.6	71.6	80.6	87.9	95.7	105.1
Indonesia	42.1	47.4	52.1	54.8	58.3	68.3	72.8	77.2	85.7	88.3	94.5	98.0	101.6
Iran	21.7	24.2	28.5	32.5	37.8	41.7	48.0	58.8	69.2	76.4	91.6	110.4	155.9
Kenya	103.5	106.5	110.2	115.3	128.9	135.3	145.2	153.3	177.0	191.2	202.2	240.5	248.2
Mexico	64.3	67.1	71.0	73.8	77.6	80.2	83.5	86.6	92.2	95.5	99.7	103.6	107.2
Nigeria	33.9	39.5	44.3	54.9	60.4	67.4	73.1	77.9	89.7	102.2	114.2	126.0	141.1
Pakistan	61.7	63.3	65.4	66.7	72.3	78.6	84.6	90.6	110.1	120.6	134.8	152.8	170.0

[77] The latest edition of the IMF World Economic Outlook Database (April 2016) can be found here: http://www.imf.org/external/pubs/ft/weo/2016/01/weodata/index.aspx.

The data (*Inflation, End-of-Period Consumer Prices, Index*) has been taken, with no further modification, from the latest IMF World Economic Outlook Database.[78]

Source Data – Employment

The worksheet ***Source Data – Employment*** contains the employment data for the 20+ countries.



Source Data - Employment

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Port Economic Impact Assessment - Economic Source Data

Employment (1000 Jobs) by Sector

Country	Source	Year	Agriculture	Mining&Oil&Gas	Food&Tobacco	Textiles	Wood&Paper&Printing	Chemicals&Minerals& Metals	Machinery&Equipment &Electronics	OtherManufacturing	Utilities	Construction	Trade	Transport_Land	Transport_Water	Transport_Air	Communication	Finance&Insurance	OtherServices	PublicServices
Argentina	ILOSTAT	2011	68	49	562	239	97	313	146	83	106	971	2,255	548	17	40	119	230	2,943	2,27
Brazil	ILOSTAT	2011	14,682	376	2,226	1,415	1,077	3,629	2,935	504	346	7,814	16,660	2,654	255	349	1,851	1,218	21,660	13,71
Colombia	ILOSTAT	2011	3,634	244	712	411	246	806	270	160	109	1,145	5,286	1,010	17	73	560	238	1,303	3,79
Côte d'Ivoire	ILOSTAT	2012	3,912	109	183	83	136	326	7	126	139	151	1,636	306	33	37	321	602	1,130	25
Dominican Republic	ILOSTAT	2011	547	10	191	59	7	108	27	2	38	238	807	231	13	21	20	93	851	49
Egypt	ILOSTAT	2011	6,810	50	646	644	176	698	123	6	432	2,716	2,572	1,406	83	112	198	201	1,805	4,61
Ghana	ILOSTAT	2010	4,302	113	551	125	72	281	68	0	40	311	1,919	289	31	40	42	70	1,314	67
Guatemala	ILOSTAT	2011	2,007	10	320	139	58	180	10	55	25	265	959	135	9	6	26	56	668	44
India	ILOSTAT	2010	191,096	2,896	10,843	5,715	2,409	10,353	8,194	4,980	1,102	37,264	37,337	13,159	1,767	517	1,685	3,244	20,422	21,30
Indonesia	ILOSTAT	2010	39,220	1,427	3,638	2,979	983	4,621	1,550	1,188	252	6,349	19,867	3,564	903	487	144	1,497	14,156	9,93
Iran	ILOSTAT	2010	3,970	112	555	255	94	1,673	894	53	198	2,820	3,233	1,193	121	278	534	243	1,452	2,98
Kenya	ILOSTAT	2012	338	3	182	19	26	27	10	8	29	116	108	95	8	30	42	90	187	83

The data (*Jobs in Thousands, if available for 2011*) has been derived from the ILOSTAT Database or, if no data were available there, from its predecessor LABORSTA.[79]

ILOSTAT typically provides employment data in ISIC Rev. 3.1 (Lvl 2) or ISIC Rev. 4 (Lvl 2) classifications, partly also just in ISIC Rev. 3.1 (Lvl 1). LABORSTA provides employment data in typically less disaggregate classifications.

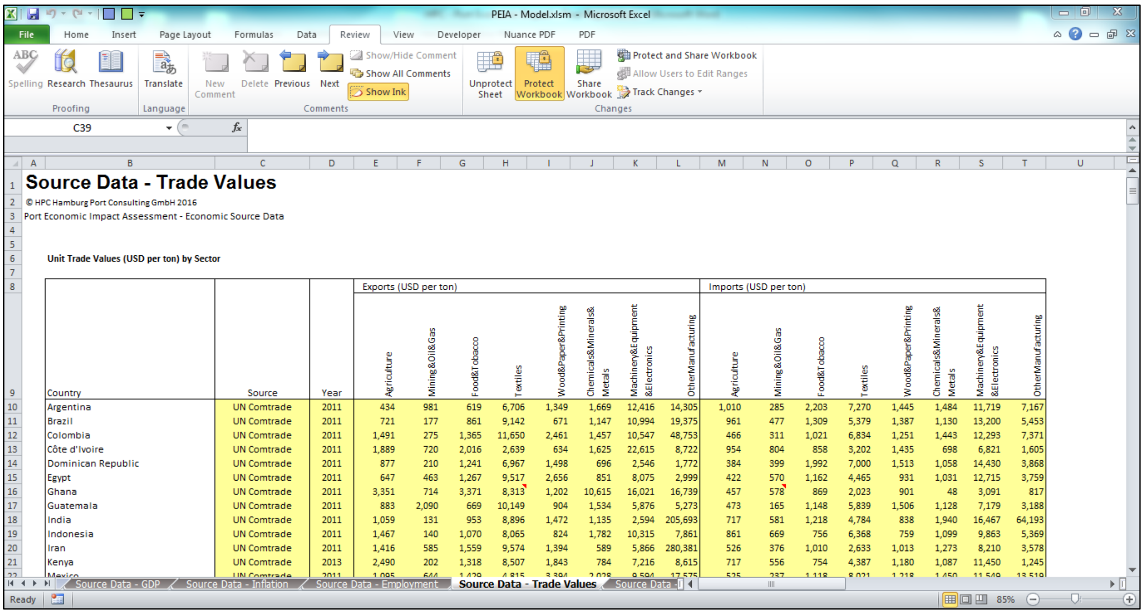
As such, the available employment data is to be allocated to the model sectors. For this sake, concordances between ISIC classifications and the model sector classification are provided in Annex 2. In case that the available employment data is not sufficiently disaggregate, job figures may be disaggregated according to sectoral shares (labor factor inputs) as found in the SAM.

[78] The latest edition of the IMF World Economic Outlook Database (April 2016) can be found here: http://www.imf.org/external/pubs/ft/weo/2016/01/weodata/index.aspx.

[79] The ILOSTAT Database can be reached here: https://www.ilo.org/ilostat/. LABORSTA can be reached here: http://laborsta.ilo.org/.

Source Data – Trade Values

The worksheet ***Source Data – Trade Values*** contains the sectoral unit trade values for exports and imports (USD per ton) for the 20+ countries.



Source Data - Trade Values

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Port Economic Impact Assessment - Economic Source Data

Unit Trade Values (USD per ton) by Sector

			Exports (USD per ton)								Imports (USD per ton)							
Country	Source	Year	Agriculture	Mining&Oil&Gas	Food&Tobacco	Textiles	Wood&Paper&Printing	Chemicals&Minerals& Metals	Machinery&Equipment &Electronics	OtherManufacturing	Agriculture	Mining&Oil&Gas	Food&Tobacco	Textiles	Wood&Paper&Printing	Chemicals&Minerals& Metals	Machinery&Equipment &Electronics	OtherManufacturing
Argentina	UN Comtrade	2011	434	981	619	6,706	1,349	1,669	12,416	14,305	1,010	285	2,203	7,270	1,445	1,484	11,719	7,167
Brazil	UN Comtrade	2011	721	177	861	9,142	671	1,147	10,994	19,375	961	477	1,309	5,379	1,387	1,130	13,200	5,453
Colombia	UN Comtrade	2011	1,491	275	1,365	11,650	2,461	1,457	10,547	48,753	466	311	1,021	6,834	1,251	1,443	12,293	7,371
Côte d'Ivoire	UN Comtrade	2011	1,889	720	2,016	2,639	634	1,625	22,615	8,722	954	804	858	3,202	1,435	698	6,821	1,605
Dominican Republic	UN Comtrade	2011	877	210	1,241	6,967	1,498	696	2,546	1,772	384	399	1,992	7,000	1,513	1,058	14,430	3,868
Egypt	UN Comtrade	2011	647	463	1,267	9,517	2,656	851	8,075	2,999	422	570	1,162	4,465	931	1,031	12,715	3,759
Ghana	UN Comtrade	2011	3,351	714	3,371	8,313	1,202	10,615	16,021	16,739	457	578	869	2,023	901	48	3,091	817
Guatemala	UN Comtrade	2011	883	2,090	669	10,149	904	1,534	5,876	5,273	473	165	1,148	5,839	1,506	1,128	7,179	3,188
India	UN Comtrade	2011	1,059	131	953	8,896	1,472	1,135	2,594	205,693	717	581	1,218	4,784	838	1,940	16,467	64,193
Indonesia	UN Comtrade	2011	1,467	140	1,070	8,065	824	1,782	10,315	7,861	861	669	756	6,368	759	1,099	9,863	5,369
Iran	UN Comtrade	2011	1,416	585	1,559	9,574	1,394	589	5,866	280,381	526	376	1,010	2,633	1,013	1,273	8,210	3,578
Kenya	UN Comtrade	2013	2,490	202	1,318	8,507	1,843	784	7,216	8,615	717	556	754	4,387	1,180	1,087	11,450	1,245

Derivation of sectoral unit trade values for a new country requires the following steps:

- Step 1: raw trade data has first to be extracted from UN Comtrade.
- Step 2: extracted raw data has to be analysed using the excel file **PEIA - Unit Trade Value Analysis.xlsx**, which is delivered with the tool.

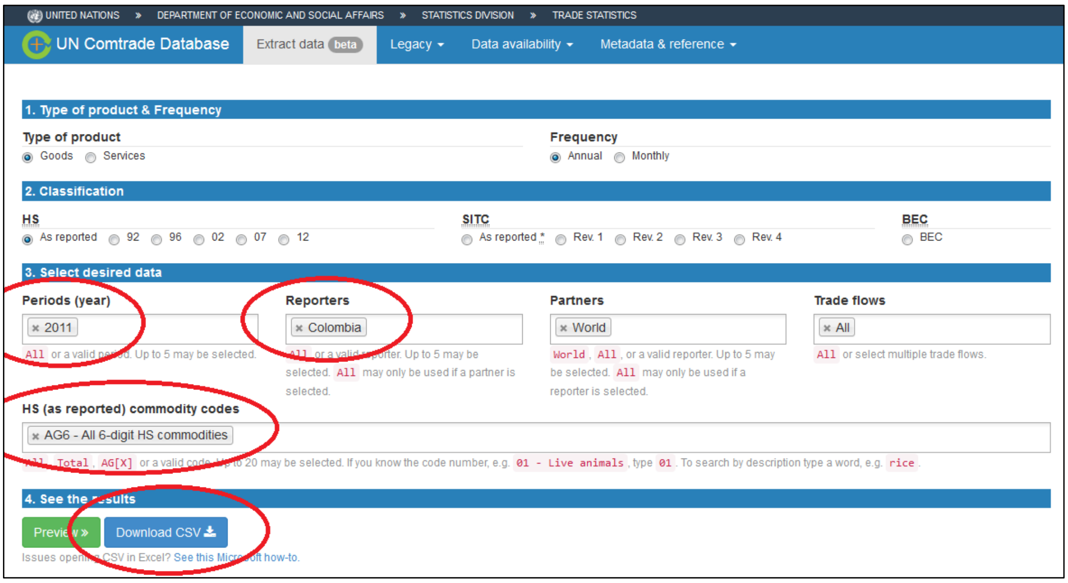
The following pages provide a detailed step-by-step guide for the derivation of sectoral unit trade values.

Manual – Step 1 – Data Extraction from UN Comtrade

- Visit the website of UN Comtrade: http://comtrade.un.org/data/

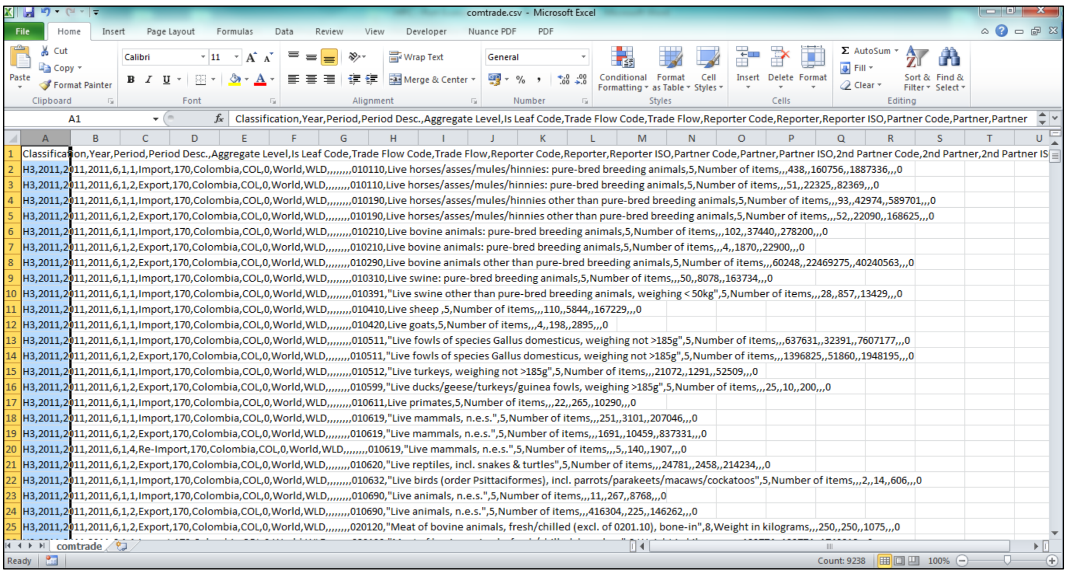
- Choose settings as shown below for the data extraction. As such, the following settings should be modified from the default settings:
  - For *Periods (year)*, select 2011.
  - For *Reporters*, select the country for which the unit trade values are to be derived (in the example below, this is Colombia).
  - Set *HS (as reported) commodity codes* as *AG6 - All 6-digit HS commodities*.

  Then, download the data as a CSV file (see below).



- Open the CSV file downloaded in the previous step in MS Excel.

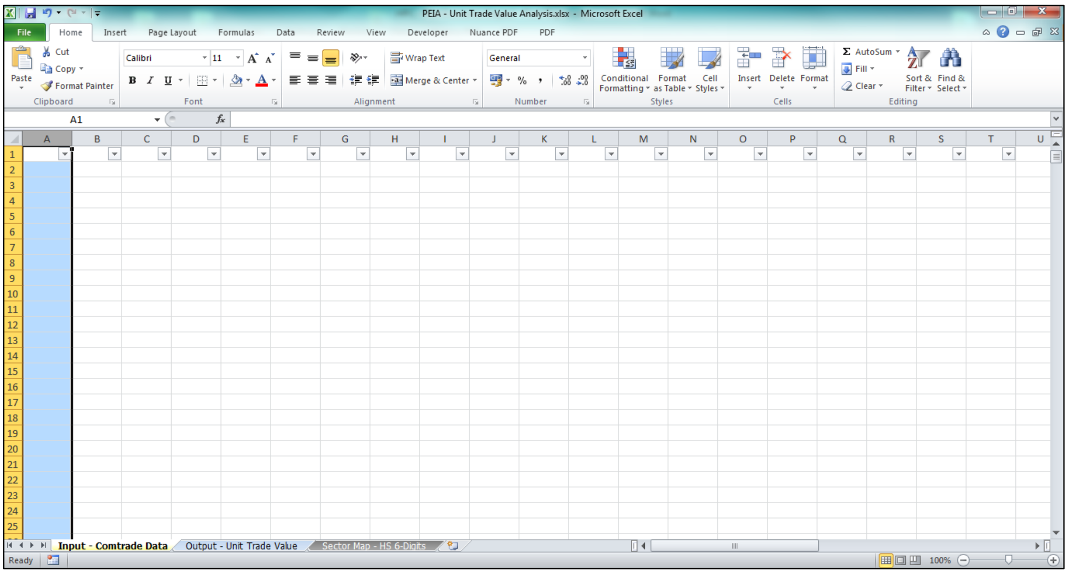
- Select column A (as shown below) and copy all data in that column.



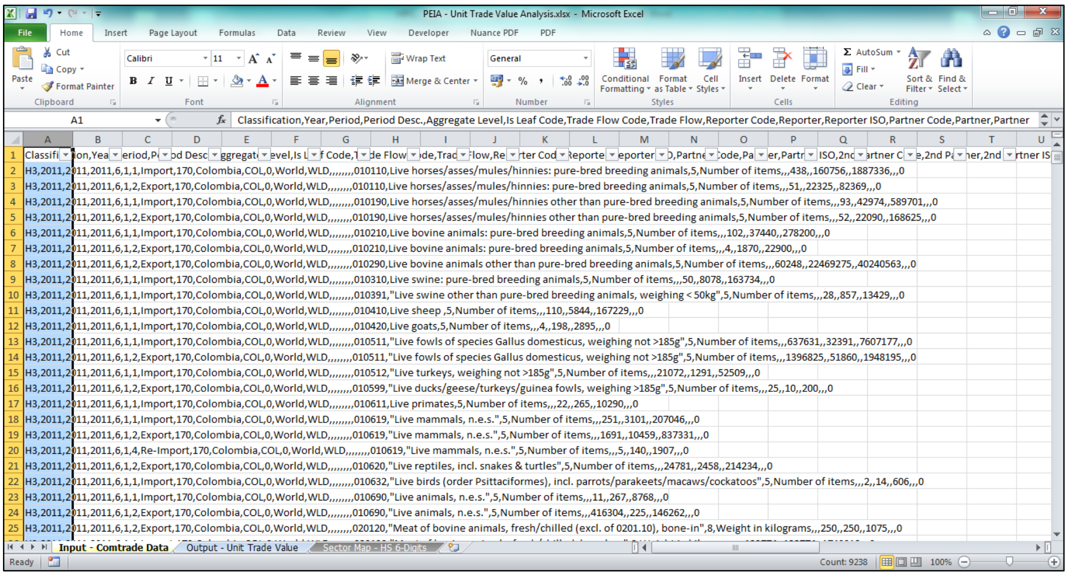
Manual – Step 2 – Analysis of Data (with **PEIA - Unit Trade Value Analysis.xlsx***)*

- Open **PEIA - Unit Trade Value Analysis.xlsx** in MS Excel.
- In the worksheet ***Input - Comtrade Data***, select column A (as shown below).

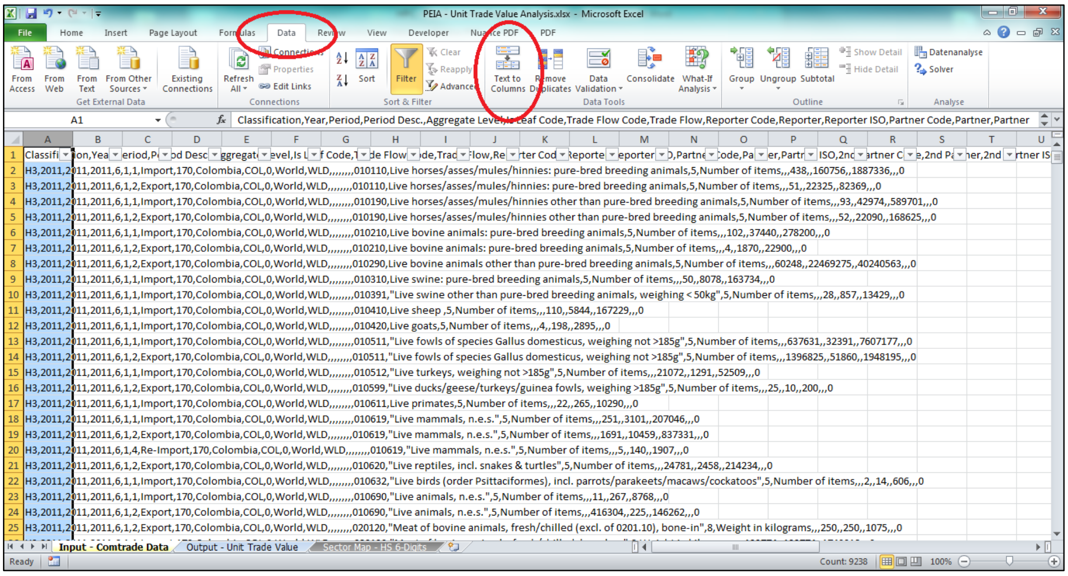
  Note: it is important to start from a fresh version of **PEIA - Unit Trade Value Analysis.xlsx** *or, alternatively, clear all data in* columns A to AI *in worksheet* ***Input - Comtrade Data*** *before the analysis.*



- Paste the data previously copied from the CSV file (shown below).

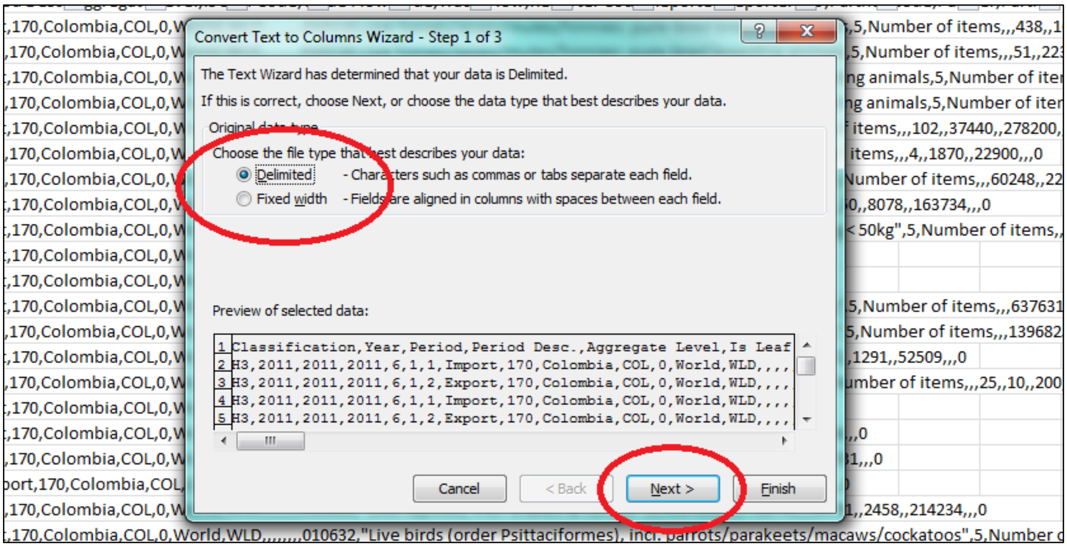


- With column A still being selected (as shown above), click on the *Data* tab in the ribbon and then the *Text to Columns* command (see below).

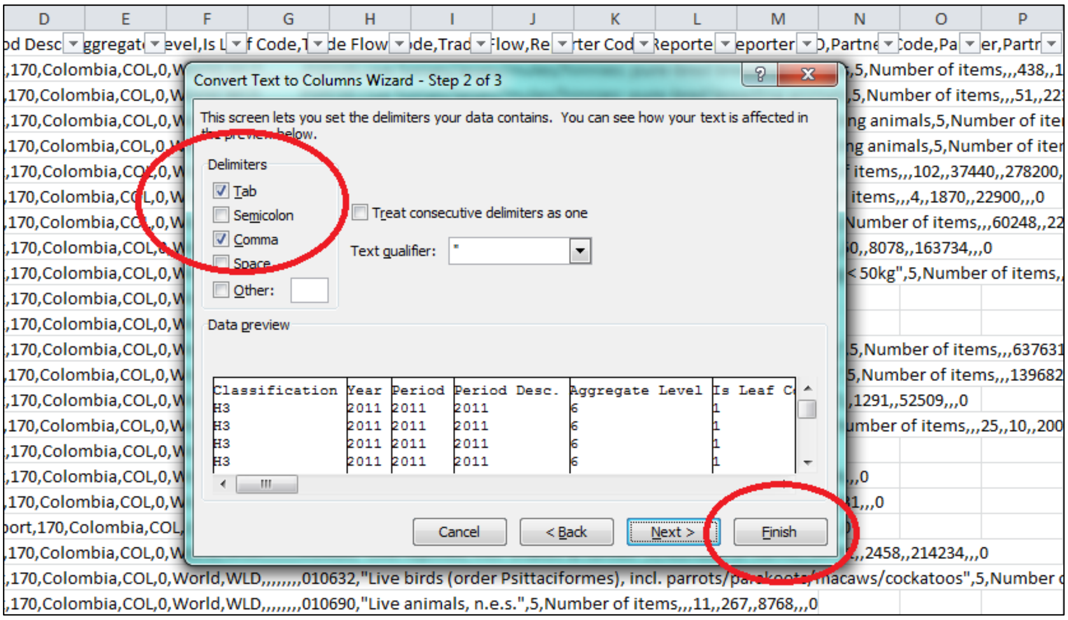


- In the *Convert Text to Columns Wizard* that comes up, do the following:

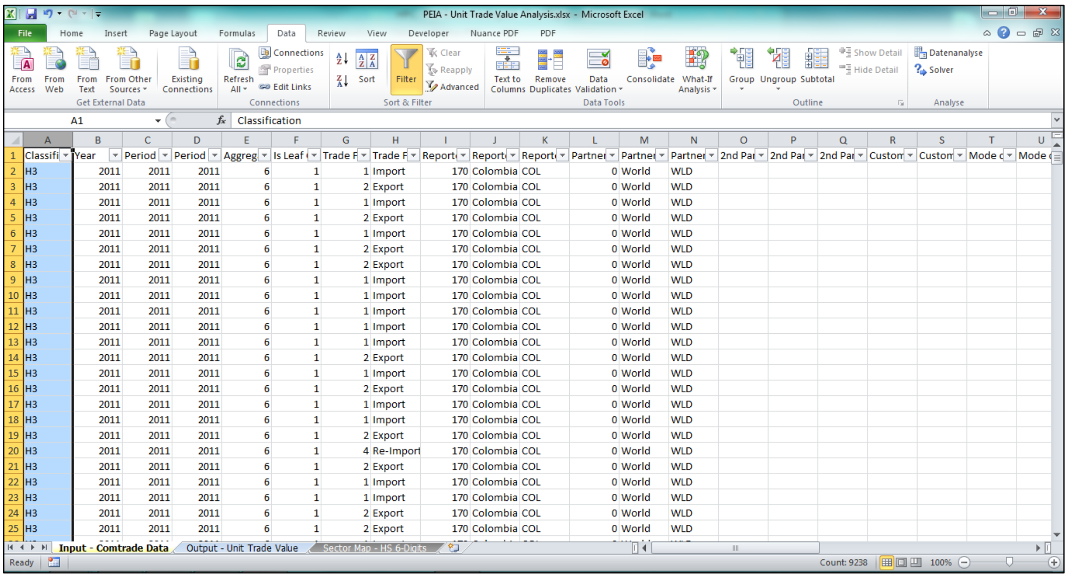
  In step 1 of 3, select *Delimited* as file type. Then click *Next.*



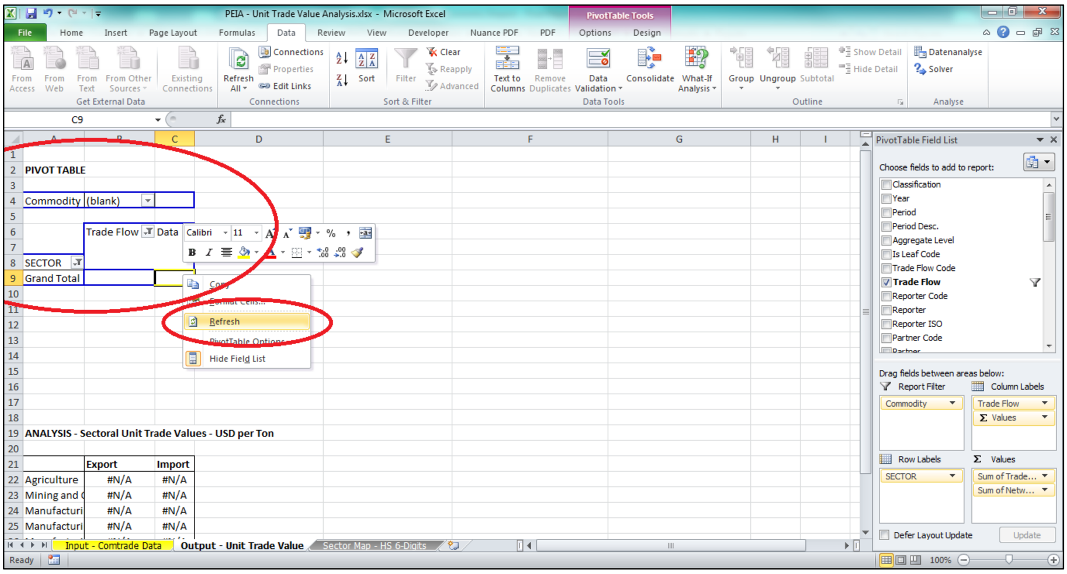
In step 2 of 3, select delimiters *Tab* and *Comma*. Then click *Finish*.



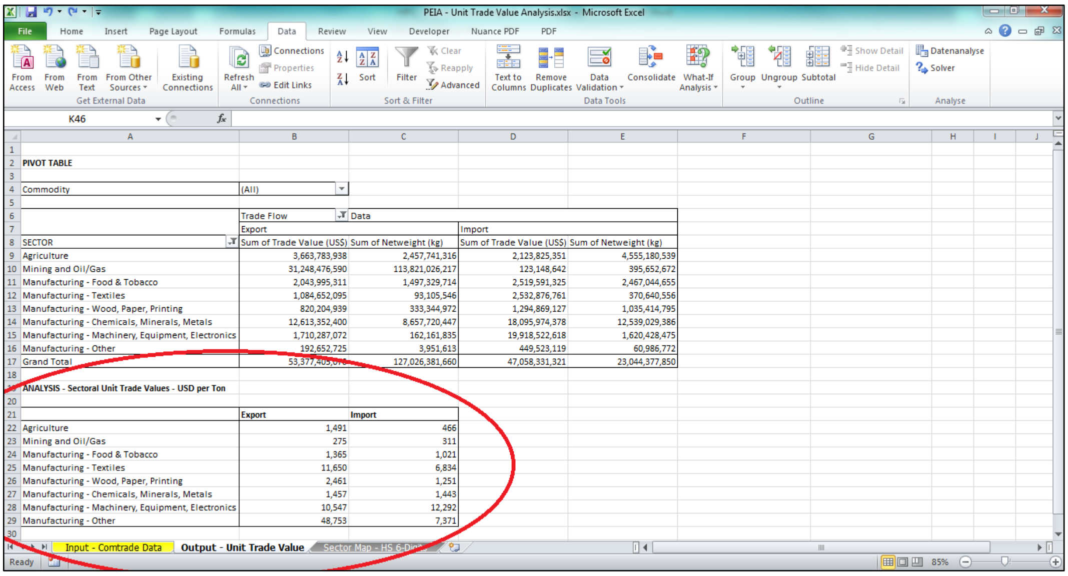
- The worksheet should now look as shown below.



- Switch to worksheet ***Output - Unit Trade Values***. Right click on the empty Pivot table (e.g. cell C9) and select *Refresh* (as shown below).



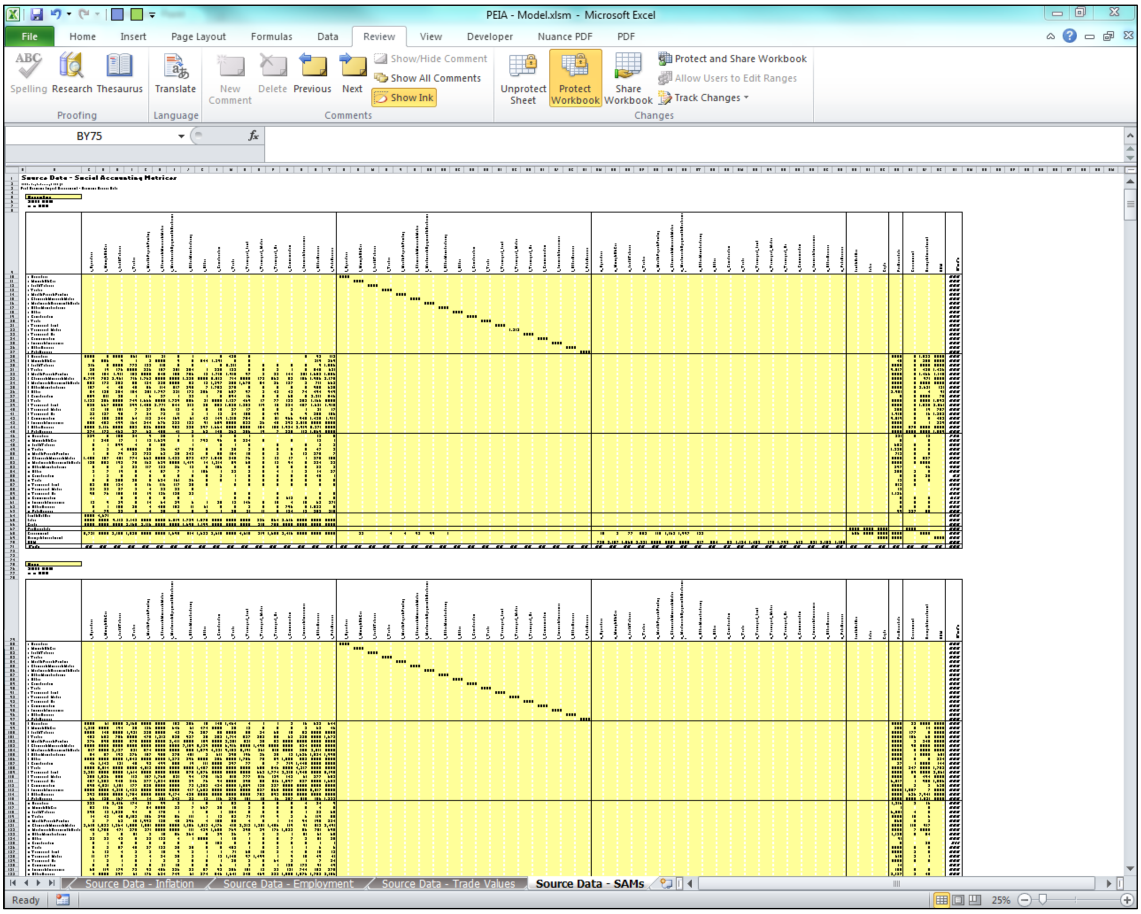
The sectoral unit trade values then appear underneath the refreshed Pivot table (as shown below).



Note: the file **PEIA - Unit Trade Value Analysis.xlsx** can then also be used to assess the value of specific commodities (as recommended for instance for bulk commodities, cf. the example of PIBT in Section 5.4). For this, the Pivot table in worksheet ***Output - Unit Trade Values*** allows to filter specific commodities (filter in cell B4).

Source Data – SAMs

The worksheet ***Source Data – SAMs*** contains the Social Accounting Matrices for the 20+ countries.



Derivation of a SAM from GTAP 9 requires the following steps:

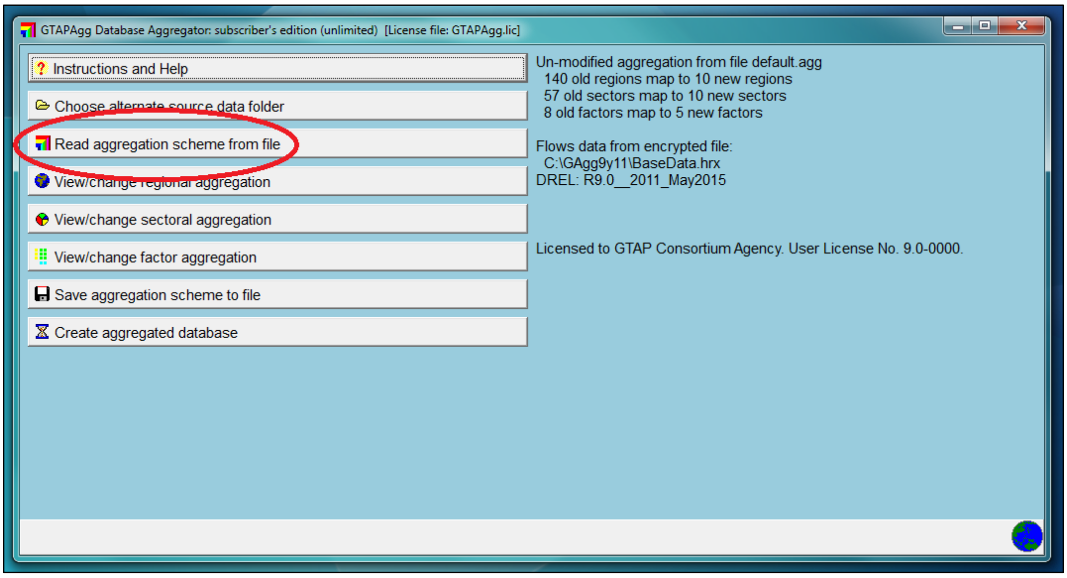
- Step 1: raw SAM data has first to be extracted from the GTAP 9 database using *GTAPAgg9y11*[80] and the aggregation scheme **PEIA - SAM Extraction.agg** (delivered with the tool).
- Step 2: the raw SAM from GTAP 9 then has to be converted into a SAM with the correct model sector classification, using the excel file **PEIA - SAM Conversion.xlsx** (delivered with the tool).

The following pages provide a detailed step-by-step guide for the derivation of sectoral unit trade values.

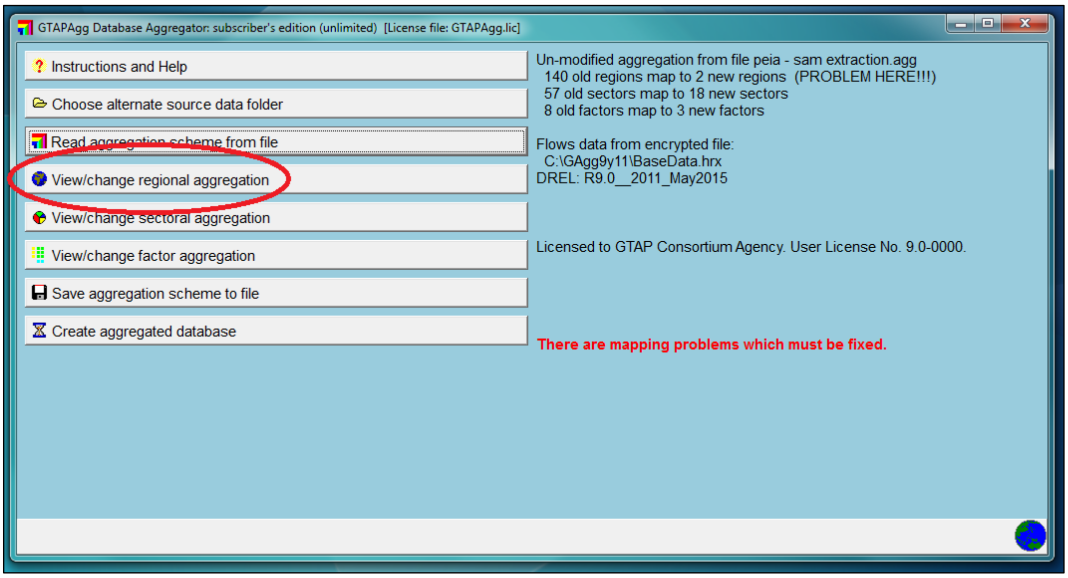
[80] This guide assumes that the user has installed the GTAP 9 database as the *GTAPAgg9y11* software package. For documentation of the GTAP 9 database, visit https://www.gtap.agecon.purdue.edu/databases/v9/default.asp.

Manual – Step 1 – Data Extraction from GTAP 9

- Start GTAPAgg9y11 with the corresponding *gtapagg.exe*.[81]
- Click on *Read aggregation scheme from file* (as shown below) and open the aggregation scheme **PEIA - SAM Extraction.agg**.



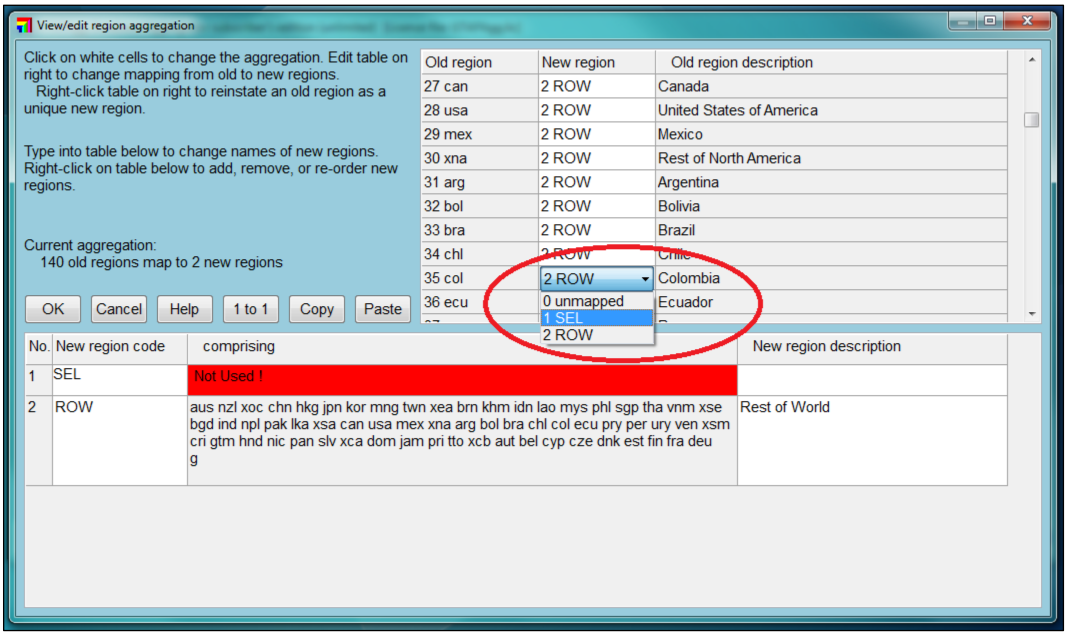
- Click on *View/change regional aggregation* (as shown below).



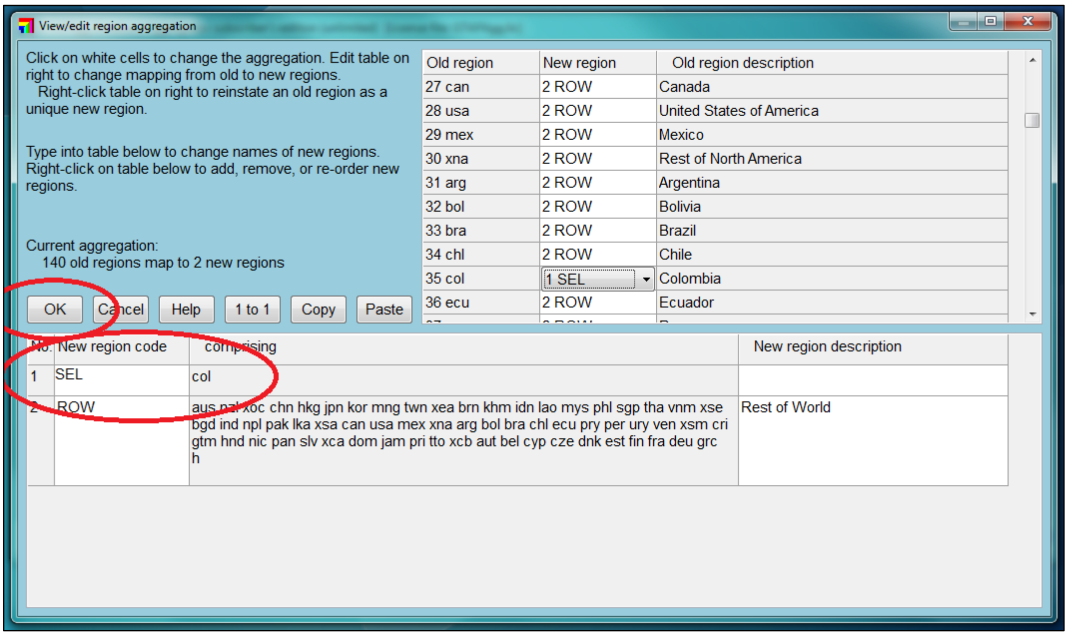
In the regional aggregation scheme, the country for which the SAM is to be derived must be selected. To do so, scroll down in the list of countries to the country of

[81] This guide assumes that the user has installed the GTAP 9 database as the *GTAPAgg9y11* software package. For documentation of the GTAP 9 database, visit https://www.gtap.agecon.purdue.edu/databases/v9/default.asp.

interest and choose *"1 SEL"* from the drop-down menu in the *New Region* column (in the example below, this is Colombia).[82]

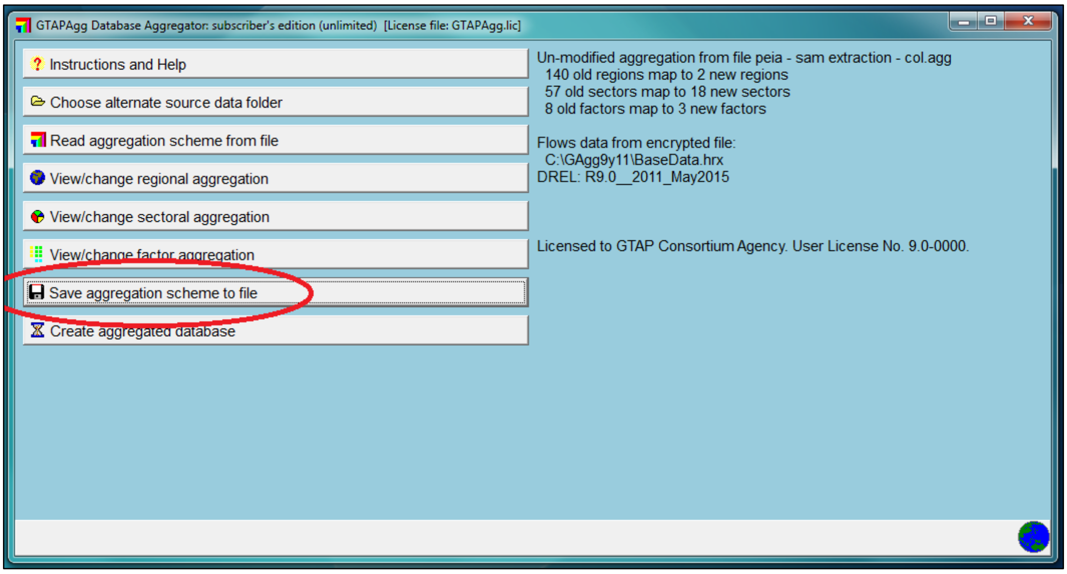


The country of interest then appears as part of the *new region code SEL* (as shown below). Click *OK*.

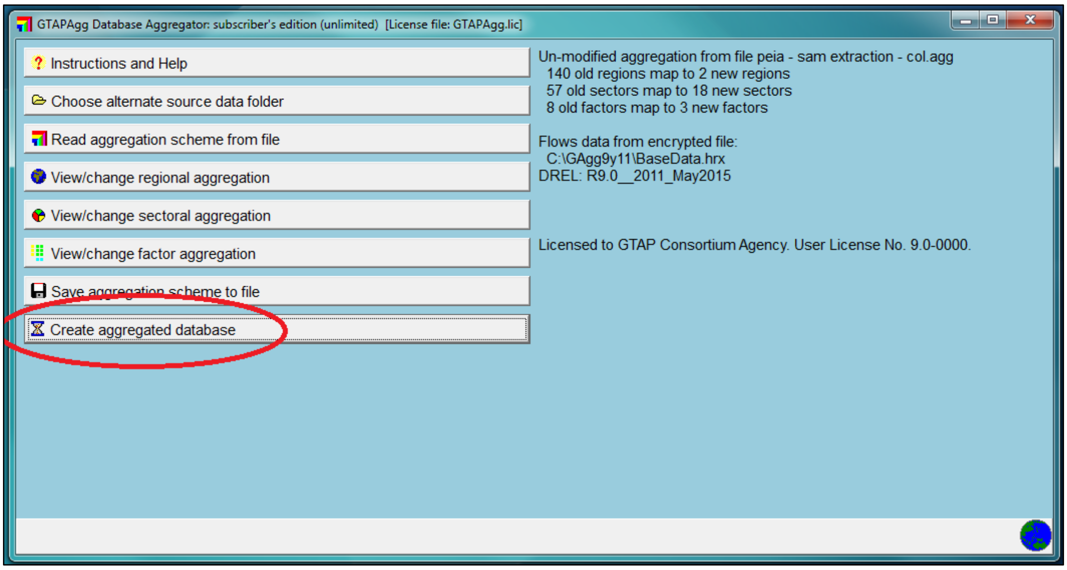


[82] In case that the user does not start from the fresh aggregation scheme **PEIA - SAM Extraction.agg** and wants to remove a country from the region "SEL": scroll down in the list of countries to the relevant country and choose *"2 ROW"* from the drop-down menu in the *New Region* column.

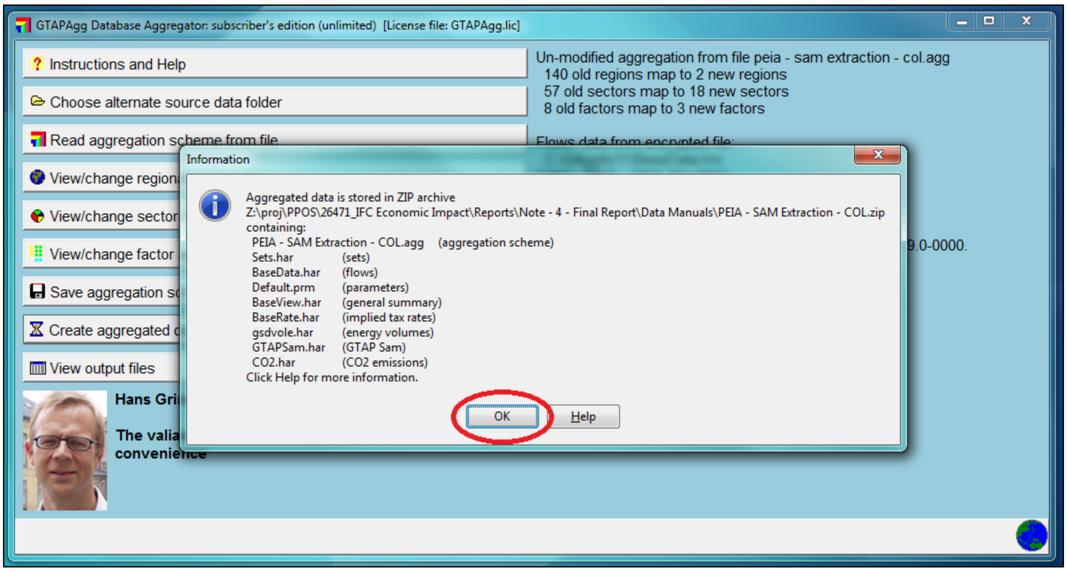
- Now click *Save aggregation scheme to file* (as shown below) and choose a folder and file name for the modified aggregation scheme.



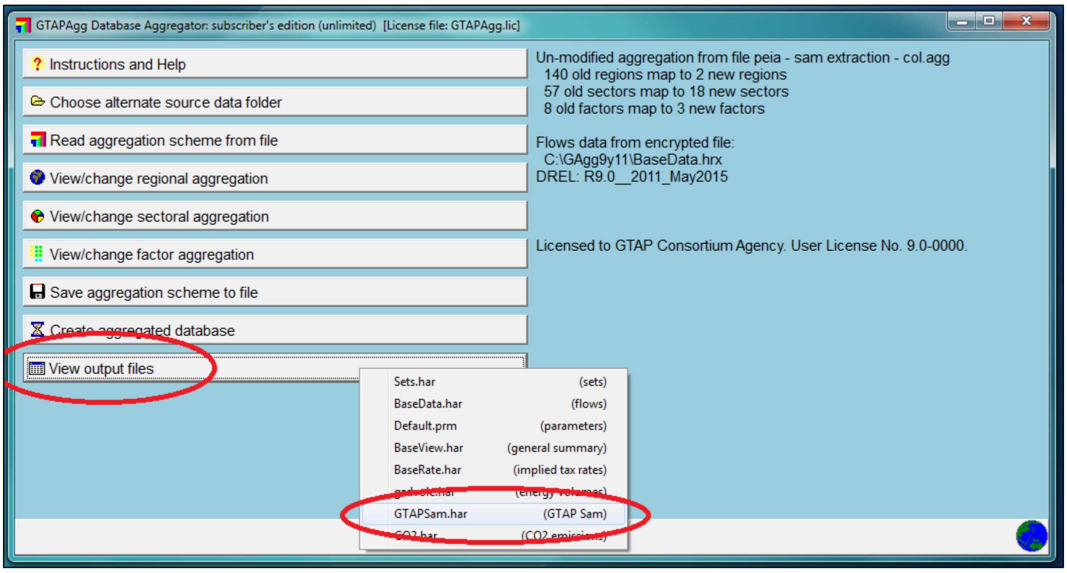
- Now click *Create aggregated database* and choose a folder and file name for the aggregated database. After that, the aggregated database is created.



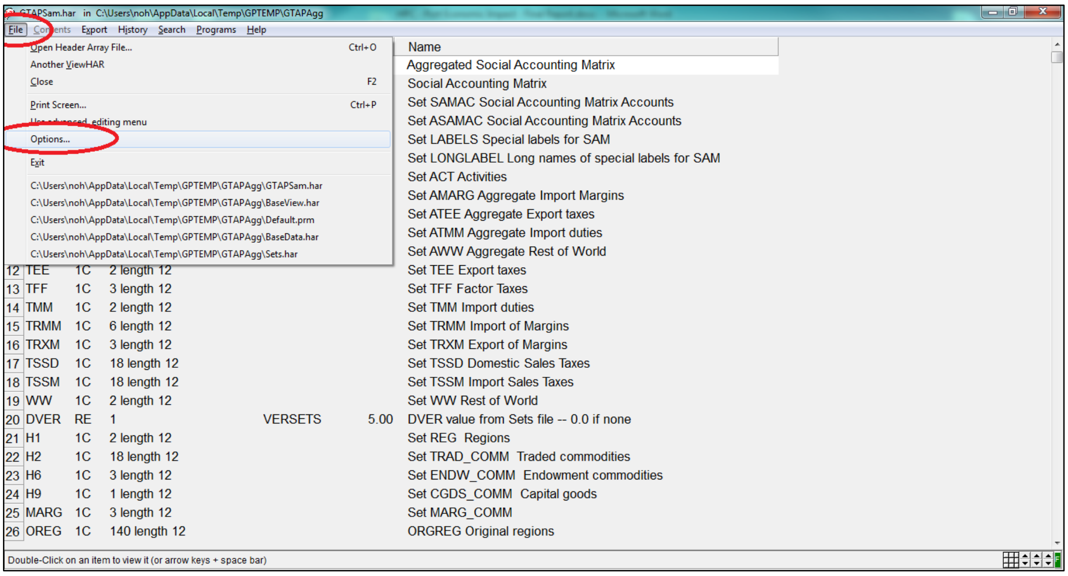
Upon completion of the aggregation process, this information is shown. Click *OK*.



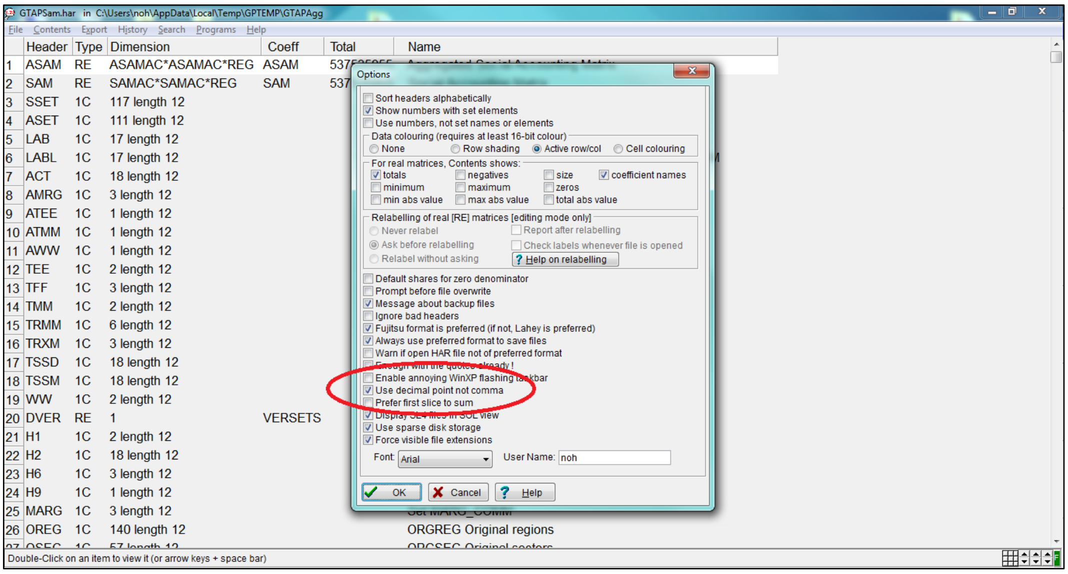
Now, click on *View output files* and then choose *GTAPSam.har* from the upcoming context menu (as shown below). This will open *GTAPSam.har* in a new window.



- On first use of *GTAPSam.har*, the user should go to options and ensure that *GTAPSam.har* uses the same decimal separator as is used by MS Excel.[83] To do so, go to *File* and then *Options* (as shown below).

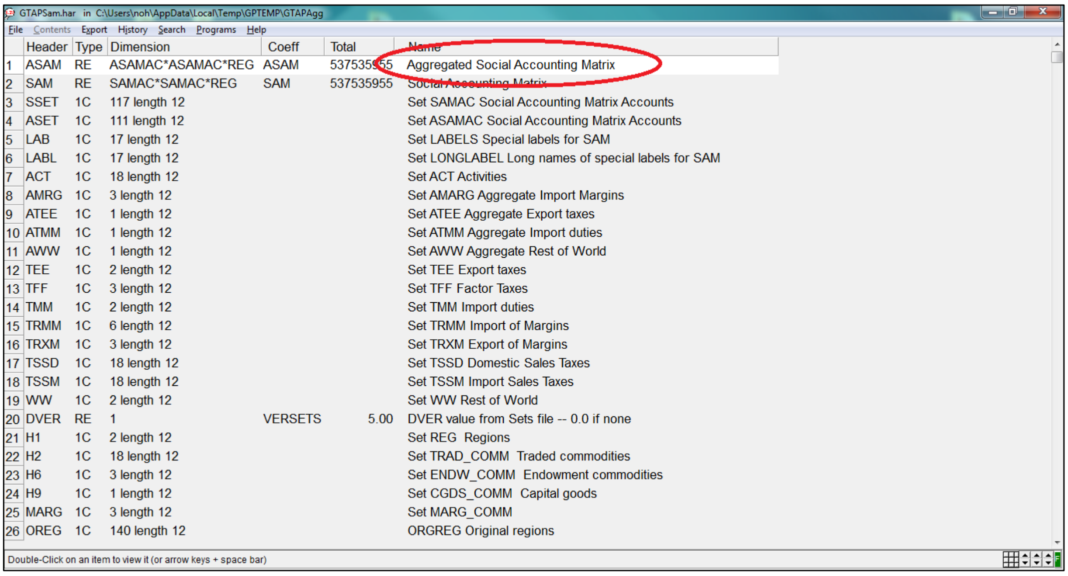


The user should then tick the box for *Use decimal point not comma* if MS Excel uses a point as the decimal separator (as shown below). Otherwise, untick the box. Finally, confirm with clicking *OK*.



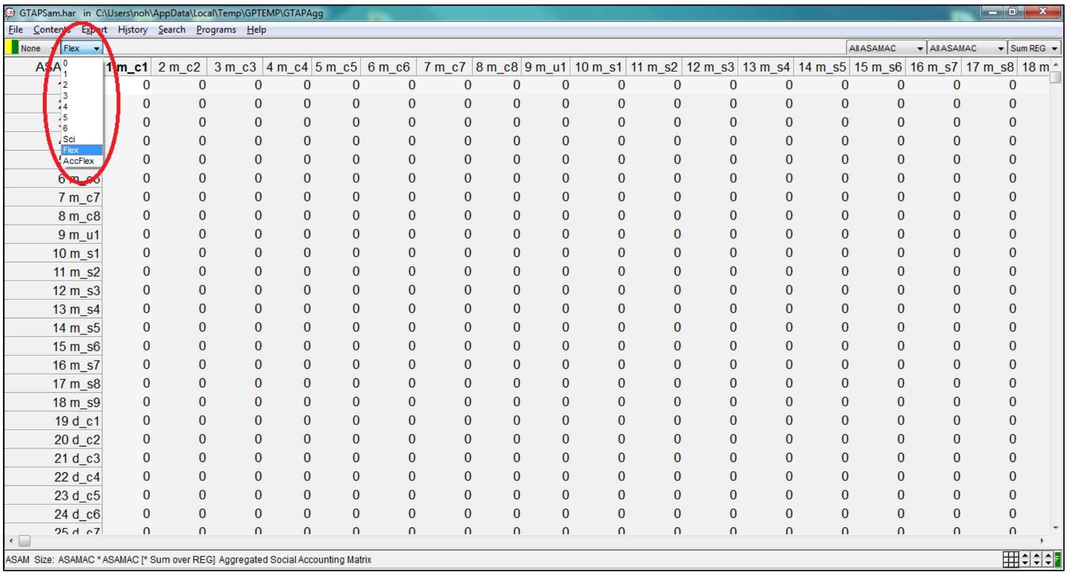
[83] *GTAPSam.har* has a comma as default setting for the decimal separator. British and American computers however use a point as decimal separator in MS Excel. If settings in *GTAPSam.har* and MS Excel are incompatible, MS Excel will misinterpret SAM data imported from GTAP.

- Now in *GTAPSam.har* click the row reading *Aggregated Social Accounting Matrix* (as shown below).



- For the aggregated social accounting matrix, set two options.

  First, select the *Flex* format for the *number of decimal places*, as shown below.[84]



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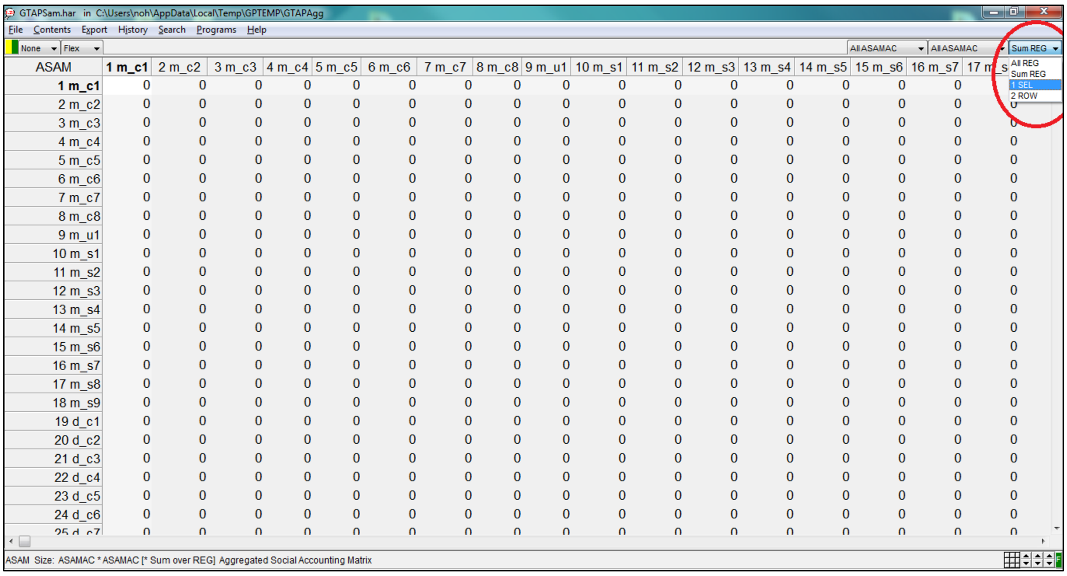
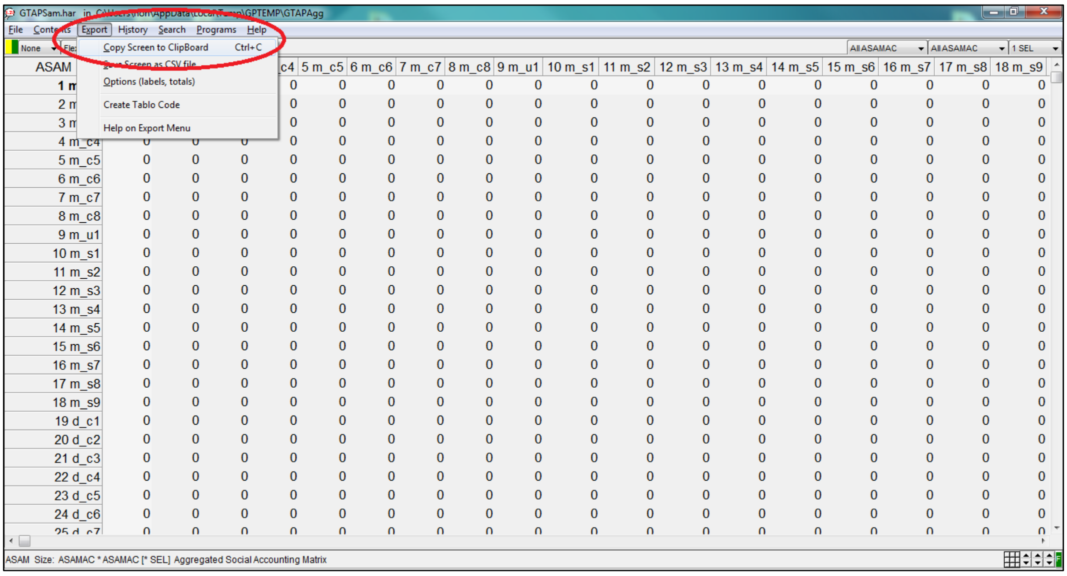
[84] Alternatively, the user may choose the *Sci* format. Selection of the decimal place options *0* through *6* however may result in insufficient accuracy of the exported SAM data.

Second, choose *1 SEL* as the region for which the SAM is to be displayed (as shown below).

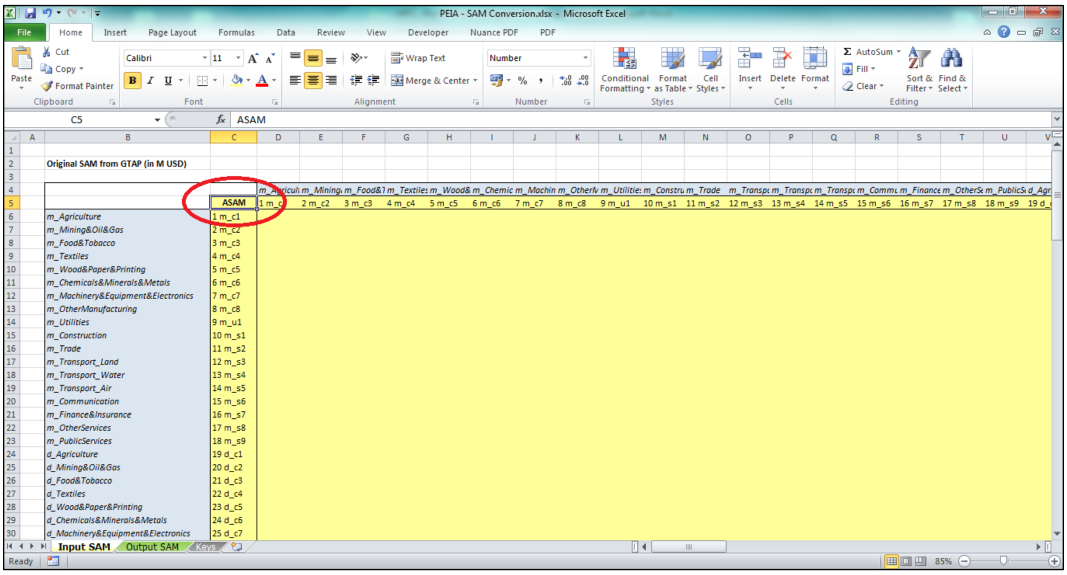


- Finally, go to *Export* and then select *Copy Screen to ClipBoard* (as shown below).

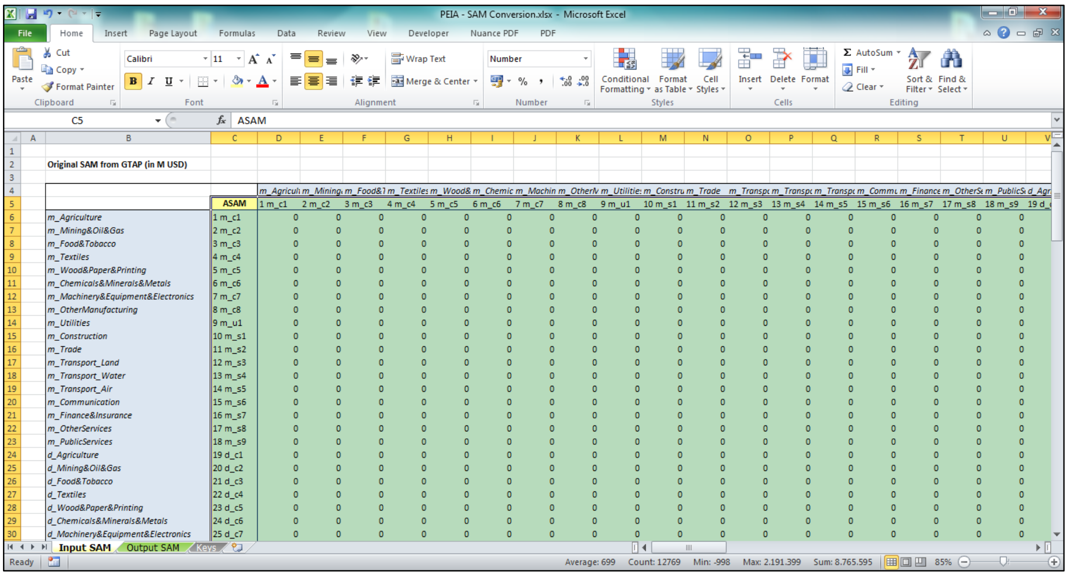


Manual – Step 2 – Conversion of SAM (with **PEIA – SAM Conversion.xlsx***)*

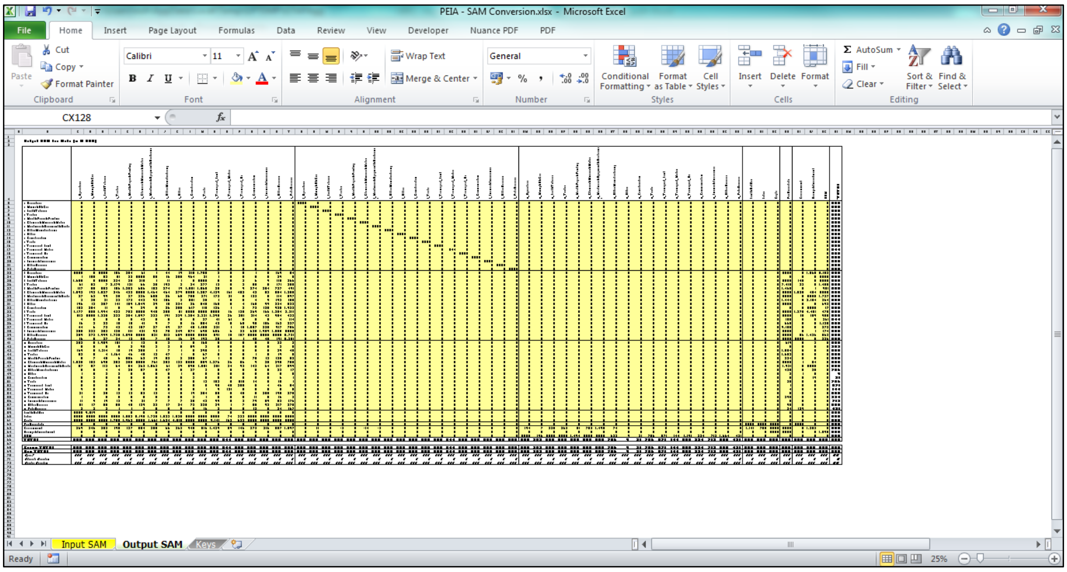
- Open **PEIA – SAM Conversion.xlsx** in MS Excel.
- In the worksheet ***Input SAM***, select cell C5 (“ASAM”, as shown below).



- Paste the data previously copied from *GTAPAgg9y11*.



- The SAM with the correct model sector classification then appears in worksheet ***Output SAM***.



Note: when inserting the SAM into the tool, only the yellow part of the SAM should be copied, i.e. excluding row and column totals.

Annex 3

DATA CONCORDANCES