Study on the Panama Canal's Economic Contribution and Sensitivity to Internal/External shocks

Final Report - Component 2 (D6)

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Report to IDB Invest & Autoridad del Canal de Panamá (ACP)

5th December 2022

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List of Abbreviations

ACP	Panama Canal's Authority
CGE	Computable General Equilibrium Model
GDP	Gross Domestic Product
GID	General Income Direction
GMI	Gross Mixed Income
GVP	Gross Production Value
GVA	Gross Value-Added
IC	Intermediate Consumption
INEC	Instituto Nacional de Estadística de Panamá
IO	Input-Output
K	Capital
NAS	National Accounting System
MEF	Ministry of Economics and Finance
L	Labor
SAE	Satellite Account of Employment
SAM	Social Accounting Matrix
SNA	System of National Accounts

SUTs	Supply and Use Tables
SSF	Social Security Fund
VA	Value-Added
VAT	Value-Added Tax

1. Introduction

The importance of measuring the impact of the Panama Canal and its recent expansion in both the Panamanian and the world economies has been discussed and analyzed in the existing literature. Studies emphasize both the relevance of the Canal for Panama's trade, GDP and employment (Hoyos et al. 2011; ACP, 2015) and for the rest of the world, by highlighting, particularly, its positive traffic and efficiency impacts on the U.S., European and Asian ports (Bhadury, 2016; Martínez et al., 2016; van Hassel et al., 2020). Econometric papers on this subject have measured the direct impact over variables such as ports' activity worldwide (Rodríguez & Ashar, 2016; Park, 2020; Miller & Hyodo, 2021), while papers and reports (Hoyos et al., 2011; Pagano et al., 2012; 2016; 2021; ACP, 2015) based on simulation models (Input-Output and Computable General Equilibrium models) have also quantified direct and indirect impacts of the Panama Canal over the national economy. Although all these studies provide useful analyses on the impact of the Panama Canal, they need to be updated with a more recent base year for model calibration.

An updated simulation model that includes the Panama Canal also allows addressing recent global events that affected the Panamanian economy through the Panama Canal. For instance, the China-USA trade war that started in 2019, the COVID-19 pandemic in 2020, and the commitments and uncertainties concerning climate change, among others, introduce the necessity to understand the socio-economic relevance of the Panama Canal activity for Panama and think about the measures and policies taken when facing these contingencies. Moreover, looking forward, the Panama Canal needs to evaluate its potential reaction facing a projected recovery of global demand until 2030 and plan accordingly the improvement or enlargement of the infrastructure linked to maritime transport activity. For instance, during 2021 the level of tons that transited through the Canal hit a record level, leading to an increase in Government resources and indirect positive impacts all over the economy (ACP, 2021; 2022a).

Two research questions summarize the motivation of this project. The first one is *what are the direct, indirect and induced economic contributions of the Canal to the Panamanian economy?* The second one is *what are the effects of different scenarios of shocks that could potentially affect the Panama Canal operations, in the recent past and future, and its direct, indirect and induced contributions to the local economy?*

Thus, the contribution of this final report is twofold. Firstly, we have estimated a 2019 version of a Social Accounting Matrix (SAM) for Panama representing 28 economic activities and isolating the activity of the Panama Canal. In a similar vein, a Satellite Employment Vector (SAE) has also been estimated to achieve a complete description of the Panamanian economy in that year. Secondly, an Input-Output (IO) model has been developed to measure the total (direct, indirect and induced) contribution of the Canal to the overall economy and to evaluate the potential repercussions of (i) the Covid pandemic over the Canal, (ii) the prospective change in global demand for Canal services and (iii) an infrastructure investment project (i.e. water management project) related to the Canal. Under these simulation scenarios the Panama Canal is the vector through which those shocks impact over socio-economic variables of the Panamanian economy.

According to the SAM for Panama 2019, and using the calibrated IO model, results indicate that the Canal is responsible for 6.16% of total GDP and 13.8% of total exports when considering the combined direct, indirect and induced effects. The latter operate through both households' labor

income and government transfers to households. The Panama Canal is also relevant for government revenue since 19.9% of this revenue is explained by the total (direct, indirect and induced) contribution of the Canal activity. In terms of employment, the Canal and its indirect and induced interactions with other sectors and economic agents generate more that 50 thousand jobs representing 2.5% of total employment in the base year. Half of these jobs are generated in Services, particularly in Commerce, Health, Education and Domestic services through the induced effects. In addition, the estimated multipliers suggest that the Canal possesses weaker forward and backward linkages than the average of the economy, which makes it a relatively independent sector within the economy.

The same modeling approach developed to compute the contribution of the Panama Canal to the country's economy allows simulating the aforementioned scenarios. Results highlight the sensitivity of the Panamanian economy to external shocks that affect the Panama Canal. These include, on the one hand, past shocks such as the Covid-19 pandemic and, on the other, future shocks such as the projected increase in global demand. In addition, there are remarkable positive spillover effects of the Canal project of infrastructure investment over employment and value-added in some particular sectors (e.g., construction) of the Panamanian economy.

The analysis of the Canal´s contribution to the Panamanian economy also highlights how its activity can mitigate the effect of some shocks. In particular, during the Covid-19 pandemic crisis, the Canal´s sustained activity helped the overall Panamanian economy to avoid facing a deeper crisis. Even when the pandemic impacted negatively over the Canal activity from May to October 2020 (-0.7% monthly average), the Canal kept on working and started displaying a quick recovery in the last months of 2020. No employment losses were observed on the Canal activity thanks to the implementation of adaptation mechanisms to sanitary cares for in situ operations and of a virtual modality of work for desk tasks.

Uncertainty about the worldwide economic recovery is still present, but the Canal has done annual projections until 2030 about the global demand for their services. Based on those demand projected trends, Panama's GDP is expected to increase by 9.62% between 2022 and 2030 (average annual growth rate of 1.1%). Additionally, employment and the government revenue are expected to increase too, by 4.03% and 31.06% respectively for the same period.

Finally, the construction of the infrastructure needed for a water management project for the Canal would bring about an increase in 2.1% of Panama's total GDP. In this case, such increase will be primarily experienced by the manufacturing and service sectors involved in the construction process. As for the employment creation, jobs are expected to increase by 1% due to the direct requirements for construction and the indirect and induced effects in the rest of the economy. However, it should be noted that this increase in employment is temporary and subject to the extension of the construction phase of the project.

Nonetheless, it is relevant to mention that quantitative results should be interpreted by taking into account the assumptions behind the modeling (i.e., shocks only in real terms, no change in expenditure patterns for households and the Government, no technological change in the production function such as the introduction of the teleworking since the pandemic, etc.), the limitation of data for scenarios design (i.e., cost structure of infrastructure projects and expected performance for the operation phase of the project) and putting them into a perspective compared

to real facts, particularly in the case of the COVID-19 simulated scenario. Notwithstanding these disclaimers about simulation results, the ACP and the IDB teams will be able to run further scenarios with the same developed simulation tool (SAM and IO model) which is part of this final deliverable.

This report is divided into 5 sections. Section 2 presents a literature review that discusses previous studies of the Panama Canal as well as other work that employs IO models to evaluate other projects. Section 3 delves into the methodological approach of the IO model, which requires the construction of the SAM for Panama in 2019 and its SAE for the same year. Additionally, this section describes the method applied to calculate the direct, indirect and induced contributions of the Panama Canal to the economy as well as the assumptions made to design and implement the different external shock scenarios. Section 4 presents and discusses the main results obtained in terms of socio-economic variables in aggregate terms and splitted by sectors. Section 5 discusses some final issues. Annexes provide more detailed information about data sources, assumptions and procedures in data elaboration and methods.

2. Panama Canal: literature review

Panama has been one of the fastest growing economies in Latin America since the beginning of the century (Koehler-Geib et al., 2015). One of the main reasons for such growth can be attributed to the existence of the Canal and its transfers to the Panamanian government, which allowed Panama to benefit from the growth of world trade by leveraging its geographical position to become a well-connected logistics and trade hub as well as a financial center.

The existence of the Canal plays a vital role in the Panamanian economy. For this reason, various works have studied its impact on the Panama economy, and particularly the potential impacts of past, current and future investments in the Canal. Additionally, given the current world scenario, it is also relevant to analyze the effects of external shocks on this economy.

2.1. Investment in infrastructure on the Panama Canal & water transport network

The analysis of the impacts of infrastructure investment in the Panama Canal is dominated by a literature that focuses on the Canal infrastructure investment that occurred from 2007 until the inauguration of its expansion in 2016.

An econometric literature that studies the Panama Canal expansion (Rodríguez & Ashar, 2016; Park, 2020; Miller & Hyodo, 2021) uses different impact evaluation techniques to study how the expansion has influenced ports worldwide. Even though their results are robust from an econometric standpoint, their methodology focuses on direct effects of the Canal activity. Consequently, they are unable to study its productive linkages with other sectors of the economy (indirect effects). However, Lanzalot et al. (2018) studied the relationship between the Canal expansion and the determinants of private investment and economic multiplier effects arising from large infrastructure projects. By using Synthetic Control Methods they were able to find causal evidence to suggest that the Canal expansion boosted private investment and GDP growth since its announcement in 2006.

Simulation models, such as IO and CGE models, provide a more comprehensive analysis in terms of direct and indirect effects of investment shocks, such as the Panama Canal expansion. Hoyos et al. (2011) studied the macroeconomic and distributional impacts of the Panama Canal expansion through a dynamic and recursive CGE model calibrated for 2003. By contrasting a *business-as-usual* scenario with that of the Canal expansion financed by international borrowing, they found beneficial effects of the Canal expansion both during the construction process and during the ensuing operation phase. More specifically, they found that this infrastructure investment would increase output growth 0.6% during the operational phase. In addition, they also found skilled-job creation and improved income distribution if redistribution policies were implemented (the Gini indicator would potentially decrease 3 points).

Likewise, Pagano et al. (2012) investigated the same issue by implementing both a CGE and an IO model calibrated to 2006. Both models deliver similar results regarding the Canal expansion´s impact on the long-run output growth rate both during the construction and operational phases, as in Hoyos et al. (2011). However, Pagano et al. (2012) focus on indirect and induced effects on other sectors of the economy. Specifically, they emphasize that the Canal expansion would ultimately be reflected in higher productivity and competitiveness in transportation, logistics, and commerce.

The ACP (2015) published a study evaluating the Canal's impact on the Panamanian economy after the expansion took place. They developed both a CGE and an IO model calibrated to the year 2010 to capture the multiplier effects of the Canal and its related activities on the economy[1]. Additionally, the use of a CGE framework enabled them to study the effects on households, firms, government, and the rest of the world in response to variation in traffic through the Canal. hey simulated four[2] long-run scenarios following the 2015 Canal expansion that differed in their assumptions about wage flexibility and capital flows. The results indicated that, in all possible scenarios, the Canal expansion would result in a higher GDP growth rate (1.5 to 1.8 times higher with respect to a non-expansion scenario). Additionally, the Canal's related activities, as well as private consumption, investment, and exports were also expected to increase. For example, fees paid by vessels were expected to increase 56% in the long run (2025) while household welfare was expected to increase between 25% and 40%. More recently, Pagano et al. (2016) extended their previous study by focusing on maritime clusters in a gravity IO model calibrated with data from 2006. The advantage of a gravity IO model is that it allows the study of agglomeration effects on the supply network by taking distance into account. The results of this study show that the Canal and ports can be considered a key driver for industries within the maritime cluster.

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[1] The study identifies two major sub-sectors within a Canal cluster. First, the international water transportation services. Second, the regional transit and distribution services. According to the results, these sectors were expected to grow between 135% and 158% from 2010 to 2025 because of the Canal expansion.

[2] ACP (2015) first presents an "Austere Scenario" where it assumes that labor markets are tight and closed, and that increased production and labor demand produce an upward pressure on wage increments. A second scenario called "Flexible scenario" assumes that labor demand will increase as wages rise. The "External labor scenario" allows the opening of the market to foreign workers. Finally, the "Capital expansion scenario" allows for an expansion of non-maritime capital.

A more recent literature addresses the impacts of the Canal expansion worldwide. Bhadury (2016) studied how the expansion impacted the U.S. port industry. His findings show that big-port complexes such as New York, Houston and Miami have increased traffic and will experience growth in the coming decade. In a similar vein, Martínez et al. (2016) used a coast choice model to verify that the Panama Canal expansion can reduce the transit time on shipments from Asia to the U.S. Finally, van Hassel et al. (2020) extended these studies to include the potential impacts on European ports finding similar results regarding the Canal expansion´s impact on worldwide route efficiency.

Even though the Panama Canal expansion was the most important maritime transit infrastructure project in recent years, other literature has used CGE and IO approaches to study similar investments in port expansions and shipment routes. Anas et al. (2016) use a quantity-based IO model to study the link between transport infrastructure investment and economic growth in the West Java region of Indonesia. Jiwei et al. (2019) take the same approach but focus on telecommunication investment. More recently, Keček et al. (2021) used the IO approach to study investment in Croatian transport infrastructure. All papers present positive indirect and induced effects suggesting that investing in this sector may bring about positive spillover effects on the overall economy of a nation. Regarding port infrastructure investment, Gulakova et al. (2017), Ki Jung et al. (2018) and Munim et al. (2019) also use IO models, and conclude that this type of investments contribute to better logistics performance, leading to higher seaborne trade, and yielding higher economic growth.

CGE models were also used to study major port development investment projects in the South African economy (Lee et al. 2012) and in the Northern Sea Route (Yumashev et al. 2017; Didenko, 2018). Lee et al. (2012) find that investing in port infrastructure projects will bring about positive induced effects in the South African economy through growth in GDP and employment. Additionally, their results suggest that this type of investment will also increase the total value of trade aiding the country´s integration in global value chains. Yumanshev et al. (2017) and Didenko (2018) provide a less optimistic view by finding that promoting the use of the Northern Sea Route may bring about negative effects on climate change ultimately affecting the world economies.

2.2. International shock impacts & the Panama Canal

The IMF (2013) suggests that due to the size of the Panamanian economy, local shocks have little to no worldwide impact.[3] On the contrary, their findings indicate that global demand and international financial shocks have a significant long-term impact on the economy of Panama (including the Canal) and its financial sector.

Recent worldwide past events have evidenced the sensitivity of Panama's economy. Chaves et al. (2021) studied how the COVID-19 pandemic impacted as an external shock to the Mesoamerican and Caribbean economies, and suggest that countries like Panama with highly liberalized trade tend to be more susceptible to the negative effects of the pandemic (i.e. epidemiological evolution and its relationship with the economic recession).

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[3] IMF (2013) developed a Structural Vector Autoregressive model to study the relationship between real GDP, domestic credit, and balance of trade with external variables such as global demand and financial conditions.

Morcillo (2022) analyzed the impacts of the trade war that started during Donald Trump's U.S. administration against China over the Panamanian trading sectors. Additionally, he quantified the sensitivity of trade in the face of the growing hostilities of the Russian Federation threatening the geopolitical scenario. His results show that trade in Panama has experienced a steady decline in the last five years. This implies that the Panamanian economy is extremely sensitive to tense international scenarios.

The literature not only measured the impact of past events over Panama's economy but also simulated prospective scenarios. Following the literature of IO models, Pagano et al. (2021) extend their line of work by using an IO model calibrated with 2012 data to evaluate investments in commercial development projects related to logistics and world trade amid post-pandemic recovery for Panama's economy.[4] Three hypothetical scenarios are simulated[5]: a "Most likely" scenario (a slight recovery of the world economy by assuming 1.5% and 2.5% annual growth rate to the U.S. and Europe respectively, and a stabilized growth for China); an "Optimistic" scenario (the rest of the world economy grows at the same rate as the "Most Likely" scenario) where the Panamanian economy experiences a faster growth rate due to the Panama Canal, ports, and air transport investment; and a "Pessimistic" scenario (China decreases its growth rate by 0.5% a year) where the Panamanian economy decreases due to a fall in world trade. Results indicate that, independently of the world scenario, investments will have large multiplier effects on the economy increasing GDP and total employment.

This literature review points to the benefits of a comprehensive methodological approach that is able to analyze the interactions between the Canal and the other sectors of the Panamanian economy. On the one hand, even though the econometric methodologies previously mentioned are successful in studying specific causal relationships between variables, they are unable to comprehensively analyze the sectorial interconnections within the economy and measure direct and spillover effects under current and prospective scenarios. On the other hand, while an IO approach aligned with Pagano et al. (2012), Pagano et al. (2016) and Pagano et al. (2021) is appropriate for the purpose of this study, it requires updated data for successful calibration. In response to this need, the following sections present a methodological approach based on an IO model using more recent, year 2019, data for calibration.

3. Methodological approach: IO model for Panama 2019

The development of a multisector simulation model is required to quantify direct, indirect and induced contributions of the Panama Canal activity to the Panamanian economy in terms of GDP, exports, government revenue, and employment, at both national and sectoral levels. The following scheme (Figure 1) of the overall methodological approach provides an idea of the step-by-step procedure we follow, from constructing the datasets required for model calibration to quantifying the direct and spillover impacts on the Canal and simulating relevant alternate scenarios.

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[4] Pagano et al. (2021) have updated their calibration data with respect to their previous works.
[5] These scenarios were constructed in accordance with the IMF projections.

Figure 1. Scheme of the overall methodological approach
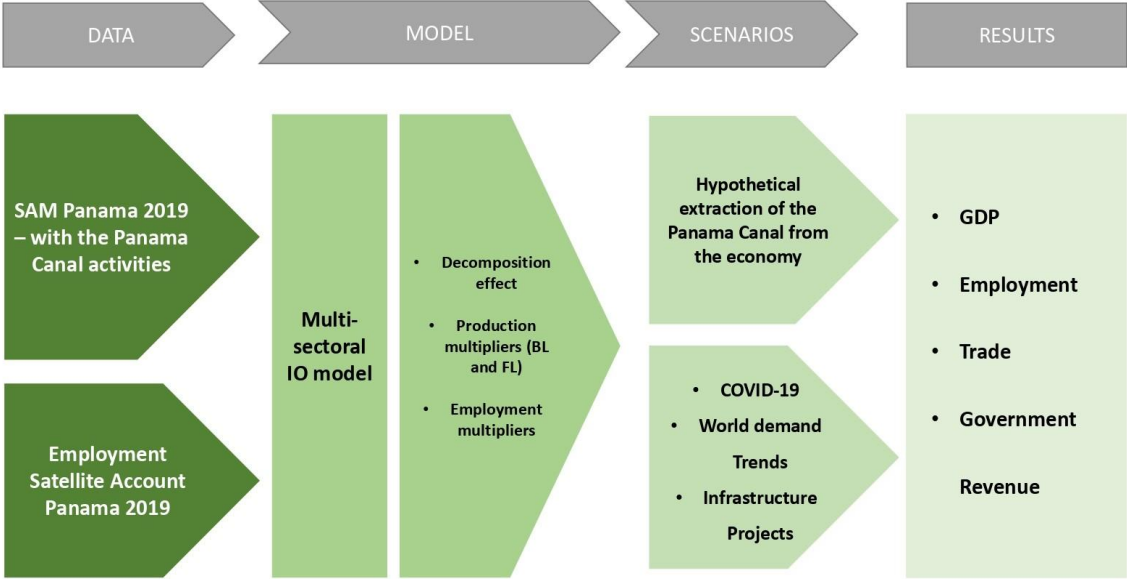
Source: Own elaboration.

The first step in the analysis is to build a Social Accounting Matrix (SAM) for Panama corresponding to the year 2019. This matrix embeds comprehensive and economy-wide data for all transactions between economic agents in the country during that year. The SAM we construct contains the economic flows between 28 economic sectors (including the Canal as one of them) and different agents. It includes households' income and expenditure divided by income deciles; government income and expenditure, and public and private investment. Since another vital part of the economy is the amount of jobs created in every industry, the SAM was complemented with a Satellite Account of Employment (SAE) for the same year.

The second step is to develop a simulation model calibrated on the constructed SAM and SAE. The choice between an IO or a CGE model depends on what types of questions and dynamics are being studied. If the objective is to analyze the impact of one sector on the overall economy or to evaluate the effects of an external shock, both models are appropriate. This is because they are both able to capture similar effects (long run direct, indirect and induced effects in the overall Panamanian economy). Even though IO models are more restricted due to their linearity assumptions and the avoidance of potential general equilibrium effects, such models provide a more transparent framework that allows the researcher to better understand and track the step-by-step dynamics of a given shock. In other words, while the CGE model mechanisms often appear as a "black box" to a non-specialized user, the IO model's do not. As a consequence, the latter allows for better and clearer manipulation of shocks and interpretation of results. From a technical standpoint, IO models are more user friendly in the sense that only basic software skills are needed (e.g. Excel) to manipulate the model. By contrast, CGE models require previous knowledge of modeling using the GAMS[6] programming language.

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[6] General Algebraic Modeling System.

Thus, we build a demand-driven (or quantity-based[7]) model to capture variations in the quantity of final demand given a simulation scenario. We follow a SAM-based model approach proposed by Round (2003), which incorporates households' income and expenditure according to income groups (deciles). The purpose of this modeling technique is to examine the effects of real shocks on the distribution of income across socio-economic groups of households.

The third step in the analysis is to use this IO model to assess, first, the direct, indirect and induced contribution of the Canal to the Panamanian GDP, exports, government revenue and employment. In particular, we use a Hypothetical extraction method (Miller & Lahr, 2001; Dietzenbacher & Lahr, 2013) to analyze a counterfactual scenario where the Panama Canal is eliminated from the economy.

Then, we perform three different scenarios with no extraction: (i) the impact of the COVID-19 pandemic on the Panama Canal activity and, consequently, on the Panamanian Economy; (ii) the effects of projected world demand trends for the Canal activity; and (iii) the consequences of a water management infrastructure project, which is of interest to the Canal's for its economic and environmental purposes. Detailed assumptions of these scenarios are explained later in the report.

The rest of this section presents a detailed description of each step of our analysis. We first start by presenting the data and assumptions made to construct the SAM and SAE for Panama 2019. We later show the main characteristics of the IO model, the hypothetical extraction method and the assumptions of the aforementioned simulation scenarios.

3.1. DATA

Social Accounting Matrix for Panama 2019

A significant amount of information is required to elaborate an IO model. This information should be structured to maintain consistency among the different elements it contains. Hence, a SAM must comply with this consistency condition, representing the circular flow of the economy in a double-entry table, where the incomes of each sector and agent are in rows and their expenditures are in columns. Consistency must be observed for each account in the SAM, as the basic budget constraint (income equals expenditure) should suit not only at an aggregate level but also for each individual sector and agent.[8]

A first objective of the SAM is to organize in a consistent and comprehensive manner the economic information of a country (or region) during a specific period, normally a stable year for macroeconomic variables. In this regard, the SAM resembles the national accounts and involves data of the System of National Accounts (SNA). In addition, the SAM requires an IO matrix that reflects the inter-industry chains of an economy; i.e., the purchase of an intermediate input by a sector represents the sale of that same input from another sector, generalizing this inter-sector relationship for all transactions within an economy. Income and expenditure budgets of households, government, and the rest of the world, apart from the firms represented at a sector

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[7] The details of this model will be further explained in the following sections.
[8] See: Pyatt y Round (1985).

level within the IO matrix, are another relevant information to build a SAM. As already mentioned, initially these budget constraints must be complied both at an individual and aggregate level.

A second objective of the SAM is to provide the statistical basis to create a simulation model that is the tool for the evaluation of different policies or exogenous shocks. Once the information of a specific country within a given year has been organized in the form of a SAM, it represents a static image that reveals the economic structure of the studied country. Considering a SAM as a starting point, an array of different IO models can be constructed, each with different characteristics.

A SAM is generally composed of 5 types of accounts: goods, factors, agents (households, government) and the rest of the world, and they should all be implicitly or explicitly represented. Disaggregation within each of these accounts is a matter of choice according to the study's conditions and objectives. The structure of the SAM limits the global model and its scope. Therefore, the disaggregation of the matrix is not neutral in terms of future simulations.

As a scheme, Table 1 presents a SAM in a square format: the rows are equal to the columns' accounts. Rows read the different sectors' income, while columns read their expenditures, highlighting the way these sectors relate with each other. The sum of each row must equal the sum of each column, implying that a sector's expenditures must equal its income.

Table 1. Basic Structure of a SAM

| | | Expenditure | | | | | | |
		Activities	Goods	Factors	Households	Government	Investment	Rest of the world	Total
Income	Activities		Domestic Supply						Activity income
	Goods	Intermediate Demand			Consumers' expenditure	Current expenditure	Demand for Investment	Exports	Total demand
	Factors	Value Added							Factorial income
	Households			Household's factors retribution		Transfers		External Transfers	Household's income
	Government		Import tariffs and other taxes		Direct taxes			External help an loans	Government income
	Savings				Private savings	Fiscal surplus		Current account balance	Total savings
	Rest of the world		Imports						Currency outflows
	Total	Output	Total Supply	Factorial expenditure	Households' expenditure	Public expenditure	Investment expenditure	Currency inflows	

Source: Own elaboration.

To elaborate the 2019 Panama SAM, official data sources and data from the Panama Canal were required. This information has multiple points of origin and often involves multiple periods. In some cases, it is possible to begin with an already existing SAM, which is updated using new

information. In other cases, the SAM must be constructed from scratch. In our case, we constructed a completely new SAM.

The main data sources that we have used to construct the 2019 Panama SAM are:

- National Accounting System for Panama (2019)
- Income and expenditure household survey for Panama (2017/2018)
- Consolidated Panamanian Government budget (2019)
- Balance of Payment for Panama (2019)
- Balance sheets for the Panama Canal (2019)

More details about these data sources are presented in Annex A.1.

Achieving information consistency can be challenging, particularly when the information comes from different sources and requires an efficient harmonization. According to Stone (1978), RAS and Cross-Entropy methods are often used to estimate missing or outdated transactions while minimizing the deviation from the real data and ensuring consistency with the available data, particularly with the data from the SNA (Bacharach, 1970; Stone, 1978). For the construction of the 2019 Panama SAM, the RAS method was employed. This method is presented in Annex A.2.

In this work, we have successfully estimated a complete matrix that represents the economy of Panama. Such a matrix is composed of 28 productive activities. In terms of agents, the matrix has 10 households divided by income, the consolidated government, and the rest of the world. The latter is mainly represented through trade variables (exports and imports). The export column represents the expenses of the rest of the world while the import row stores the incomes of the rest of the world. Table 2 presents the sectorial opening.

Table 2. Sectorial opening for the SAM of Panama 2019.

Num.	Sector	Cod.
1	Agriculture, Forestry and Fishing	AGRIC
2	Exploiting of mines and quarries	MINER
3	Food, beverages, and tobacco	ALIME
4	Textiles and leather	TEXTI
5	Wood and paper	MADER
6	Chemicals and plastics	QUIMI
7	Non-metallic minerals	NOMET
8	Other manufacturing industries	OTIND
9	Electricity and gas supply	ELECT

10	Water treatment and supply	AGUAS
11	Construction	CONST
12	Commerce	COMER
13	Hotels and restaurants	HOTEL
14	Transport by land	TRTER
15	Aquatic transport	TRACU
16	Air transport	TRAER
17	Travel agencies	AGENC
18	Complementary transport activities	TROTR
19	Panama Canal	CANAL
20	Mail and telecommunications	TELCO
21	Financial and insurance activities	FINAN
22	Real estate activities and rentals	INMOB
23	Business services	SEMPR
24	Teaching	EDUCA
25	Health and social services	SALUD
26	Public administration	ADMPU
27	Community services	SCOMU
28	Domestic services	SDOME

Source: Authors´ own elaboration.

Figure 2 presents the main features of the Panama Canal regarding its sources of income and expenditure. Panel (a) on the left shows that the main destination of the Canal´s output is exports with 70.3% of total Gross Value of Production (GVP), followed by intermediate sales to other sectors of the Panamanian economy (16.4%) and sales to households (12.6%). Panel (b) shows that the Canal activity is value-added intensive (86.6% of GVP) and particularly capital intensive. In fact, 55.5% of total GVP is accounted for by "remuneration to capital", which are the benefits generated by the operation of the Canal. Labor costs (19.9%) and Gross Mixed Income (GMI) (11.2%) are the following most relevant expenditure items. Inputs demanded from the Canal (NIC) are mainly national (6.6% of total GVP) since imported inputs (IIC) only represent 2.8% of the Canal GVP.

Figure 2. Composition of income and expenses of the Panama Canal.

(a) Income	(b) Expenses
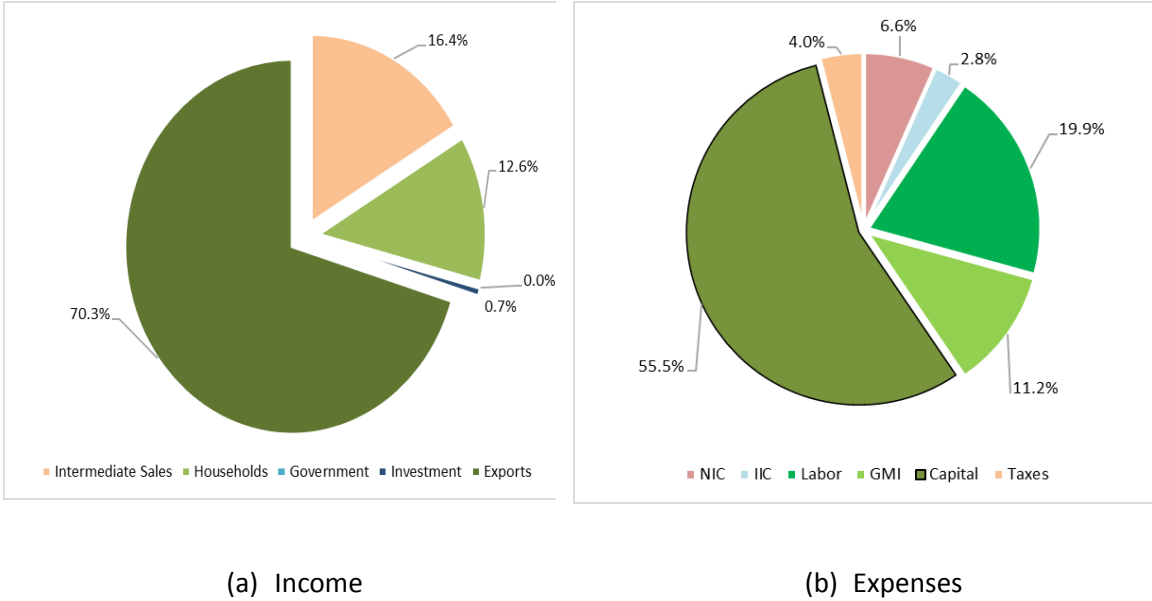
Source: Own work based on INEC, MEF and DGI.

Table 3 describes both the sectoral linkages of the Canal with the rest of the economy and the share of each sector in Panama´s total value added and exports. First, to characterize the Canal´s sectoral linkages, the first two columns display, respectively, the sectoral composition (% shares) of the Canal´s intermediate consumption and intermediate sales[9]. This is useful to get a glance at the main activities that either sell to or buy from the Canal. As an example, considering the Agriculture, Forestry and Fishing sector, Table 3 shows that the Canal does not buy any inputs from this sector but sells to it 4% of its intermediate sales. Second, the last two columns highlight the structure of the Panamanian economy by displaying the participation of each sector in Panama´s total value added and exports. For example, Agriculture, Forestry and Fishing generates 2.3% of Panama´s total value added and 1% of its total exports. The final row of the table provides totals for each variable measured in millions of Balboas.

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[9] Intermediate sales account for all the sales to other national sectors. Sales to foreign sectors are accounted for in the exports.

Table 3. Panama 2019. Sectoral vinculation of the Canal and sector shares in Panama´s value added and exports per sector.

Sector	Canal		Panama	
	Intermediate consumption	Intermediate sales	Value Added	Exports
Agriculture, Forestry and Fishing	0.0%	4.0%	2.3%	1.0%
Exploiting of mines and quarries	1.5%	4.6%	2.6%	2.3%
Food, beverages, and tobacco	0.1%	4.8%	3.0%	2.2%
Textiles and leather	0.0%	0.2%	0.0%	0.5%
Wood and paper	1.7%	0.4%	0.4%	0.2%
Chemicals and plastics	0.8%	0.3%	0.4%	1.2%
Non-metallic minerals	5.9%	1.8%	1.4%	0.3%
Other manufacturing industries	3.5%	0.3%	0.7%	2.3%
Electricity and gas supply	20.3%	1.9%	1.7%	0.0%
Water treatment and supply	2.5%	0.0%	0.2%	0.0%
Construction	0.4%	4.4%	20.5%	0.0%
Commerce	13.9%	46.5%	19.0%	26.5%
Hotels and restaurants	0.9%	0.5%	3.8%	4.1%
Transport by land	1.4%	0.8%	2.5%	10.2%
Aquatic transport	0.4%	1.1%	0.7%	3.0%
Air transport	1.5%	12.4%	1.4%	11.8%
Travel agencies	0.1%	2.2%	0.2%	1.0%
Complementary transport activities	0.3%	6.3%	0.7%	2.6%
Panama Canal	1.6%	0.7%	4.8%	12.1%
Mail and telecommunications	6.1%	0.9%	2.1%	4.0%
Financial and insurance activities	7.5%	0.6%	6.2%	9.6%
Real estate activities and rentals	1.1%	0.6%	8.6%	0.3%
Business services	23.6%	1.8%	5.0%	4.1%
Teaching	3.5%	0.3%	3.0%	0.0%
Health and social services	1.0%	1.4%	4.2%	0.7%
Public administration	0.3%	1.2%	3.0%	0.1%
Community services	0.0%	0.2%	1.2%	0.0%
Domestic services	0.0%	0.0%	0.4%	0.0%
Total (%)	100%	100%	100%	100%
Total	214.5	530.6	58,743.7	18,703.6

Source: Authors´ own elaboration.

Note: BP: Basic Prices

The first column of Table 3 shows that the most important input demand linkages of the Panama Canal are Business Services, Electricity and Gas Supply, Commerce, Financial and Insurance Activities, Mail and Telecommunications and Non-metallic Minerals. Those sectors account for 23.6%, 20.3%, 13.9%, 7.5%, 6.1% and 5.9% of the Canal´s intermediate consumption, respectively. In terms of intermediate sales, the most important sectors are Commerce (46.5%), Air Transport (12.4%), Complementary Transport Activities (6.3%), Food, beverages, and tobacco (4.8%), Exploiting of mines and quarries (4.6%), and Construction (4.4%).

The last two columns of the table provide a glimpse at the structure of the Panamanian economy. Service sectors dominate the generation of value added with the most important sectors being Construction (20.5%), Commerce (19%), and Real Estate Activities and Rentals (8.6%). In turn, the most important export sectors are Commerce (26.5), Transport by land (10.2%), Air transport (11.8%), and Financial and Insurance Activities (9.6%). Since the Canal enters as one of the 28 sectors, the corresponding row displays in particular the Canal´s relative importance in terms of those two economic variables. The Canal contributes 4.8% to Panama´s total value added and 12.1% to its total exports.

Table 4 summarizes the information of the full estimated SAM by presenting a 4x4 version (the Macro SAM) that group sectors in Primary, Industrial, Canal, and Services aggregates[10]. To read the matrix note that each agent is represented by a row and a column. In the rows we represent the incomes of the agent while in the column we account for the expenses. For example, the first row shows that the Primary Activities sector sells its products to all for aggregated sectors (as intermediate products) while it also sells to households and exports for an overall total of 4,916 million balboas. Reading the matrix through its columns, we can see for example that households purchase 631 millions balboas from this sector.

According to the table, the sum of all four activities have a GVP (Gross Value of Production) of approximately 102,427 million balboas, of which 3,229 million correspond to the Canal (3.1%). Total intermediate Canal consumption (national and imported) is 304 million (consumption of 204 million of the four aggregated sectors plus imported consumption of 90 million), of which 4 million is consumption of their own-produced goods and services. Panama´s 2019 GDP at market prices is 66,985 million balboas (sum of factors, taxes on factors, and taxes on products nets of subsidies) while the Canal services represent 4.3% of total GDP. In terms of Value Added, 86.5% of Canal´s total value of production is value added (2,795 million balboas), which indicates that services provided by the Canal are value-added intensive. Regarding net tax collection, we can observe that total collection net of subsidies for 2019 is 8,641 million balboas (3,575 million corresponds to social contributions), of which the Canal contributes 129 million (sum all the taxes that are in the column that corresponds to the Canal). However, net taxes on production are negative for the Canal (-30 millions of balboas). This is mainly due to the fact that the canal almost does not pay taxes on products (4 millions of balboas) and receives subsidies that are mainly related to

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[10] The full version of the matrix with all 28 activities can be found in an Excel file annex.

provisions for investments[11] (34 millions of balboas). Final demand for the Canal was of 2,698 million, out of which most were exported services (2,269 million balboas). Both for households and for the government, national consumption of services represents the majority of their budget with 20,227 and 7,906 million balboas respectively. Finally, the result for the rest of the world was a deficit for the economy of Panama of 7,137 million balboas. In the same line, the government presents a fiscal deficit in 2019 of 2,103 million balboas (3.1% of GDP).

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[11] This information comes from "Supply Tables", which are sectorial matrices that account for the composition of supply per sector at market prices. Such tables (not shown here) were provided to us by the Panamanian national institute of statistics. We note that the information included in the Supply Tables is consistent with the balance sheet of the Canal, which shows the provisions and contributions it receives from the government.

Table 4. Social Accounting Matrix for Panama, 2019. The Canal + 3-sector reduced version. Millions of Balboas at basic prices.

	PRIMARY	INDUSTRIAL	CANAL	SERVICES	FACTORS	TAXES	HOUSEHOLDS	GOV	INV	EXPORTS	GPV
PRIMARY	177	1,776	3	1,713			631			615	4,916
INDUSTRIAL	348	744	26	3,232			4,163	69	359	1,240	10,181
CANAL	46	42	4	440			407		21	2,269	3,229
SERVICES	709	1,452	182	17,107			20,227	7,906	21,938	14,579	84,100
FACTORS	2,879	3,481	2,795	49,588							58,744
T_PROD	71	1,332	4	589			308		25	64	2,393
S		-84	-34	-154							-273
TL	71	162	157	3,185							3,575
TGMI	2	1	2	44							49
TK	166	189		2,142							2,497
T_HOG							400				400
HOUSEHOLDS					48,905			4,448			53,353
GOV					4,421	8,641					13,062
INV							22,915	2,742			25,657
IMPORTS	449	1,086	90	6,215	5,418		9,335		3,313	8,835	34,740
BNI							-5,034	-2,103		7,137	0
GPV	4,916	10,181	3,229	84,100	58,744	8,641	53,353	13,062	25,657	34,740	0

Source: Own work based on INEC, MEF and DGI.

Note: This is a simplified version of the 2019 Panama SAM, for presentation purposes only. The full-extent SAM is available within complementary documents.

Note: Factors contains: (i) Labor, (ii) Mixed gross income (GMI), (iii) Capital, and (iv) Public capital. TP: Taxes on products. S: Subsidies. TL: Taxes on labor. TGMI: Taxes on GMI. TK: Taxes on capital. Gov: Government. Inv: Investment. GPV: Gross production value. BNI: Superavit/deficit.

Satellite Account of Employment for Panama 2019

In order to capture the Canal´s impact on employment, it is necessary to complement the SAM with a SAE. This additional matrix should be consistent with the SAM in terms of sector disaggregation and the base year for data sources. In order to construct this vector we have used various databases, summarized in the following figure.

Figure 3: Databases used to construct the Satellite Account of Employment for Panama 2019.

Database	Source	Year
Labor Market Survey	INEC	2019
National Economic Census		2011
Panama Canal	ACP	2019

Source: Own elaboration.

For the 2019 Panama SAE, the Labor Market Survey for 2019 provided by INEC (21 main activities) and the National Economic Census of 2011 (employment information at 4-digit of activity to reach the 28-sectors disaggregation of the SAM particularly to open the Manufacturing industry sectors, the Transport & Storage and Administrative and support service activities) were considered as official data. Additionally, the Authorities of the Panama Canal supplied valuable information about employment in the Canal (9,575 total jobs), which is mainly in the public sector, composed of male employees older than 24 years old and with university degree or vocational formation background. Data sources and raw data for employment is presented in Annex A 4.

In addition to the number of jobs by sector, the SAE also contains qualitative information about occupational categories, sex, age[12], and educational background. Figure 4 indicates the employment categories of Panama´s 2019 SAE.

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[12] The age threshold was chosen following the "youth employment" definition provided by the ILO (2022). Specifically, youth employment involves workers between 16 and 24 years of age.

Figure 4. Employment categories included in the 2019 SAE for Panama

Occupational Dissagregation	Sex	Age	Educational Backgroung
-Public sector worker -Private sector worker -Independent worker -Manager -Family worker	-Male -Female	-Up to 24 years of age -Older that 24 years of age	-No education -Only primary education (complete and incomplete) [1] -Only secondary education (complete and incomplete) [1] -Tertiary education -University education -Vocational [2]

[1] The database available did not provide enough information to distinguish between a completed primary and secondary education and an incomplete one.

[2] This type of education refers to people who received technical skills such as carpentry, plumbing, culinary arts, etc.

Source: Own elaboration

Some methodological issues should be noted. First, the methodology employed combines data from different years. Specifically, we combine the National Economic Census (NEC) of 2011 with the Labor Market Survey 2019 to disaggregate employment in the Manufacturing Industries as well as in Transportation & Storage. One of the main disadvantages of this approach is relying on outdated information. Since the NEC 2011 does not provide disaggregated data about occupational category, age and educational background, the structures of the aggregated sectors were applied to construct the final version of the SAE.

Total employment in 2019 was 1,950,025 jobs. Figure 5 shows the sectoral decomposition of employment.

Figure 5. Sectoral participation in the overall employment. Year 2019.
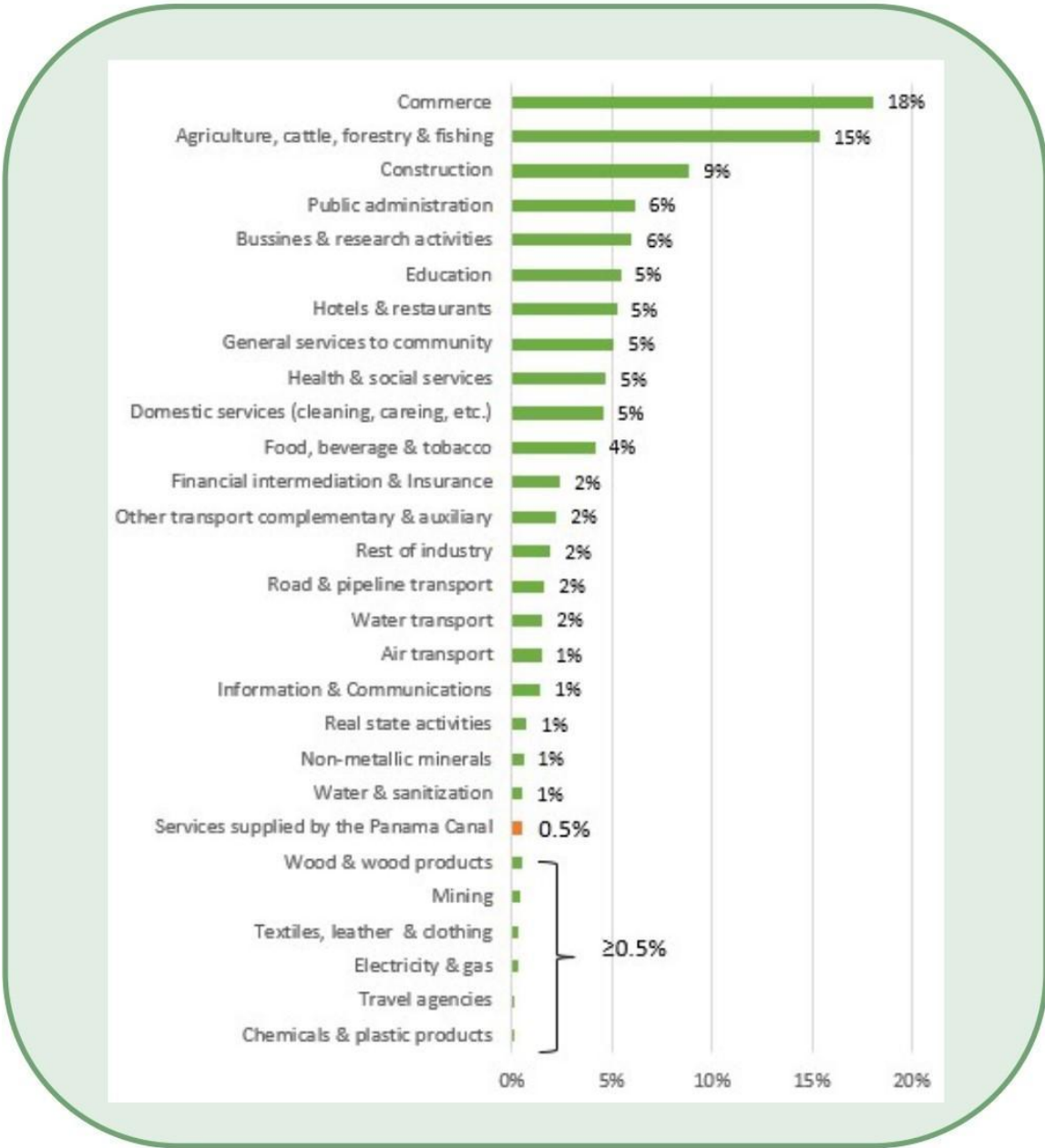
Source: Own elaboration using data form INEC and the Canal Authority.

Commerce and the primary sectors account for the largest share in overall employment, with a participation of 18% and 15%, respectively. By contrast, Services supplied by the Panama Canal only represent 0.5% of total employment in the country. Even though the Canals' participation may appear low, it is higher than other industrial and primary activities such as Wood & wood products; Mining; the Textile industries; Electricity & Gas, Travel agencies and Chemicals & plastic products. This fact can be better appreciated in Figure 5.

Figure 6 disaggregates employment by occupational category, educational background, age and sex, distinguishing the Panamanian economy from the Panama Canal. As shown in the figure, the Panama Canal employment is predominantly composed of Public Sector workers, and workers with university and vocational education. Also, most workers are males (88%) and above 24 years old (96%). In both cases, these shares are above those for the whole economy.

Figure 7. Employment by Occupational Category, Educational Background, Age and Sex for the Panama Canal and the Total Economy. Year 2019.

Occupational Category
In percentages

Panamá Canal: 99% | 1%
Total Economy: 15% | 45% | 31% | 3% | 6%

Legend: Public Sector worker | Private sector worker | Independent worker | Manager | Family worker

Educational Background
In percentages

Panamá Canal: 3% | 54% | 43%
Total Economy: 3% | 21% | 45% | 29% | 1%

Legend: No Education | Only Primary Education | Only Secondary Education | Tertiary | University Education | Vocational

Age
In percentages

Panamá Canal: 4% | 96%
Total Economy: 16% | 84%

Legend: Up to 24 years | Older than 24

Sex
In percentages

Panamá Canal: 88% | 12%
Total Economy: 57% | 43%

Legend: Males | Females

Source: Own elaboration.

Step-by step, procedures regarding the SAE estimation are available in Annex A.4. Additionally, the SAE estimation can also be found there.

3.2. MODEL

Based on the SAM-based IO model constructed for Panama with 28 sectors, 10 households, one public agent (government), and the rest of the world (Round, 2) in 2019, we are able to compute the total contribution of the Panama Canal to the Panamanian economy isolating direct, indirect and induced impacts. Additionally, any exogenous shock (e.g. the Covid-19 pandemic, the potential global demand and concretion of investment projects) that affects the Canal activity also leads to direct, indirect and induced effects over the local economy. As we will explain in the next section, we will model the contribution of the Canal also as a shock, in this case a shock that makes all the Canal´s activity disappear.

As shown in the following scheme (Figure 7), the direct impact of any shock corresponds to the effect on GDP, employment, government revenue, exports, or any other relevant variable, coming from changes in the Canal´s own activity. In the particular case where we estimate the total contribution of the Canal to the Panamanian economy, the direct effect isolates the Canal´s activities contribution. Nevertheless, total impacts of any shock are more comprehensive and also include spillover effects, which are either indirect or induced.

Indirect effects emerge from the intersectoral relationships between the Panama Canal and the rest of sectors that produce goods and services in the economy. Indirect effects operate when the Canal buys goods and services as inputs (purchases), pulling the activity of other sectors. The transaction matrix between sectors is essential in this step to compute the indirect effects through the application of the IO model.

Additionally, the induced effects in the economy can appear through two different channels. Firstly, changes in sectoral economic activity generate households' income variations stemming from changes in labor income. This will, in turn, lead to changes in households' expenditure in the goods and services produced by the different sectors of the economy. Secondly, changes in sectoral economic activity also produce variations in the Canal capital dividends received by the government as its main owner. According to the government budget, capital dividends from the Canal activity are usually allocated to households' transfers and/or to infrastructure investment. The assumption behind the model is that any change in government revenue due to capital dividends from the Canal will be allocated to household transfers as current expenses. Thus, an extra channel for the induced effects is the change in households' expenditure when their income is modified through transfers. Summing up, induced effects come from households' expenditure when their income changes through labor remunerations and/or government transfers.

Since in the 2019 Panama SAM the household account is splitted into 10 household groups according to deciles of income, the induced effects will capture the differences in the income sources and expenditure patterns across deciles.

Figure 7. Decomposition of effects of the Panama Canal impact over the Panama economy
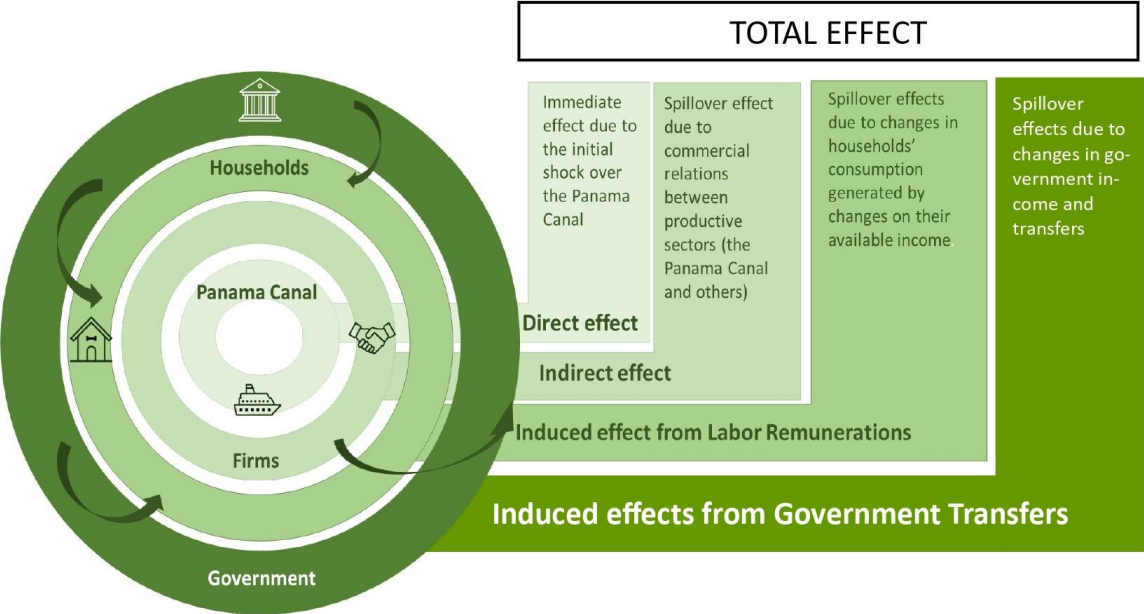
Source: Own elaboration.

Summing up, the decomposition of the total economic contribution of the Panama Canal to the economy will come immediately from its own activity (direct effect), then through the economic interaction (intermediate purchases and sales) with other sectors of the economic (indirect effects), and finally, through additional households' expenditure stemming from labor income and government transfers (induced effects). Different model's configurations and closures allow the decomposition of the total Canal impact into direct, indirect and induced effects shown in Figure 7.

In Annex A.5, we present the mathematical details of the SAM-based demand-driven IO model.

The magnitude of the indirect and induced effects relative to the direct effects defines production and employment multipliers for any direct impact on the Canal´s activity. These multipliers, which depend on the strength of the Canal´s forward and backward linkages with the rest of the

economy, allow characterizing this sector as either *strategic, pushing, key* or *independent* based on Rasmussen categories (Rasmussen, 1956).[13]

A backward-looking (BL) relationship indicates the interconnections between a sector and sectors "upstream" in the production chain. The BL relationships denote the ability of a sector to drag growth in supplying industries when it grows (or similarly when it shrinks). On the contrary, a forward-looking (FL) relationship refers to the interconnections "downstream" the production chain. In our demand-driven IO model, it specifically denotes how a sector is dragged by the growth of industries downstream. It represents the reaction of a sector in response to the increase of overall final demand of the economy.

Table 5 shows these values for the Panama Canal compared with the total economy's average. The Canal's production multipliers are below the economy's average when computing only direct and indirect effects, denoting that the Canal has little drag backwards and is weakly dragged forward by the interaction with the rest of the economic sectors. These characteristics of the Canal within the production chain are consistent with the definition of an *independent sector* according to Rasmussen (1956).

Table 5. Backward and forward relationships for the Panama Canal in contrast with the Economy's average. Year 2019.

	Direct & Indirect effects only		Direct, Indirect & Induced effects	
Sector	BL	FL	BL	FL
Panama Canal	1.09	1.26	1.57	1.34
Economy's average	1.38	1.38	1.55	1.55

Source: Own elaboration.

Additionally, Table 6 contrasts the employment multipliers for the Panama Canal with those of the economy's average. These indicators show the amount of job positions created for every new unit of final demand. In this case, the estimates show that the employment multipliers of the Canal

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[13] Rasmussen proposes a four-category classification according to the results of both indicators: *key sectors* having an above-average drag with strong forward and backward linkages; *strategic sectors* having little effect on the rest of the sectors but highly affected by them; *pushing sectors*, which significantly affect the rest of the sectors and *independent sectors*, which have little drag both backward and forward in the chain. So, it would be interesting to identify the role of the Panama Canal for the Panamanian economy.

surpass the economy's average when analyzing the most comprehensive effects (direct, indirect and induced effects). In other words, the induced effects of a given shock upon the Canal significantly increases employment compared to direct & indirect effects only. The reason why the employment multipliers of the Canal are above the average of the rest of the economy is mainly due to the fact that direct employment requirements for the Canal are low (2.97 workers per unit of output).[14] In contrast, the total labor requirements generated by the Canal are equivalent to 15.7 workers per unit of output.[15] Hence, the employment multiplier of the Canal considering the three effects is equivalent to 5.3.

Table 6. Employment multipliers for the Panama Canal in contrast with the economy's average. Year 2019.

Sector	With direct & indirect effects only	With direct, indirect & induced effects
Panama Canal	1.50	5.30
Economy's average	1.73	2.13

Source: Own elaboration.

In the Annex of this document, the production and employment multipliers can be found for the 28 sectors of the economy.

3.3. DESIGN OF SIMULATION SCENARIOS

Equipped with the data (SAM and SAE) and the calibrated IO model, and having characterized the type of interconnection of the Canal with the rest of the economy and with the world, the next task is to use this toolkit to simulate the effect of different shocks to the Canal´s activity under relevant alternate scenarios.

The first scenario assumes the total removal of all activity of the Canal (hypothetical extraction method). Modeling this hypothetical shock is intended to capture the overall impact of the Canal by computing its direct, indirect and induced contribution to the Panama economy.

The second scenario concerns the Covid-19 pandemic. Since we already know the real overall impact of the pandemic on the Panamanian economy, the main purpose of simulating this scenario is to disentangle the specific impact of the pandemic that has operated through the activity of the Canal. Based on the observed effect of the pandemic on the Canal´s activity we can also isolate the indirect and induced effects of that shock over national and sectoral value-added, employment and government revenue.

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[14] In the case of the Canal, for every unit of output produced, 2.97 workers are needed. As a reference, the economy's average number of workers per unit of output produced is 35.47.

[15] Total labor requirements from the Canal are high in the Primary, Commerce and service sectors.

The third scenario is built upon the ACP projected increase in demand of the Panama Canal services until 2030. The focus of this exercise is on the Panama Canal activity and then, the consequences over the Panamanian socio-economic variables due to spillover effects.

The fourth scenario concerns the simulation of an investment project related to the Canal. Based on the ACP annual reports, we simulate the effects of a specific infrastructure investment project for water management. Other similar infrastructure investment projects could be run by the ACP and the IDB teams by following the same design and simulation methodology in this exercise.

In addition to the methodology already described, simulation exercises require additional information to parametrize the magnitude and transmission channels of the shocks. Next, we detail the assumptions and the data considered for each of these four scenarios.

Hypothetical Extraction Method

In order to compute the direct and indirect contributions of the Panama Canal to the economy we applied the so-called Hypothetical Extraction Method. This method is designed to quantify the relevance of one specific sector in the economy. In order to do so, the sector is "extracted" from the economy to study the repercussions in terms of production and value added.

This method was first developed by Miller & Lahr (2001) and later extended by Dietzenbacher & Lahr (2013). Based on an IO model, it evaluates what would happen to the economy if one particular sector became inoperable. Some specific applications can be found in Guerra & Sancho (2010), who study the Spanish energy sector; Yuan, et al. (2013) in the Chinese manufacturing sector, and Dietzenbacher, van Burken, & Kondo (2019) for the U.S. car industry.

From a technical standpoint, the extraction method consists in removing the pertinent transactions (both purchases and sales) from a specific sector to later run the model and quantify the differences with respect to a "business-as-usual" model (i.e. with no extraction).

In the context of this project, we extract all components in the production function of the services supplied by the Panama Canal from the overall economy and all sales that the Canal does to the intermediate and final demand (domestic and exports). It allows measuring its direct and indirect contributions to the economy according to data of the base year. Moreover, it is expected that induced effects generated by the Canal dividends to the government will be larger than the ones obtained from households labor income change, since the government's income from the Canal is much more significant than households' income in 2019, our base year of calibration for the model.[16]

A technical description of this methodology can be found in section A5 from the Annexes.

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[16] Labor remunerations from the Canal to households were 641 million balboas in 2019 while the Canal transfers to the Government (dividends and fees collection) equaled 1,792 million balboas during that year.

Covid-19 impact through the Panama Canal activity

The purpose of this scenario is to evaluate the impact of the Covid-19 pandemic and the isolation measures implemented locally and globally over the Panama Canal and the rest of the country's economy.

Properly evaluating the impact of the Covid-19 pandemic over the Panama Canal required the use of monthly data on the Canal´s activity due to the fact that production and activity significantly fluctuated within the year 2020 due to internal lockdowns as well as lockdowns and logistics disruptions in other countries. The required monthly data was provided by the ACP.

It is also important to point out that this information was requested both for 2020 and 2019 so that the direct impact of the pandemic over the Canal could be measured as the difference between the monthly activity levels in both years. The following table shows the information provided by the ACP. The variable considered in the analysis as a measure of the Canal´s activity is Tons Canal de Panamá/Sistema Universal de Arqueo de Buques (Tons CP/SUAB). It is a measure of the loading capacity of a vessel and is the one that is used to charge fees.

Table 7: Thousand Tons CP/SUAB transited through the Panama Canal in 2019 and 2020.

Year	January	February	March	April	May	June	July	August	September	October	November	December	Total
2019	40,688	36,018	38,865	37,373	40,541	37,908	39,801	42,519	39,030	45,006	44,082	44,493	486,322
2020	44,979	39,105	40,744	37,514	34,331	31,246	36,554	39,569	37,535	44,269	44,156	45,711	475,714
Difference	4,291	3,088	1,879	141	-6,210	-6,662	-3,247	-2,950	-1,495	-736	74	1,218	-10,609

Source: ACP - Gerencia de Análisis de Mercado - Oficina de Asuntos Corporativos.
Note: the 13th March 2020 the Panamanian government declared a state of emergency and the lockdown with restriction for people movement on the 24th March same year.

By comparing 2019 and 2020 month by month, since March 2020 we start appreciating in Table 7 a sudden slowdown in transit. This reduction is due to the national lockdown that took place at the start of the pandemic and only started to consistently reverse in October 2020. The drop in the Canal´s activity was larger (not shown) in the segments of vehicles carriers (-21%), natural gas liquified (-15%), and passengers (-10%), the latter as cruise lines suspended their operations in early spring. By contrast, other demand segments of Canal services (bulk cargo for grains and raw materials for the chemical industry) continued growing, which helped mitigate the overall negative impact of the pandemic (ACP, 2021).

Table 8 converts tons CP/SUAB into balboas, which is the unit of measurement in our IO model. The first line of the table measures the monthly Covid-19 impact in thousand CP/SUAB (it just reproduces the last line of Table 7). The second row translates this impact into million balboas (the "quantity shock" in our IO-model terminology). The third line quantifies the impact of the shock

relative to the existing activity[17]. For instance, the shock in May 2020 represents 1.28% of the Canal production in 2019. In order to introduce these shocks in the IO model we follow a similar methodological approach as in the Hypothetical Extraction exercise where we perform a partial extraction equivalent that only takes into account the reduction percentage experienced each month from May to December of 2020.

Table 8: Difference between 2019 and 2020 thousand tons and equivalent Quantity shock.

	May	June	July	August	September	October	November	December
Difference (In thousand tons CP/SUAB)	-6,210	-6,662	-3,247	-2,950	-1,495	-736	74	1,218
Quantity Shock (in million balboas)	-41.23	-44.23	-21.56	-19.58	-9.93	-4.89	0.49	8.09
Reduction in terms of the Canal production in 2019	-1,28%	-1,37%	-0,67%	-0,61%	-0,31%	-0,15%	0,02%	0,25%

Source: Own elaboration based on ACP - Gerencia de Análisis de Mercado - Oficina de Asuntos Corporativos.

The direct effects of the Covid-19 shock on the Canal activity are those presented in Table 8. Since the direct effects of the Covid-19 pandemic on the Canal are negative, it would be expected that indirect effects over the rest of sectors follow the same dynamic. Additionally, from May 2020 the induced effects would be negative as well. It is expected that labor remuneration (i.e. households' income) in the Canal sector will be reduced and thus households' expenditure. A similar logic can be applied for the government: a reduction in the Canal's activity will mean less dividends and fee collection transferred by the Canal to the State. Therefore, the government's transfers to households will be reduced as well as its expenditure. For instance, induced effects that come from lower Canal's dividends spent in government's transfers to households would be greater than those from lower labor income for households.

The following figure provides a basic scheme of the main impact channels of this shock in the simulation.

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[17] Even though the direct shock is carried out in millions of balboas, we assume that prices remain constant while allowing for quantities to vary.

Figure 8 : Scheme of impact channels (Covid-19 pandemic).

Direct Effects

Activity variations in the Canal due to the COVID-19 pandemic

Indirect Effects

Activity variation in other sectors of the economy due to interindustry relations with the Canal

Induced Effects

-Variations in household consumption due to variations in their income

-Variations in household consumption due to variations in government transfers
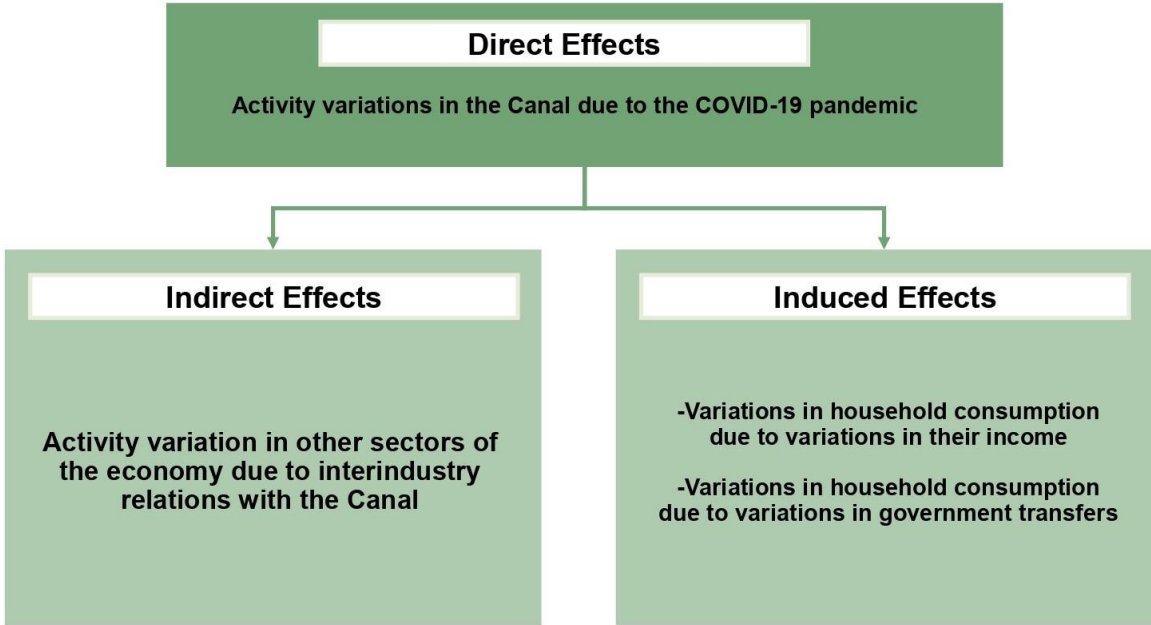
Source: Own elaboration.

Projected growth in demand for the Canal services

In this scenario we simulate the growth in demand for Canal services by using the ACP projections about the evolution of world trade. Thus, we can assess how global trends in trade flows may affect the activity of the Canal and the Panamanian economy up to 2030.

Since we are using a quantity-based model, we need a measure of how the demand for Canal services in real terms will vary over the years. In the context of the Panama Canal, the quantity demanded can be interpreted as the amount of tons that will transit the Canal per year paying fees. This information was provided by the ACP and is presented in Table 9. As it can be appreciated, we have used the variable CP/SUAB 1997 that accounts for the amount of tons that transit the Canal yearly[18]. Additionally, this variable contains the tons of all vessels that pay fees in other units.

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[18] We have excluded from the analysis sweet water and energy charges. The reason for this is the fact that these variables were expressed in values instead of quantities. As a consequence, we were unable to differentiate the quantity variation from the price variations.

Table 9: Thousand Tons CP/SUAB 1997 projected in the Canal up to 2030 and associated quantity shock.

Concept	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Container ship	164,803	166,332	184,312	202,994	196,498	199,457	205,949	211,208	216,845	221,684	226,498	232,050
Bulk carriers	76,518	80,950	90,056	83,814	77,697	78,968	79,249	79,794	80,162	80,529	80,975	81,353
Vehicle carrier/RoRos	53,181	41,138	47,549	4,4971	46,283	46,716	47,149	47,291	47,865	48,439	49,014	49,588
Tankers	22,561	67,447	63,427	67,867	67,710	70,440	74,697	75,514	76,983	79,102	81,095	82,596
Chemical tankers	44,353	1,835	1,658	1,568	1,766	1,765	1,619	1,724	1,805	1,845	1,886	1,933
Gas tankers	37,790	44,606	52,827	55,454	48,642	49,424	50,236	49,733	51,453	53,037	54,671	56,167
GNL	43,014	46,410	61,005	46,316	45,966	47,984	60,356	55,956	56,412	61,792	69,719	76,608
Refrigerators	6,553	6,224	5,782	5,659	5,365	5,060	4,926	4,661	4,306	3,934	3,881	3,854
Passengers	9,941	10,102	996	7,236	11,758	10,777	107,68	10,876	11,075	11,227	11,276	11,419
General Cargo	8,540	8,135	6,412	7,074	6,374	6,256	6,554	4,835	4,746	4,652	4,555	4,547
Others	1,848	1,594	2,424	1,700	1,995	2,090	2,093	2,033	2,046	2,059	2,071	2,084
Grand Total high draft	469,102	474,773	516,447	524,652	510,052	518,937	543,596	543,626	553,698	568,300	585,639	602,199
Small	547	414	297	366	288	291	294	297	300	303	307	310
TOTAL	469,650	475,187	516,744	525,019	510,340	519,228	543,890	543,922	553,998	568,603	585,946	602,509
Quantity Shock (in million balboas)				381	280	341	510	511	580	680	800	913

Source: Own elaboration based on ACP - Gerencia de Análisis de Mercado - Oficina de Asuntos Corporativos.

The values observed in Table 9 were constructed by the ACP based on different world factors affecting maritime commerce in the coming decade. Some of these key variables/assumptions for projected growth in demand for the Canal services include the current Ukraine-Russia war, new logistics after the Covid-19 pandemic, future environmental regulations (i.e. GHG reductions commitments) and potential changes in production and consumption patterns worldwide.

These values correspond to unrestricted projections that do not take into account the installed capacity limitations of the Canal. Nonetheless, when compared with the restricted projections for 2030, there are no significant differences that justify for the moment a large investment in a new Canal expansion (see Figure 9).

Figure 9 : Restricted and unrestricted ACP projections of tons CP/SUAB that transit the Canal yearly (2022-2030).
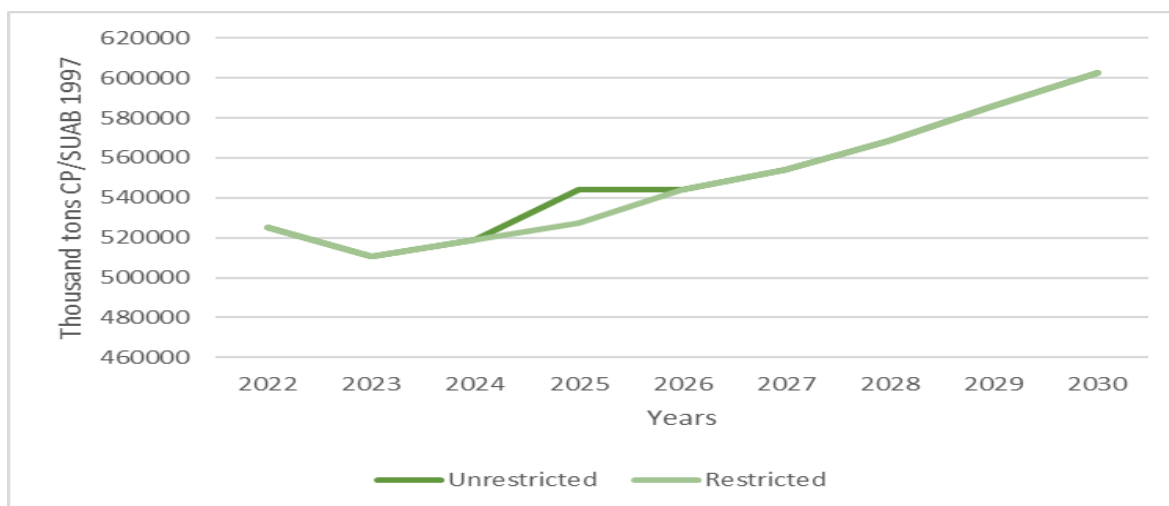
Source: ACP - Gerencia de Análisis de Mercado - Oficina de Asuntos Corporativos.

To determine the magnitude of the demand shock in this simulation exercise, we estimated a "quantity shock" (expressed in million balboas) proportional to the expected increment in total tons transited through the Canal each year. These values are displayed in the last row of Table 9 and must be interpreted as the direct effects of the shock to the Canal. Since the yearly direct shocks are positive, the indirect effects over all the productive structure of Panama should be expected to also be positive. Finally, the induced effects from both households' expenditure (due to variations in their labor remuneration and government transfers) are expected to increase, pushing the demand of other sectors' production.

The following figure provides a basic scheme of the main impact channels of this shock in the simulation.

Figure 10: Scheme of impact channels (Growth in world trade).

Direct Effects

Increase in quantity demanded of production of the Canal

Indirect Effects

Increase in production of other sectors in the economy due to interindustry relations with the Canal

Induced Effects

-Increase in household consumption due to variations in their income

-Variations in household consumption due to variations in government transfers
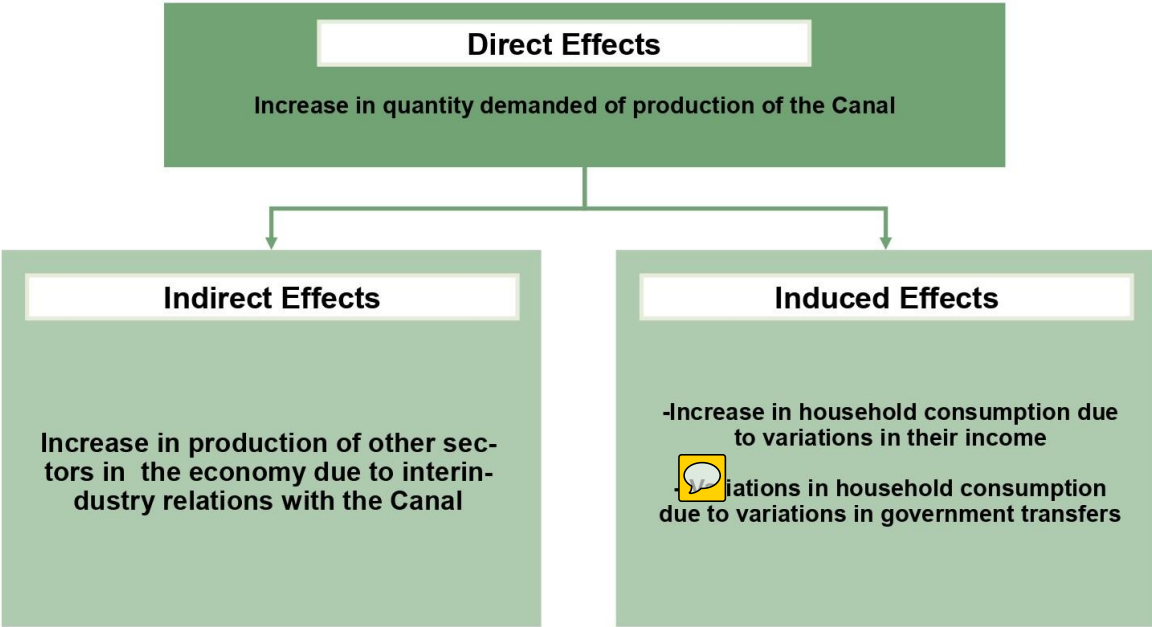
Source: Own elaboration.

Infrastructure Investments projected in the Panama Canal: water management project

In September 2020, the Panama Canal published the specifications for the prequalification of those interested in participating as proponents of the tender, for the design, construction and implementation of an optimized water resource management system. This system would ensure the availability of water for human consumption and for the Canal´s transit operations, as well as

favoring the competitiveness of this interoceanic route in terms of allegiance to sustainable development and socio-environmental management.

According to the information provided by the ACP, the total cost of this project is 1,880 million balboas. Its components are detailed in Table 10.

Table 10: Total project cost for water management infrastructure project-In million balboas

Concept	Amount
Water resource program administration	$ 65
Contingencies	$ 15
Water resource administration	$ 1,800
Total	**$1,880**

Source: ACP (2022b).

The simulation of the impact of an infrastructure project should be divided into two phases. First, a "construction phase" should simulate the effects on the economy of the construction of the project, where some productive sectors are more heavily involved such as Wood & Wood products. Second, the "operational phase" should simulate the effects on the economy once the infrastructure project begins operations. Here, the positive effects may come from, for instance, productivity improvement in the Canal activities (transit and water provision to the communities) and even an increase in the intermediate demand of the Canal. These ideas are summarized in the following figure.

Figure 11: Scheme of Investment in a Water Management System.
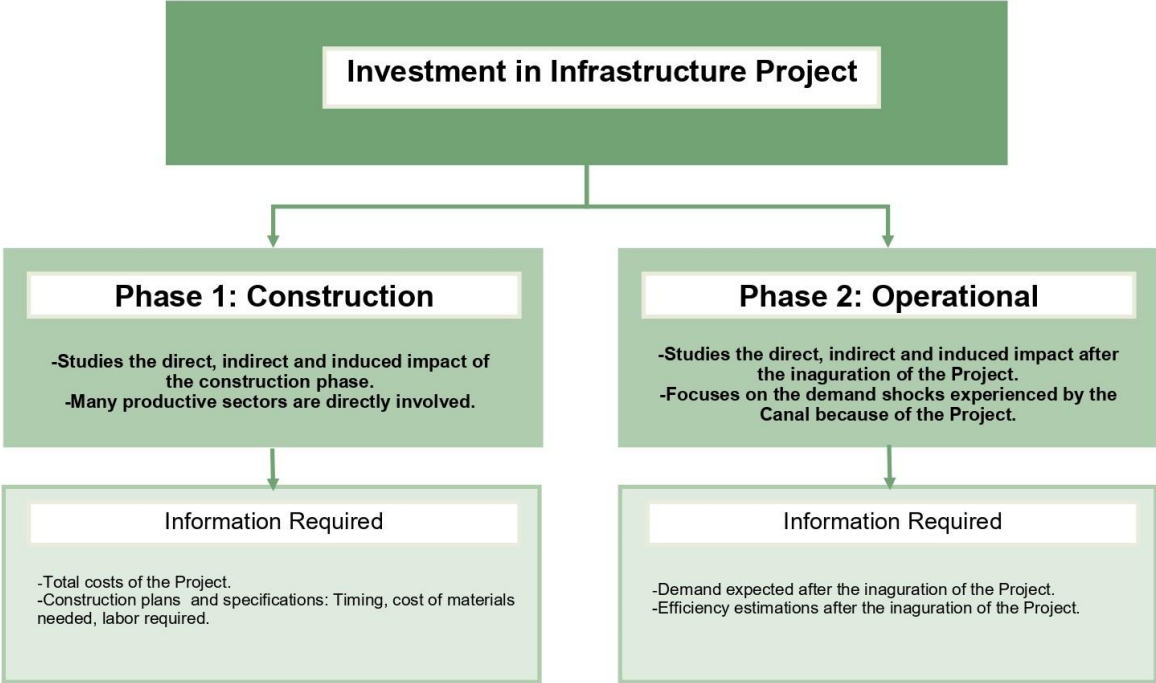
Source: Own elaboration.

Simulating each of the two phases requires different specific information and data. The construction phase requires information on the different inputs and the labor required to construct the infrastructure project, as well as total cost of the project. The simulation of the operational phase requires data about the potential impact on the Canal production once the construction phase is accomplished. Given the current lack of detailed information from the ACP about the expected improvements of the project during the operation phase, in this simulation we will only consider the construction phase´s impact.

To simulate the impact of the construction phase of this project, we use information provided by the ACP based on a Sample project. This information is presented in the following table.

Table 11: Construction structure for a Sample project for Water networks-in percentages and million balboas.

	Structure	Direct Shock
Agriculture, cattle, forestry & fishing	0%	
Mining	0%	
Food, beverage & tobacco	0%	
Textiles, leather & clothing	0%	
Wood & wood products	0%	$ 4.68
Chemicals & plastic products	0%	
Non-metallic minerals	4%	$ 74.28
Rest of industry	19%	$ 349.25
Electricity & gas	0%	
Water & sanitization	0%	
Construction	0%	
Commerce	5%	$ 86.20
Hotels & restaurants	0%	
Road & pipeline transport	0%	
Water transport	0%	
Air transport	0%	
Travel agencies	0%	
Other transport complementary & auxiliary	0%	
Services supplied by the Panama Canal	0%	
Information & Communications	0%	
Financial intermediation & Insurance	3%	$57.81
Real estate activities	2%	$ 43.13
Business & research activities	0%	
Education	0%	
Health & social services	0%	
Public administration	0%	
General services to community	0%	
Domestic services (cleaning, caring, etc.)	0%	
Labor	19%	$353.36
Private Capital	17%	$328.10
Product taxes	22%	$417.94
Labor Taxes	8%	$ 141.34
Imports	1%	$23.92
Total	**100%**	**$ 1.880.00**

Source: own elaboration based on World Bank (2021).

It is noteworthy that this IO model can be used to assess the impact of the operational phase once the detailed information of this phase becomes available. Additionally, other infrastructure simulations (e.g., an investment of 2,400 million balboas in power generation using renewable sources, electric and hybrid vehicles used in the activity of the Canal mentioned in the ACP Annual Report 2021) can be performed following the same methodology.

4. SIMULATION RESULTS

4.1. Contribution of the Panama Canal to the national economy

Figure 12 shows the IO model estimation of direct, indirect and induced effects generated by the existence of the Panama Canal on the Panamanian economy. Specifically, the variables presented are GDP, Government Revenue[19] and total Exports. Additionally, Figure 8 decomposes induced effects in two terms. On the one hand, "Induced effects from labor remunerations" show the impact of changes in labor remunerations received by households. On the other hand, "Induced effects from government transfers to households" show the impact of changes in household expenditures in response to increased reception of government transfers.

The total effect of the Panama Canal is equivalent to 4,102 million balboas of 2019, which is 6.16% of Panama's GDP. Figure 8 shows that 71% of this total can be attributed to the direct effect, being 2,.925 million balboas of 2019 the direct contribution made by the Canal. On a similar vein, only 5% of the total effect is indirect, that is the impact of the Canal on its suppliers of goods and services. This result stems from the weak backward and forward linkages of the Panama Canal with other sectors discussed in previous sections. Finally, induced effects account for the remaining 24% of the total effect. Of the total induced effects, one third are stemming from the labor remunerations of Canal employment, while the remaining two thirds are stemming from the government transfers allowed for by the Canal´s benefits.

The relative importance of the induced effects is consistent with the importance of the Canal over total government revenue. As displayed in Figure 8, the Canal contributes 19.9% of this total. In particular, most of this revenue comes from the direct effect (1,922 million balboas) which is composed by the dividends transferred from the Canal to the Government (1,792 million balboas) and the taxes paid by the Canal (129 million balboas). These results support the idea that the Canal plays a significant role in financing government expenditure.

Finally, the Canal contributes to 13.8% of Panama's total exports. From a composition point of view, 88% of the total contribution are direct exports from the Canal. As far as the indirect effects are concerned, these are mainly focused on the Commerce and Business & research activity sectors. Induced effects are more significant and mainly affect exports of the Commerce and Financial sectors.

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[19] Government revenue consists of total tax collection and the dividend and revenues transferred by different sectors to the government (including the Panama Canal).

Figure 12. Direct , Indirect and Induced effects of the Panama Canal in the Panamanian economy-2019.

Gross Domestic Product
(In million balboas)

			677	4.102
2.925	191	310	16%	100%
71%	5%	8%		

Direct Effect | Indirect Effect | Induced Effect from labor remuneration | Induced Effect from govern-ment transfers | Total Effect

6.16%

Government Revenue
(In million balboas)

			90	2.084
1.922	32	41	4%	100%
92%	2%	2%		

Direct Effect | Indirect Effect | Induced Effect from labor remuneration | Induced Effect from govern-ment transfers | Total Effect

19.9%

Exports
(In million balboas)

			175	2.577
2.269	52	80	7%	100%
88%	2%	3%		

Direct Effect | Indirect Effect | Induced Effect from labor remuneration | Induced Effect from govern-ment transfers | Total Effect

13.8%

Source: Own elaboration.

Figure 13 shows the role the Panama Canal plays in employment creation. Even though the direct contribution of the Canal to total employment is 0.5% (see Figure 5), simulation results indicate that the Canal contributes 2.58% to total job positions in Panama. In the case of employment creation, induced effects are responsible for the largest impact component, even larger than the direct effects. This reflects the effect of households´ expenditure from labor income and government transfers on labor intensive sectors such as Business and research activities; Commerce; Education; Water and sanitation; Information and Communications and the Financial sectors.[20] This phenomenon is connected with the high employment multiplier presented in section 3.3.

Figure 13. Direct ,and Indirect and Induced effects of the Panama Canal in total labor-2019.
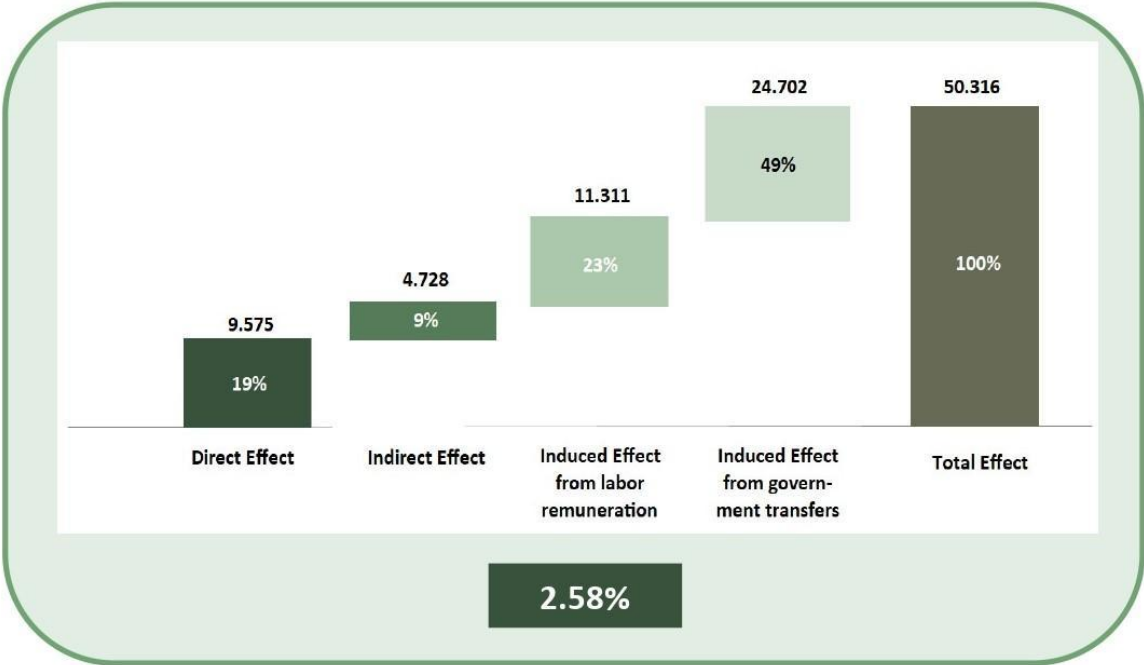
Source: Own elaboration.

Figure 14 delves deeper into labor creation effects. From a sectoral point of view, the main positive total effects generated by the existence of the Canal are concentrated in the service sectors of the economy. On the contrary, job creation in the manufacturing sectors is low.

Overall, the existence of the Canal creates male dominated job positions. However, it should be noted that 28.16% of the total male job positions created are directly attributed to the Canal. In contrast, when it comes to female job positions, only 5.63% of the 20.3 thousand new jobs are directly employed by the Canal.

Additionally, the Canal creates primarily jobs positions occupied by older workers. Specifically, only 14% of workers are less than 24 years of age.

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[20] Sectorial results are available in Table A7.1 from the Annexes.

Figure 14 also provides information connected to job composition according to occupational categories and educational background. 23% of new jobs belong to the public sector while 41% are private sector workers. These numbers suggest the existence of the Canal in the Panamanian economy generates 4.31% of total public sector jobs and 2.34% of private sector ones. Specifically, most of these job positions belong to the Business & Research activities sector. When it comes to independent workers, managers, and family workers, these can be attributed to indirect and induced effects.

Finally, 32% of employment created by the Canal corresponds to university educated workers. In addition, 9% are vocational workers. It can also be seen that 34% of total job creation corresponds to people with secondary education. Job creation for workers with no education or tertiary education is non-significant.

Figure 14. Sectorial effects of the Canal on the Panamanian Economy. Employment composition.

Sectorial Labor Effects of the Panama Canal
In thousand job positions

Sector	Value
Primary	10
Manufacturing	4
Electricity, Gas and Water	1
Services	26
Panama Canal	10

Employment by Sex
In thousand job positions

Male: 30 (59%)   Female: 20 (41%)

Employment by Age
In thousand job positions

Older than 24: 86% — 43
Up to 24 years: 14% — 7

Employment by Occupational Categories
In thousand job positions

Category	Value	Percent
Public Sector Worker	13	25%
Private Sector Worker	21	41%
Independent worker	12	24%
Manager	1	3%
Family worker	3	7%

Employment by Educational Background

- Vocational -9%
- No education -3%
- Only Primary education -22%
- Only Secondary education -34%
- Tertiary education 0%
- University education -32%

Since our model incorporates different types of households, one issue that must be analyzed is how household income is affected by the presence of the Canal. In this sense, Figure 15 illustrates how much the Canal contributes to total income according to household deciles.

As it can be appreciated, richer households receive higher income from the existence of the Canal. Nonetheless, the percentage contribution of the Canal to every decile is equivalent to 14.66% of their own income in 2019 (base year).

Figure 15. Household income created by the Canal by decile. In million balboas
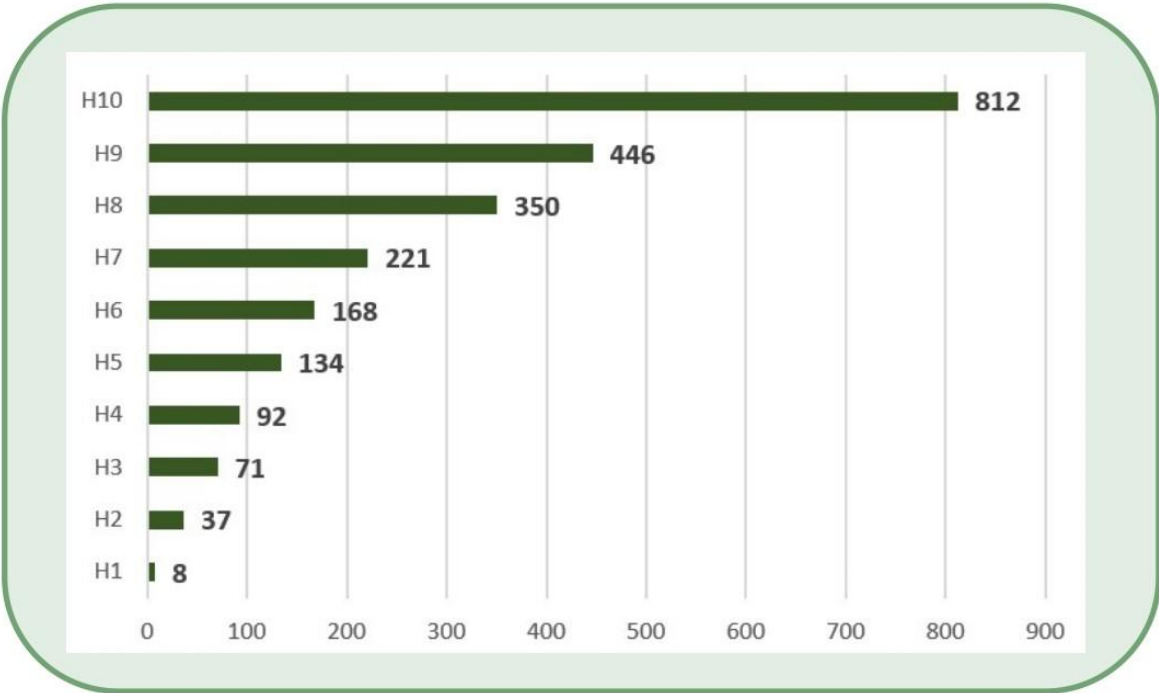
Source: Own elaboration.

Finally, Figure 16 puts into perspective the contribution of the Canal to the aggregated variables with respect to the other 27 sectors of the economy. In order to achieve this, we performed the same Hypothetical Extraction method to each sector of the economy.

As it can be appreciated, the Construction sector is the most relevant when it comes to GDP and Government revenue. On the other hand, the Commerce sector is on the top as far as exports and employment are concerned.

From this final exercise it can be seen that the Panama Canal holds a much more significant role in the economy than the Primary and Manufacturing sectors as far as GDP, government revenue and exports are concerned. By contrast, the jobs contribution of the Canal is minor compared to the Commerce, Construction, Agriculture and Food industry.

Even though other service sectors (e.g., Financial and insurance activities and Real estate activities) may be more important in terms of GDP contribution when compared with the Canal, the latter plays a key role in total government revenue and exports.

Figure 16. Percentage total effects of extracting each sector from the Panamanian economy

Note: Sectors are: 1-Agriculture, Forestry and Fishing; 2-Exploiting of mines and quarries; 3-Food, beverages, and tobacco; 4-Textiles and leather; 5-Wood and paper; 6-Chemicals and plastics; 7-Non-metallic minerals; 8-Other manufacturing industries; 9-Electricity and gas supply; 10-Water treatment and supply; 11-Construction; 12-Commerce; 13-Hotels and restaurants; 14-Transport by land; 15-Aquatic transport; 16-Air transport; 17-Travel agencies; 18-Complementary transport activities; 19-Panama Canal; 20-Mail and

telecommunications; 21-Financial and insurance activities; 22-Real estate activities and rentals;23-Business services; 24-Teaching; 25-Health and social services; 26-Public administration; 27-Community services; 28-Domestic services.

Source: Own elaboration.

More detailed information connected to the sectoral effects the Canal has in the economy is presented in section A.7 of the Annexes.

4.2.   Covid-19 impact on the Panama Canal

Table 12 shows the monthly variations of Panama's GDP given the negative quantitative shocks that happened since May 2020 due to the outbreak of the pandemic. Columns 2 and 3 show the direct and indirect effects of the shock. It can be appreciated that from May up until October both direct and indirect effects are negative, the latter ones less significant. Column 4 shows the induced effects due to variations in labor income. The negative direct shocks in the Canal affect more significantly household labor income thus bringing about a greater induced effect. Such a phenomenon is even more relevant when considering the induced effects due to a variation in the government income due to the Canal's dividends and, consequently, government transfers to households (column 5).

The reason for this result is the fact that one of the Panamanian government's sources of income are the transfers from the Canal of fees collected. If less ships transit the Canal, less fees are collected and, therefore, the Panamanian government's income diminished. This will ultimately negatively affect the transfers received by households from the government.

Table 12: Simulated GDP variation due to the Covid-19 outbreak in 2020 - In million balboas.

Month	Direct Effect	Indirect Effect	Induced Effect from Labor remunerations	Induced Effect from Government transfers	Total Effect
May	-37.3	-5.0	-9.6	-18.3	-70.2
June	-40.1	-5.3	-10.3	-19.6	-75.3
July	-19.5	-2.6	-5.0	-9.6	-36.7
August	-17.7	-2.4	-4.6	-8.7	-33.4
September	-9.0	-1.2	-2.3	-4.4	-16.9
October	-4.4	-0.6	-1.1	-2.2	-8.3
November	0.4	0.1	0.1	0.2	0.8
December	7.3	1.0	1.9	3.6	13.8
Total	-120.3	-16.0	-30.9	-59.0	-226.2
Percentage Variation					-0.34%

In a similar vein, table 13 shows the monthly variations of government revenue from May 2020 to December 2020. In this case, most important variations are due to the direct effects experienced during the months of May and June. Additionally, most of the direct reduction of the government revenue can be attributed to the Canal dividends (93% to be exact). Overall, the total effects reach a 0.93% negative variation in total government revenue. From this total variation, 18% represents a reduction in tax collection in both the Canal and the rest of the sectors of the economy while 82% is attributed to a reduction in dividends from not only the Canal but also other public firms.

Table 13: Simulated Government revenue variation due to the Covid-19 outbreak in 2020 - In million balboas.

Month	Direct Effect	Indirect Effect	Induced Effect from Labor remunerations	Induced Effect from Government transfers	Total Effect
May	-24.54	-0.89	-2.03	-2.71	-30.2
June	-26.32	-0.96	-2.18	-2.90	-32.36
July	-12.83	-0.47	-1.06	-1.42	-15.78
August	-11.66	-0.43	-0.97	-1.29	-14.34
September	-5.91	-0.22	-0.49	-0.59	-7.20
October	-2.91	-0.11	-0.24	-0.32	-3.58
November	0.29	0.01	0.02	0.03	0.36
December	4.81	0.18	0.40	0.54	5.93
Total	-79.05	-2.88	-6.55	-8.66	-97.15
Percentage Variation					-0.93%

Note: Percentage Variation in relation to the SAM 2019 Government Revenue.
Source: Own elaboration.

As for total export variation, Table 14 shows the monthly variation of Panama's exports. Overall, the effects of the pandemic over the Canal end up generating a reduction of 0.66% of Panama's total exports. The most important variations are again focused on May and June of 2020. Like previous variables, direct effects are responsible for a great part of total effects. In this specific case, direct effects constitute 75% of the total reduction in exports.

Table 14: Simulated export variation due to the Covid-19 outbreak in 2020 - In million balboas.

Month	Direct Effect	Indirect Effect	Induced Effect from Labor remunerations	Induced Effect from Government transfers	Total Effect
May	-28.98	-1.41	-3.23	-5.01	-38.6
June	-31.09	-1.51	-3.46	-5.37	-41.43
July	-15.15	-0.74	-1.69	-2.63	-20.21
August	-13.77	-0.67	-1.54	-2.39	-18.36
September	-6.98	-0.34	-0.78	-0.88	-8.98
October	-3.44	-0.17	-0.38	-0.60	-4.59
November	0.35	0.02	0.04	0.06	0.46
December	5.68	0.28	0.64	0.99	7.59
Total	-93.37	-4.54	-10.40	-15.83	-124.14
Percentage Variation					-0.66%

Note: Percentage Variation in relation to the SAM 2019 exports.
Source: Own elaboration.

Figure 17 shows the simulated sectoral participation of the reduction in GDP, government revenue and exports for the Panamanian economy.

As far as GDP is concerned, the biggest negative impact is absorbed by the Canal itself. This is mainly due to the direct effects of the pandemic activity slowdown on the Canal. On a second level, the service sectors are also affected. In this case, the main negative effects are attributed to induced effects due to variations in government transfers on Commerce, Real Estate Activities and Hotels and Restaurants. In the case of the manufacturing sectors, the most significantly affected is the Food, Beverages and Tobacco production. Finally, effects in the Primary sectors as well as in the Energy, Gas & Water sectors are less significant. Detailed results for the direct, indirect and induced effects on each of the 28 sectors are presented on table A8.1 of the Annexes.

When it comes to government revenue, it can be appreciated that most contributions lost are due to the Canal. Again, this is mainly due to the direct effects of the pandemic on the Canal. On a deeper level, this reduction is mainly attributed to a diminution in dividends provided by the Canal to the government. As for the contribution of the Service sectors to the government revenue, the main reductions are attributed to a decrease in tax revenue from the Commerce sector. Finally, there is also a reduction in the tax collection of the Rest of Industry sector due to indirect and induced effects.

Finally, Covid-19 pandemic mainly affected the overall exports in the Canal and service sectors. On the one hand, export reduction in the Canal is due to direct effects. On the other hand, the most

significant export reductions in the service sectors are due to induced effects and concentrated in the Commerce and Financial sectors.

Figure 17: Simulated total sectoral participation of GDP, Government Revenue and Exports variations due to Covid-19 outbreak in 2020 - In million balboas
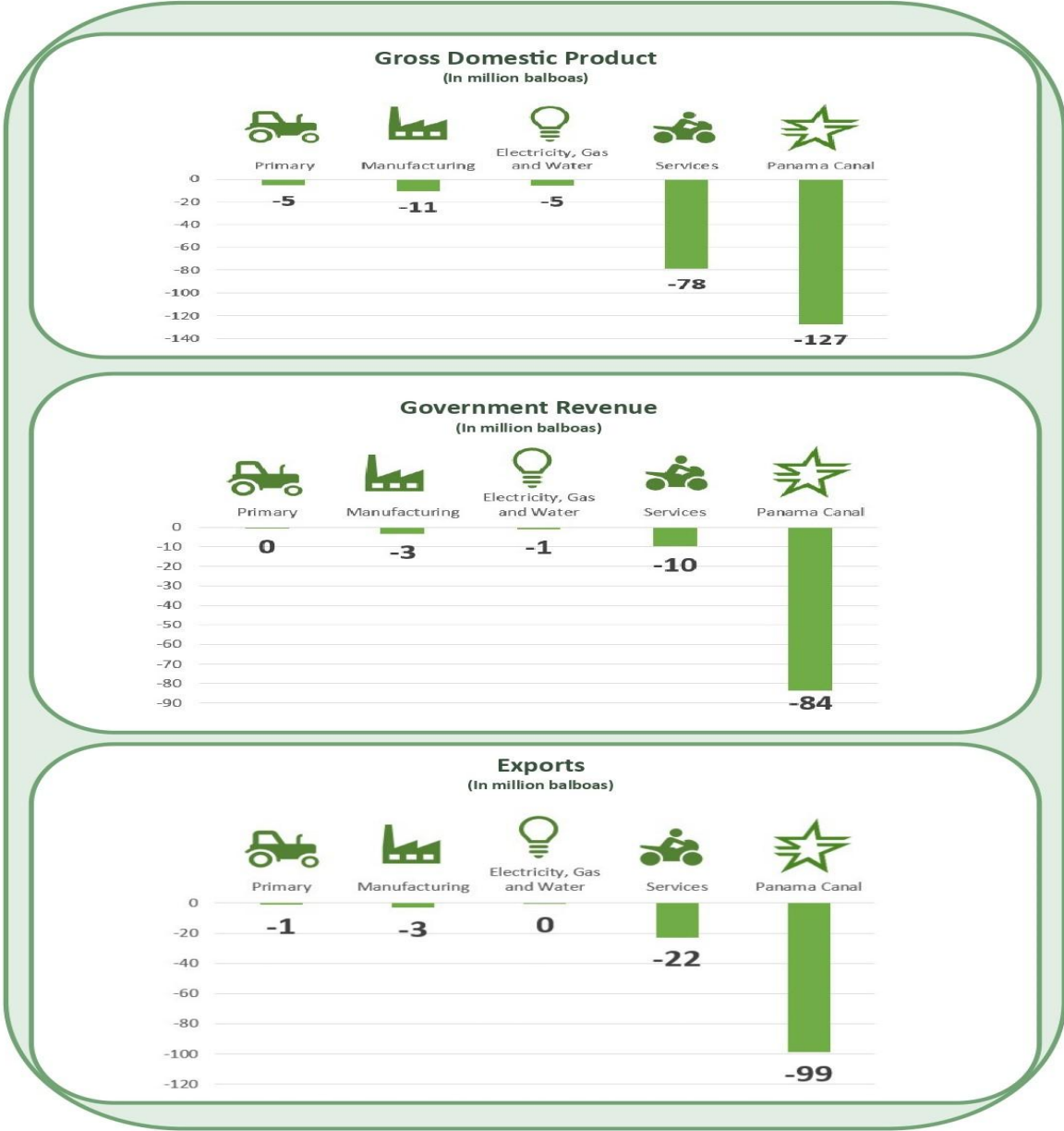
Source: Own elaboration.

It is important to point out a number of assumptions that enable these results and that also help to understand and put them into a perspective compared to what really happened in Panama during the 2020. Firstly, this shock solely focuses on quantities. Consequently, we assume that prices have remained constant over 2020. This assumption is made so as to be able to capture the

pandemic impact in real terms. In other words, what this simulation is trying to answer is the following question: *What were the effects of the pandemic over the Canal and the panamanian economy if prices had remained unchanged?.* Secondly, we also assume that the government revenue and expenditure structure remains the same as 2019. This could be argued as a weak point since it is known that the government's expenditure structures were highly modified amidst the Covid-19 crisis. For these reasons, results for this scenario must be interpreted as the negative effects if the government had not changed its expenditure pattern. If changes in government expenditure patterns during 2020 were to be introduced, specific information regarding executed government budgets during 2020 would be needed.

Table 15 shows the effects on monthly labor. The direct effects obtained from the model indicate that the number of job positions should have diminished in the Canal. In this sense, it is important to point out the correct interpretation of these numbers. The model estimates the changes in labor requirements of each sector. However, institutional regulations of the labor market and other policies that were effectively implemented during 2020 are not incorporated in the shock. Moreover, firms' decisions of keeping most of their employees were taken based on a short-run crisis due to the pandemic and thus, a relatively higher costs of firing for then rehiring their labor resources. For this reason, the negative variations in employment should be interpreted as the labor variations proportional to the reduction in activity given each sector's production function. In other words, labor impact under this scenario only shows a negative scale effect proportional to the GDP impact, and it does not consider the change in the work modality, from face-to-face to teleworking.

Nevertheless, this technological change made it possible to cushion the fall in the added value of many sectors with a high service component, such as that of the Canal and the Financial Services. For instance, it is important to note that the teleworking modality in the Canal reached 10% and 11% of all employees during 3 months from June 2020 and no firing was executed (i.e., only some vacation periods for some staff with the minimum staff in-situ for operational tasks in transit) according to the consolidated report the ACP (Vicepresidencia de Capital Humano). In short we can say that the estimated negative labor impact in this pandemic scenario was in fact partially compensated with a quick reaction of sectors in implementing mechanisms of adaptation to sanitarily and mobility restriction, such as the working modality.

Similar to what happened with the GDP, induced effects due to a reduction in household and government expenditure are the most significant.

Table 15: Simulated labor variation due to the Covid-19 outbreak in 2020 - In job positions.

Month	Direct Effect	Indirect Effect	Induced Effect from Labor remunerations	Induced Effect from Government transfers	Total Effect
May	-122	-121	-300	-649	-1,192
June	-131	-129	-322	-696	-1,278
July	-64	-63	-157	-340	-625
August	-58	-57	-143	-309	-568
September	-29	-29	-73	-157	-288
October	-14	-14	-36	-77	-142
November	1	1	4	8	14
December	24	24	59	128	236
Total	-394	-389	-968	-2,093	-3,844
Percentage Variation					-0.20%

Note: Percentage Variation in relation to the SAE 2019 employment.
Source: Own elaboration.

As far as job composition is concerned, Figure 18 present the total simulated variations of employment according to sex, age, occupational categories and educational background. Results indicate that employment reduction would have mainly affected male job positions above 24 years of age. Additionally, this reduction would have also focused on private sector workers with secondary education. As it was previously mentioned, such employment reductions estimated by this Covid-19 simulation did not occur in fact. This was prevented due to institutional regulations and potential greater firing and rehiring costs for firms in the short-run.

Figure 18: Simulated employment variations by sex, age, occupational category and educational background due to the Covid-19 outbreak of 2020.
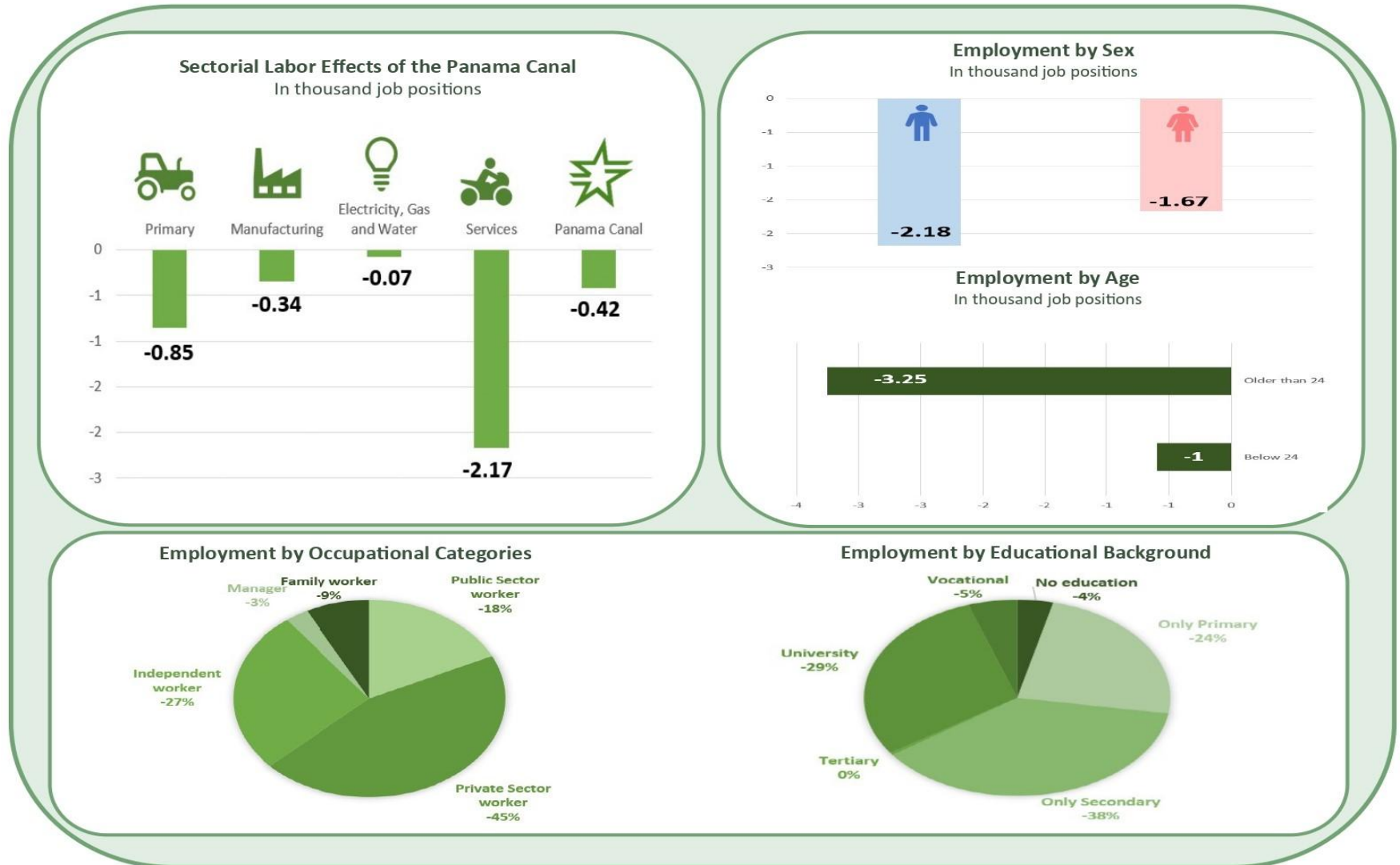
Source: Own elaboration.

On a final note, Figure 19 shows the simulated effects on income for the 10 deciles. Results suggest that household income would have been reduced by 1.2% solely by the effects of the pandemic in the Panama Canal.

It is important to point out that, as it was previously mentioned, this simulation exercise does not incorporate the role public policies played during the 2020 pandemic. Social policies implemented by the government (such as the "Solidarity Bond") might have attenuated this impact on households, specifically in the lower income deciles.

Figure 19. Simulated household income variation due to the COVID-19 outbreak of 2020- In million balboas.
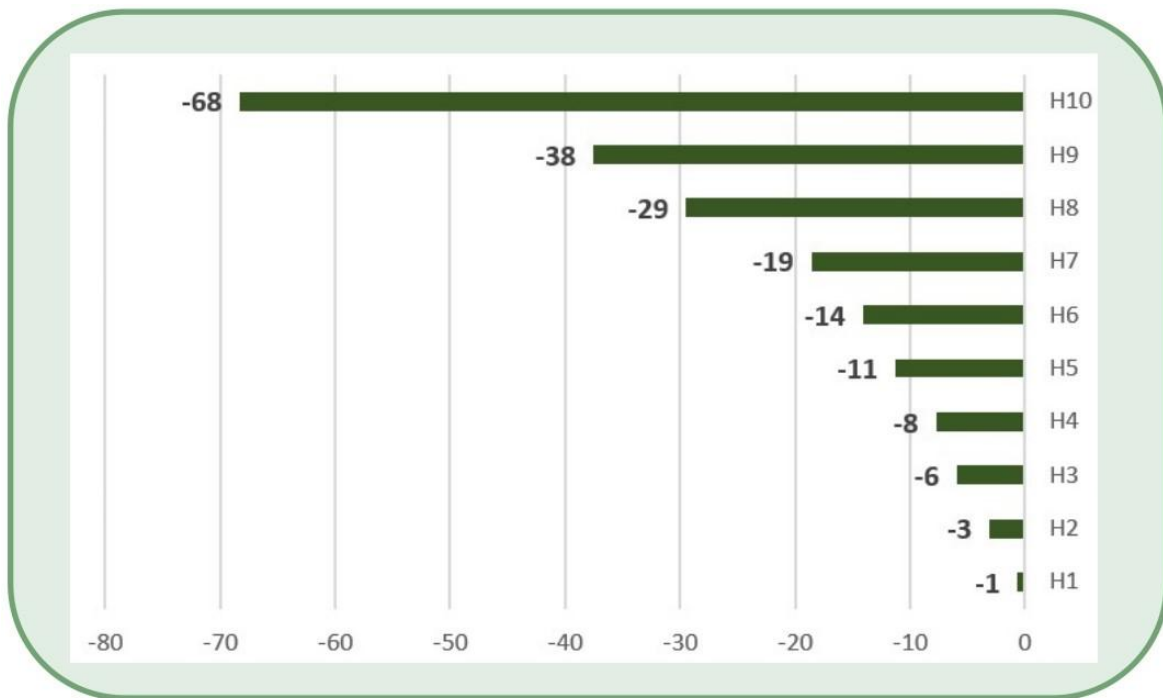
Source: Own elaboration.

4.3.   World demand trends impact on the Panama Canal

Table 16 shows the yearly total GDP variations from 2022 to 2030 on an increment in the quantity of tons that transit the Canal. Direct effects are due to a shock produced specifically in the Canal so as to achieve the projected quantity estimates for a given year.   Results suggest that the accumulated expected increment of GDP in 2030 is 9.62% compared to the SAM situation in 2019. This means that the average annual growth rate of GDP is 1.1%.

Similar to the previous scenarios, the positive induced effects produced by an increment in government transfers to households are the most pronounced. Again, the logic behind these results lies in the fact that with higher Canal transits, higher will be the income collected through fees. As a consequence, transfers to households will increase bringing about more expenditure.

Table 16: Simulated GDP variation of World demand trends - In million balboas.

Year	Direct Effect	Indirect Effect	Induced Effect from Labor remunerations	Induced Effect from Government transfers	Total Effect
2022	344.78	23.08	37.61	82.81	488.29
2023	253.38	16.96	27.64	60.86	358.84
2024	308.72	20.67	33.68	74.15	437.22
2025	462.29	30.95	50.43	111.03	654.71
2026	462.50	30.96	50.46	111.08	655.00
2027	525.24	35.16	57..30	126.15	743.85
2028	616.18	41.25	67.22	147.99	872.65
2029	724.18	48.48	79.00	173.93	1,025.59
2030	827.31	55.39	90.26	198.70	1,171.66
Total	4,524.58	302.90	493.61	1,086.70	6,407.79
Percentage Variation					9.62%

Note: Percentage Variation in relation to the SAM 2019 GDP.
Source: Own elaboration.

Table 17 shows the yearly variation of government revenue. Total results suggest that government revenue will increase 31.06% from 2022 to 2030, from which only tax revenue represents almost 13% of that total revenue increase. It is evident that most of the income that the government would earn comes from the activity of the Panama Canal for the next 9 years according to the Canal's demand projections. More specifically, 85% of the total government revenue increase is directly attributed to Canal dividends. In annual terms, government revenue is expected to increase 3.45% each year.

Table 17: Simulated Government Revenue variation of World demand trends - In million balboas.

Year	Direct Effect	Indirect Effect	Induced Effect from Labor remunerations	Induced Effect from Government transfers	Total Effect
2022	226.54	4.16	5.44	11.97	248.11
2023	166.48	3.06	4.00	8.80	182.34
2024	202.85	3.72	4.87	10.72	222.16
2025	303.75	5.58	7.29	16.06	332.68
2026	303.89	5.58	7.30	16.06	332.82
2027	345.11	6.34	8.29	18.24	377.97
2028	404.87	7.43	9.72	21.40	443.42
2029	475.82	8.74	11.42	25.15	521.14
2030	543.59	9.98	13.05	28.73	595.36
Total	2,972.90	54.58	71.38	157.14	3,256.00
Percentage Variation					31.06%

Note: Percentage Variation in relation to the SAM 2019 Government Revenue.
Source: Own elaboration.

Finally, Table 18 presents the potential year increase in total exports. Overall, an increase in the Canal's demand will mean a total increase of exports equivalent to 21.52% when compared with 2019 total exports. In annual terms, exports will increase, on average, 2,39%.

Table 18: Simulated Exports variation of World demand trends - In million balboas.

Year	Direct Effect	Indirect Effect	Induced Effect from Labor remunerations	Induced Effect from Government transfers	Total Effect
2022	267.56	6.55	10.18	22.41	306.69
2023	196.63	4.81	7.48	16.47	225.39
2024	239.58	5.86	9.11	20.06	274.62
2025	358.75	8.78	13.65	30.04	411.22
2026	358.91	8.78	13.65	30.06	411.40
2027	407.59	9.98	15.50	34.13	467.21
2028	478.17	11.70	18.19	40.04	548.11
2029	561.98	13.76	21.38	47.06	644.17
2030	642.01	15.71	24.42	53.77	735.91
Total	3,511.17	85.94	133.56	294.04	4,024.71
Percentage Variation					21.52%

Note: Percentage Variation in relation to the SAM 2019 Exports.
Source: Own elaboration.

From a sectoral point of view, Figure 20 shows the effects in terms of GDP, government revenue and exports on the main sectors of the economy.

As for GDP variations, direct effects mean that an increase of 4,568 million balboas are focused on the Canal. This amount represents 71% of total GDP increase. On a second note, the service sectors account for 1,449 million balboas which contribute 23% to the total GDP variation for 2030. More specifically, the positive effects observed in these sectors are mainly due to induced effects and focus on the Commerce, Real Estate Activities, Hotels & Restaurants and Financial activities. On a third note, the GDP contribution of the manufacturing sectors represents a 3% of total GDP increase and is due to positive indirect effects on the Non- Metallic minerals and Rest of Industry sectors. Additionally, there are also significant induced effects in the Food, beverages & Tobacco production sector. Finally, the sectoral contribution of the Primary and Electricity, Gas & Water sectors only represents a 3% contribution[21].

In a similar vein, sectoral government revenue contributions are also due to the positive demand shocks experienced by the Canal. From a composition point of view, only 7% of the Canal's contribution to government revenue is attributed to taxes. On the contrary, 93% is due to increments in future dividends. Positive effects of service sectors are connected to induced effects on tax revenues. Strictly speaking, within the service sectors, increase in tax collection represents 84% of their total contribution to government revenue. Finally, total contributions of the Primary, Manufacturing and Energy, Gas & Water sectors are less significant but entirely composed by tax payments[22].

Finally, the sectoral composition of exports shows that the Canal is responsible for 88% of total export increase. Secondly, the service sectors contribute 10%. Less significant are the export contributions of the Primary (0.3%), Energy, Gas & Water (0.02%) and Manufacturing (1.2%) sectors. In the case of the Canal, export increase is due to the direct effects. Exports in the service sectors are boosted due to induced effects on the Commerce and Financial sectors[23].

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[21] Results for the 28 economic sectors can be found in table A9.1 of the Annexes.
[22] Results for the 28 economic sectors can be found in table A9.2 of the Annexes.

[23] Results for the 28 economic sectors can be found in table A9.3 of the Annexes.

Figure 20: Simulated total sectoral participation of GDP, Government Revenue and Exports variations of World demand trends- In million balboas.

Source: Own elaboration.

Table 19 shows the potential jobs that will be created in the economy because of the increase in the Canal's transit. Overall, this scenario suggests that in 2030 the Panamanian economy will experience a 4.03% increase in total job positions.

From a composition point of view, 14,814 jobs could be directly created from the increase in tons transited through the Canal each year. Such job creation constitutes 19% of the total. As far as indirect effects are concerned, 7,349 jobs will be created representing 9%. Finally, induced effects from labor

remunerations and government transfers will be responsible for the creation of 56,435 job positions in 2030 (representing 72%).

Table 19: Simulated labor variation of World demand trends - In job positions.

Year	Direct Effect	Indirect Effect	Induced Effect from Labor remunerations	Induced Effect from Government transfers	Total Effect
2022	1,129	560	1,343	2,957	5,989
2023	830	412	987	2,173	4,402
2024	1,011	501	1,203	2,648	5,363
2025	1,514	751	1,801	3,965	8,031
2026	1,514	751	1,802	3,967	8,034
2027	1,720	853	2,046	4,505	9,124
2028	2,017	1,001	2,401	5,285	10,704
2029	2,371	1,176	2,821	6,211	12,580
2030	2,709	1,344	3,223	7,096	14,371
Total	14,814	7,349	17,628	38,808	78,598
Percentage Variation					4.03%

Note: Percentage Variation in relation to the SAE 2019 employment.
Source: Own elaboration.

Figure 21 shows further information connected to labor creation. From a sectorial point of view, the service sectors are the ones who contribute the most job positions (51% of total employment creation). Specifically, the most benefited sectors will be the Commerce; Hotels & Restaurants; Education and Health sectors. Additionally, nearly 20% of new job positions will belong to the Primary sectors. This job creation is mainly due to induced effects. Finally, Job creations in the Canal will represent 19% of total job creation[24].

As far as employment composition is concerned, results indicate that the majority of jobs created will be private sector workers with secondary education. Additionally, most of them will be men above 24 years of age.

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[24] Results for the 28 economic sectors can be found in table A9.4 of the Annexes.

Figure 21: Simulated employment variations by sex, age, occupational category and educational background of World demand trends .
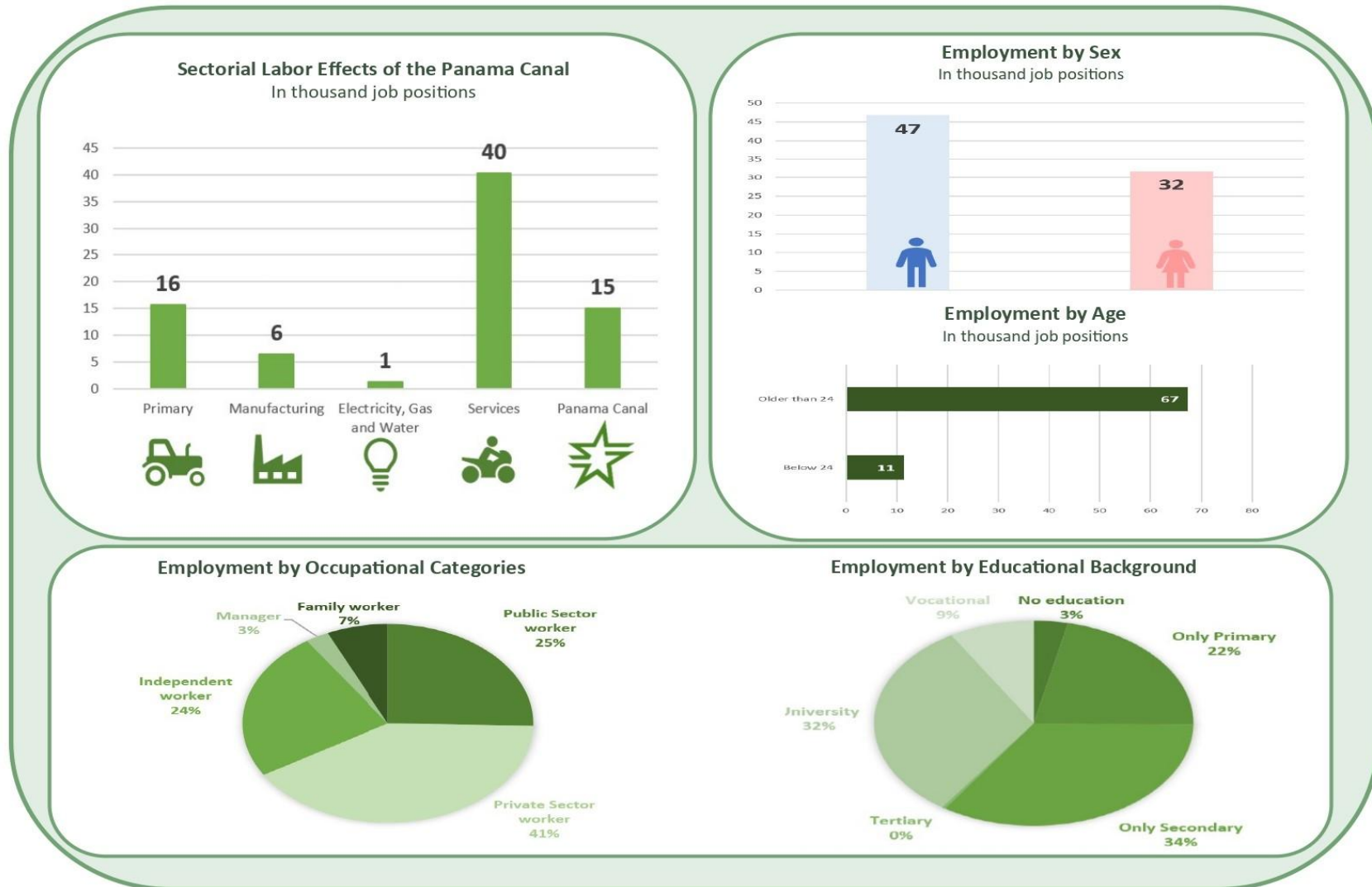
These projected demand trends will also have a positive impact on household income. Figure 22 shows the expected variations for each income decile. These results are the accumulation of each year's income increase. In all cases, income is expected to increase by 23% in 2030 with respect to the base year (2019).

Figure 22: Simulated household income variation of World demand trends- In million balboas.
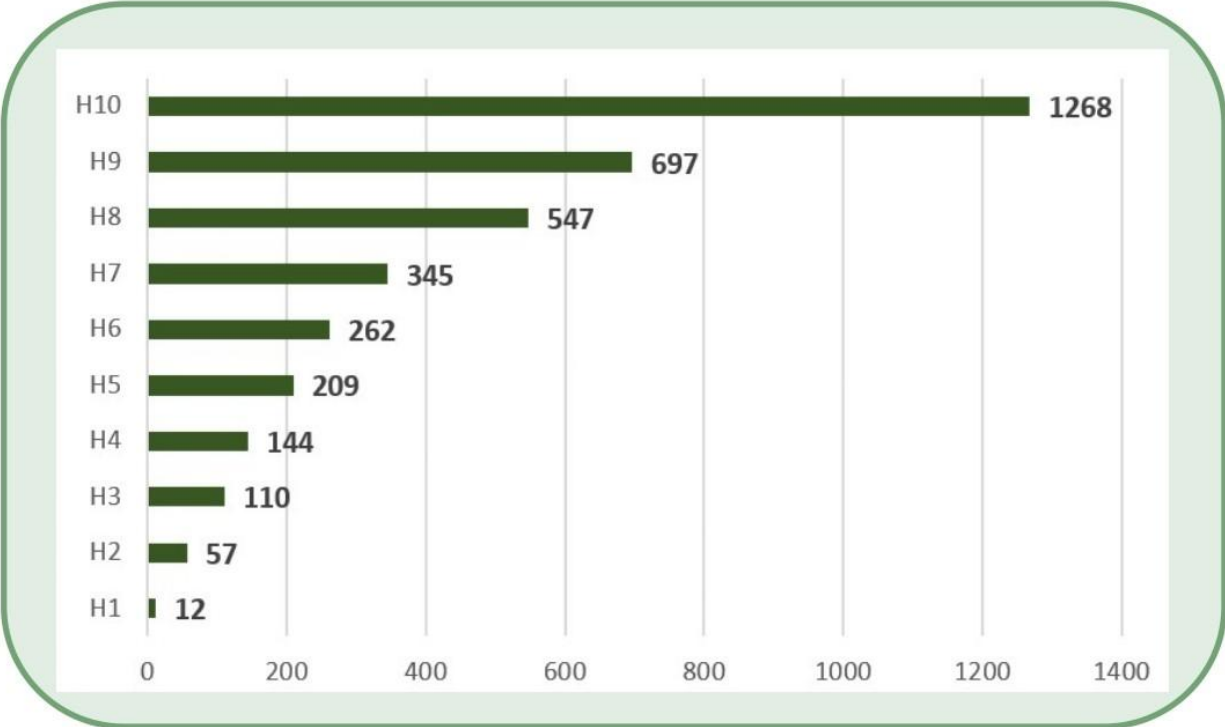
Source: Own elaboration.

4.4. Infrastructure Investments projected in the Panama Canal: water management infrastructure

The final simulation presented in this document is connected with Infrastructure investments for a water management project. It should be noted that the results presented correspond to the construction phase of the project and must be complemented with an additional simulation for the operational phase to get the overall impact of this kind of project of investment. Table 20 summarizes the most relevant variables.

Table 20: Simulated GDP, Government revenue and exports after an Infrastructure project (water management project - construction phase)-In million balboas.

	GDP	Government Revenue	Exports
Direct Effect	822.81	164.28	138.45
Indirect Effect	543.47	23.59	42.91
IInduced Effect from Labor remunerations	198.84	28.75	53.80
Induced Effect from Government transfers	1.78	0.26	0.48
Total Effect	1,566.89	216.88	235.64
Percentage variation	2.4%	2.1%	1.3%

Source: Own elaboration.

Results show positive direct, indirect and induced effects due to the construction phase. As far as the effects on GDP are concerned, the construction phase of this project will mean a positive variation of total GDP equivalent to 2.4%. From a composition standpoint, direct effects are the second most significant. Specifically, the 822.81 million balboas generated by the direct effects of the shock account for 53% of the total effect. Secondly, the 543.47 million balboas indirectly generated represent 35%. Contrary to previous shocks, the induced effects are less significant (13% of the total shock). The induced effects from government transfers are extremely low since the construction phase of this project does not directly involve the Canal.

Government revenue is expected to increase approximately 217 million balboas representing 2.1% of total government revenue. However it is important to point out that 93% of this new government revenue is attributed to an increase in tax revenue. More specifically, tax collection is expected to increase by 202 million balboas. Given that the total cost of the project is 1,880 million balboas, the government recovers 11% of the cost of the project in tax revenue .

Total exports will also increase under the construction phase creating a positive variation of 1.3%. The 138.45 million balboas worth of exports directly generated by the construction phase represent 59% of the total effects. On a second level, induced effects from labor remunerations account for 23% of the total effect while indirect effects represent 18%.

Figure 23 shows the sectoral effects in terms of GDP, government revenue and exports for this scenario. As opposed to previous simulations, manufacturing and service sectors are the ones most positively affected. These results are not surprising since the construction phase involves Wood, Non-metallics and Rest of industry products. Additionally, the most affected service sectors are Commerce, Real Estate and Financial activities. In this case, the positive effects on the Panama Canal are due to indirect and, mainly, induced effects from variations in labor remunerations.

Figure 23: Simulated total sectoral participation of GDP, Government Revenue and Exports variations after an Infrastructure project (water management project - construction phase)-In million balboas.

Source: Own elaboration.

As far as employment is concerned, results indicate that this project has a significant job creation capacity. Other than the direct requirements (i.e. the amount of labor directly needed for the construction of the project) which represent 52% of total jobs, indirect and induced effects also bring

about an increase in employment. The 3,180 job positions indirectly created account for 15% of the total effect while the induced job positions represent 33%.

Table 21: Simulated labor variations after an Infrastructure project (water management project - construction phase)-In job positions.

Direct Effect	11,147
Indirect Effect	3,180
Induced Effect from Labor remunerations	7,101
Induced Effect from Government transfers	64
Total Effect	21,492
Percentage Variation	1%

Source: Own elaboration.

However, it must be pointed out that construction of major infrastructure projects usually takes place over various years. For this reason, the total job creation would take place over a prolonged period of time. Additionally, these new jobs created in the economy are not permanent. On the contrary, they will exist during the construction of the project.

Figure 24 shows the sectoral job creation capacity of this infrastructure project. As it can be appreciated, most jobs will be created in the manufacturing sectors. This result is mainly due to direct effects on employment. In other words, direct requirements of this construction phase mainly involve workers from the Rest of Industry sector. Additionally, job positions are also created in the Wood and Non-metallic sectors due to indirect and induced effects. As for the service sectors, most jobs will be created in the Commerce sector due to direct, indirect and induced effects.

Figure 24 also shows qualitative data for employment connected with this scenario. All in all, employment creation will be male dominated with a significant participation of private sector workers with secondary education.

Figure 24: Simulated employment variations by sex, age, occupational category and educational background after an Infrastructure project (water management project - construction phase) .
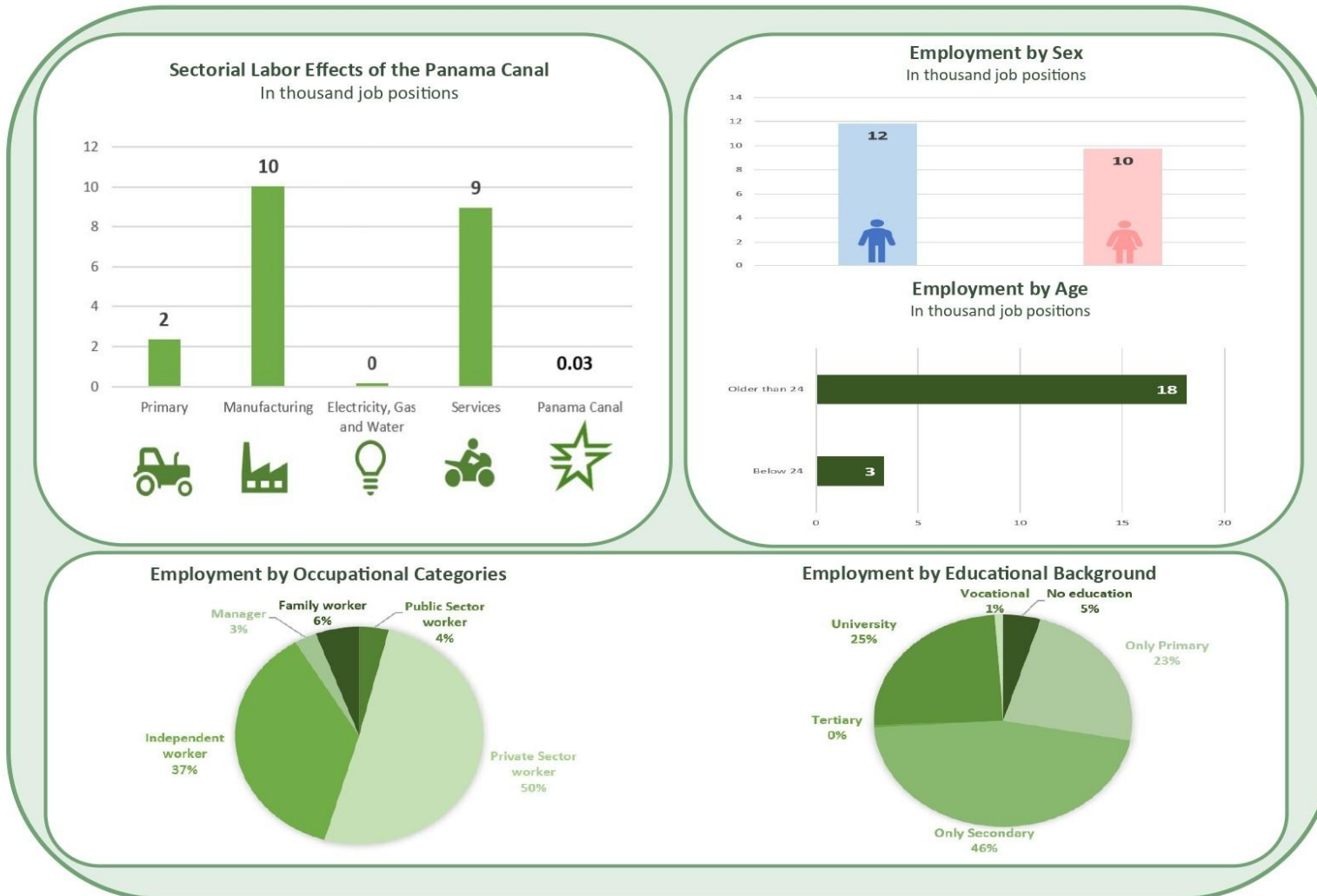
Source: Own elaboration

Finally, Figure 25 shows the expected income variations after the construction phase of this project. Overall, household income is expected to increase by 3%.

Figure 25. Simulated household income variation after an Infrastructure project (water management project - construction phase)- In million balboas .
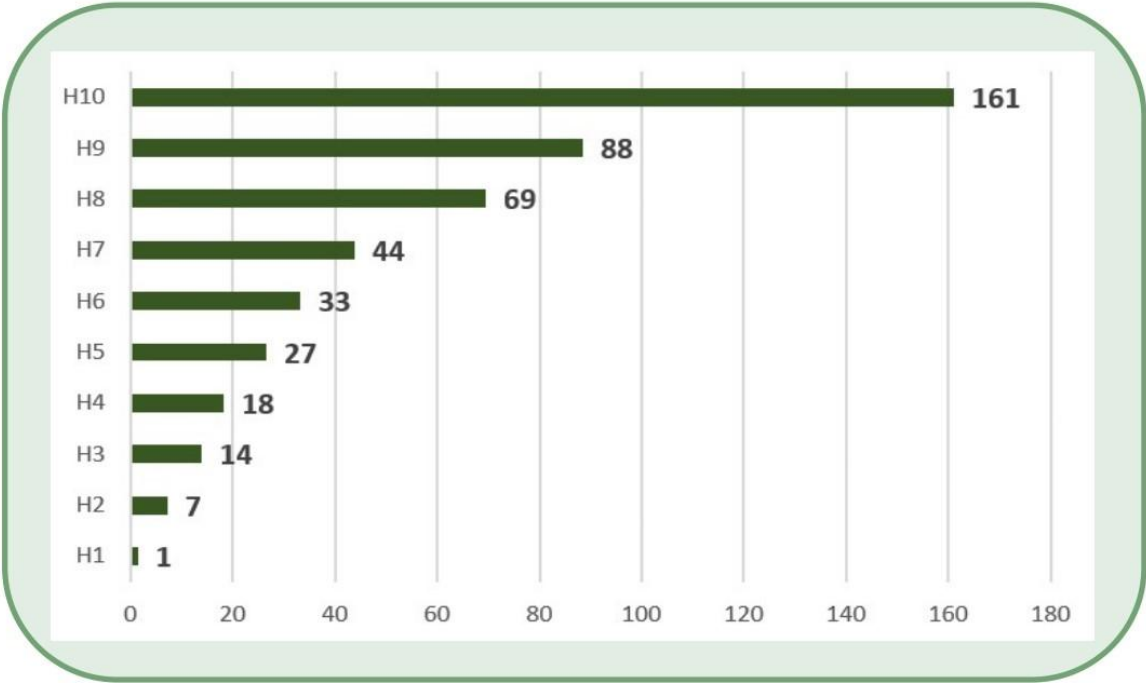
Source: Own elaboration

5. Concluding Remarks

The socio-economic relevance of the Panama Canal activity to the country has been demonstrated since the construction of the SAM 2019 for Panama and across all simulated scenarios. The quantification of the total contribution of the Canal to the local economic highlighted different channels, i.e. directly, indirectly through its interaction with the rest of sectors, and induced by the change in households' income (labor remunerations and the allocation of the Canal capital dividends as government's transfers) that lead an additional push to final demand of national goods and services. Disentangling all these mechanisms was possible thanks to the development of a simulation IO model and all essential dataset for its calibration (SAM & SAE Panama 2019).

As far as the SAM 2019 estimation is concerned, this report presents the final version. This last update of the matrix has successfully incorporated all the suggestions received from the ACP and IDB teams. In particular, we improved trade information regarding re-exports to incorporate the latest information transmitted by ACP authorities. We refine the information of the government revenue and expenditure. We included households' income and expenditure according to income

deciles to identify income distribution impacts. Finally, we opened the capital account into private capital and public capital to isolate the dividends received by the government from sectoral activities.

When it comes to the SAE 2019 a final estimation was achieved by combining 2019 data from the Labor Market Survey and the National Economic Census of 2011. In this way, it was possible to extend the 21 sector disaggregation of the Labor Market Survey to match the 28 sectors from the SAM. Additionally, the available information was sufficient so as to present sectorial job positions according to occupational categories; sex; age and educational background. With respect to the difficulties in estimating the jobs in the Travel Agency sector mentioned in previous reports, this was solved by using the National Economic Census data. Finally, it is important to point out that employment of the Canal was ultimately built due to the valuable information provided directly by the ACP.

Given the previous data, a SAM-based IO model was developed and calibrated to Panama 2019 so as to measure the total contribution of the Panama Canal to the Panamanian economy. For this purpose, the simulation carried out consisted of a hypothetical extraction of the Canal from this economy.

Simulation results suggest that the total contribution of the Canal to the economy is relevant for GDP (6.16%) and employment (2.58%) but particularly for the total government revenue (19.9%). Direct contribution of the Canal in every economic variable is more significant than its indirect contribution (e.g., 72% of total Canal contribution to the Panamanian GDP is due to its direct effect). This result is consistent with the analysis of production and employment multipliers that characterize the Canal as an independent activity among Panamanian sectors. Moreover, total induced effects are more significant than the indirect ones. Specifically, induced effects due to variations in government transfers to households play an important role in total effects, which is particularly remarkable for induced employment (i.e., 49% of total contribution of the Canal to employment is explained by induced impacts due to government transfer to households). This illustrates particularly the importance of the Canal when it comes to financing government current expenditure (i.e. transfers to households).

Results associated with the Covid-19 scenario show that the overall impact of the pandemic in the Canal and, consequently, in the rest of the economy could imply an accumulated reduction of 0.34% of Panama's GDP. As for employment, the total accumulated reduction would have been equal to 0.2%; however, the mechanism of a quick adaptation to the restrictions allows the Canal to continue operating keeping its own employees. Perhaps the most important consequence is the one associated with the government revenue. The estimations presented in this report show that due to the pandemic activity slowdown in the Canal, total government revenue decreased by almost 1%. Such reduction could have meant another budgetary restriction for the government amidst the growing expenditures created by the Covid-19 crisis.

According to the demand projections elaborated by the ACP, we have estimated the expected effects on the Canal and the Panamanian economy of an increase in the amount of vessels that will transit the Canal up until 2030. If the projections are true, it can be expected that total GDP will have an annual growth of 1.1%. Total employment will also be positively affected experiencing an annual growth of 0.8%. As for government revenue and total exports, their annual growth equals

3.45% and 2.39%, respectively. The obtained results show the importance of the Canal as a way of capturing positive spillovers of international changes in production and consumption patterns.

Finally, we have evaluated the effects of a potential investment in a water management project within the IO model. Simulation results show that the construction phase of this project brings about positive increments in GDP (2.4%), government revenue (2.1%) and exports (1.3%). Additionally, this project can increase total employment by 1%. Nonetheless, as it was previously mentioned that these increments are temporary and subject to the duration of the construction phase. For a full evaluation of the impacts of an infrastructure project, the results of the construction phase should be complemented with those estimated for the operation phase. However, no data about the potential impact of this project in terms of production for the Canal is available.

The developed tool for simulations is also delivered to the ACP and the IDB teams. It will allow performing updates of these simulations and also to run additional scenarios that could be of interest for the Canal and for the Panamanian economy.

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A1. Data sources for the 2019 Panama SAM & SAE

A 1.1. Official Sources Available

In this first subsection we will describe the primary sources that were used for constructing the 2019 Panama SAM. The elaboration of a SAM requires a compilation of diverse information on the economy. This should include data on tax collection; sectoral production; foreign trade; government expenditure; among others. This matrix has successfully incorporated all the available information in a consistent framework to represent the economy of Panama.

National Accounting System for Panama 2019

Among the various sources used for the 2019 Panama SAM, the SNA constitutes the main starting point. The INEC provides yearly information (including 2019) for the following variables:

- Macroeconomic aggregate values (GDP, private and public consumption, trade balance, global supply, and demand).
- Economic activity (production and value-added) for each sector.
- Income generation accounts for each production factor.
- The Supply and Use Tables (SUT) containing every sector.

This information gives a framework of consistency to the elaborated matrix, which will require additional and more detailed information. For that reason, the SNA was complemented with other sources from official entities such as:

- Ministry of Economics and Finance (MEF): public budget information at a consolidated regional and national level.
- General Income Direction: yearly statistical information on each particular tax.

Income and Expenditure Surveys in Panama

Information coming from household level surveys, such as the "Household's income and expenditure survey" 2017/2018[25], is relevant to identify patterns in household expenditure and income. This information was matched to ensure correspondence with the social structure used in the analysis. Those surveys are particularly useful to exploit detailed microeconomic information to better represent the households of Panama.

Consolidated Government Account

The fiscal analysis is carried out by the consolidated government, which means considering national and regional data, net of transactions within themselves. Relevant information was gathered from the Ministry of Economics and Finance (MEF), as well as INEC and the GID. It is also necessary to highlight that the information distinguishes between economic subsidies and transfers given by the government towards households.

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[25] Available at the INEC public web site.

International Accounting – Balance of Payments

Data was obtained from the 2019 Balance of Payments, from INEC. This source provides the information on transactions between residents and non-residents, split between current account, capital account and international reserves. Data was used to analyze the interaction with the rest of the world and elaborate the rest of the world account.

Household's Income and Expenditure Survey for 2017/2018

This specific database was used to estimate the income and expenditure distribution between 10 household deciles. It provides information connected to sources of income and expenditure from various households of the country. Even though the years surveyed do not coincide with our base year for the SAM, the distributional structures were extrapolated. This survey is carried out and published by INEC.

Market Labor Survey for 2019

In order to estimate a Satellite Account of Employment for Panama 2019, we have employed the Market Labor Survey for 2019 provided by INEC. This database contains labor information for 21 economic activities according to its occupational category, educational background, sex and age.

National Economic Census for 2011

Since the Market Labor Survey provides insufficient information to construct the SAE with the desired sectoral disaggregation, the National Economic Census for 2011 was used as a complement.

A 1.2. Panama Canal information

For the information of the Canal, we access the Supply and Utilization Tables provided by the INEC. The Utilization Table provides information on the intermediate and final destination of the services produced by the Canal. The Supply Table describes the composition of the total supply of goods and services of the economy. Value added was obtained from the Utilization Table. Additionally, to characterize the Canal activity we access the balance sheet of the canal for the year 2019.

As far as employment data is concerned, information regarding total job positions was facilitated by the ACP.

A2. RAS methodology for SAM consistency

In some cases, the absence of information or its incompleteness may require some procedures to face this challenge. RAS is a method that allows estimating a complete and update matrix when having an initial (outdated) matrix and only the (new) sums of the columns and rows. This method also allows including restrictions when there are some known elements for the new matrix. As we can see, this is a powerful method to conciliate or update data. According to Mastronardi et al. (2018), this method is widely used for the estimation of IO matrices and SAMs.

More technically, the RAS methodology is an algorithm which starts with an initial matrix (*A*), which is composed by elements a_{ij}, and vectors that contain the total sums (*y**) required for rows and columns. By using and iterative process, the RAS method looks for a new matrix *A**, whose elements are a_{ij}^*, that respects those totals (Stone, 1978). Mathematically, the iterative process searches for vectors r_i and s_j to meet the following condition:

$$a_{ij}^* = r_i a_{ij} s_j$$

The problem with the estimation of a *NxN* SAM consists in identifying *N²* non-negative parameters only counting with *2xN-1* independent restrictions of rows and columns. The RAS procedure imposes bi-proportional conditions in order to reduce the problem by finding *2xN-1* coefficients for r_i and s_j, arriving at a single solution. The procedure is an iterative algorithm that alternately complies (on each iteration) with rows or columns totals, changing the a_{ij} coefficients.

Minimum information required by this method is the total of rows and columns of the new matrix. This requirement is fairly restrictive. If only partial information is available in both the vectors y* or the Matrix A, the RAS method will not be able to estimate the new matrix, since the minimum requirement is to know all the borders of the coefficient matrix.

A3. Step by step elaboration of the 2019 Panama SAM

This subsection presents a methodological and practical analysis over the construction of the Panama 2019 SAM. Firstly, the procedure followed to obtain the macroeconomic aggregates is described. Secondly, the process of elaboration of the disaggregated SAM (supply and demand accounts) is detailed. The model presents the following disaggregation: 28 productive sectors, 10 representative households separated by deciles of income, the government, and the rest of the world.

A 3.1. Macroeconomic Aggregates

Global demand is the value of the amount of goods and services effectively demanded in a country separated in different elements, such as private consumption (C), investment (I), public consumption (G) and exports (X). Global demand is defined as:

$$AD = C + I + G + X$$

Global supply represents the value of all final goods and services produced by the different sectors of the economy – *Gross Domestic Product (GDP)-* plus imports (M). Since the information for demand is generally presented at market prices, net taxes over products are included (VAT, specific taxes, others) in the supply to achieve consistency between global supply and demand. Meaning:

$$AS = GDP_{mp} + M$$

Finally, effective global aggregate demand must equal the effective production level. In equilibrium, planned expenditure (target aggregate demand) equals effective production.

$$AS = AD$$

The supply and demand table comes from INEC. Information presented in Table A3.1 shows the values of macroeconomic aggregates previously mentioned. Here, we can observe the GDP at market prices for 2019 was 66,984 million balboas.

Global supply and demand calculated in the SAM must be consistent with the information published by the National Accounting.

Table A3.1. Estimation of Global Supply and Demand for Panama 2019. In millions of balboas.

Concept	Mil. Balboas	%
Market Price GDP	66,984	69.6%
Imports	29,322	30.4%
GLOBAL SUPPLY	**96,306**	**100.0%**
Household consumption	35,072	36.4%
Public Consumption	7,975	8.3%
Gross Domestic Investment	25,657	26.6%
Exports	27,603	28.7%
GLOBAL DEMAND	**96,306**	**100.0%**

Source: Own elaboration based on INEC.

A 3.2. Supply Accounts

In this subsection, the supply accounts for goods and services for the 2019 Panama SAM are detailed, whether they are of domestic or imported production.

Production

The goal of the production account is to establish the Gross Value Added (GVA), the Gross Production Value (GPV) and the Intermediate consumption (IC) generated by each economic sector, determining the economy's GDP.

The GVA and GPV for 2019 were obtained from INEC. The IC is calculated as a difference.

In this SAM, the production account is composed of 28 sectors, listed in Table A3.2. In this table, we also show sector participation in GVA, IC and GPV for 2019. The two largest sectors in terms of GPV are Construction and Commerce representing 21.5% and 17.4% respectively. When observing GVA, the participation of these sectors is 20.5% and 19.0%, respectively.

Additionally, other important areas in terms of GPV and GVA are Real Estate Activities and Rentals, Financial and Insurance Activities and Food, Beverages, and Tobacco. However, GPV and GVA outside of the main two sectors is very evenly distributed, and over ten sectors hold between 2 and 6% of GPV each. The Panama Canal, for instance, contributes to 3.2% in the GPV and 4.8% in the GVA of the country.

Table A3.2. Sectorial Gross Production Value, Gross Value Added and Intermediate Consumption in producer prices for Panama 2019. As percentages of total values.

Sector	GVP	VA	IC	VA Intensity
Agriculture, Forestry and Fishing	2.5%	2.3%	3.1%	0.52
Exploiting of mines and quarries	2.3%	2.6%	1.7%	0.65
Food, beverages, and tobacco	5.2%	3.0%	8.7%	0.33
Textiles and leather	0.2%	0.0%	0.2%	0.15
Wood and paper	0.6%	0.4%	0.8%	0.38
Chemicals and plastics	0.7%	0.4%	0.8%	0.37
Non-metallic minerals	1.8%	1.4%	2.4%	0.43
Other manufacturing industries	1.5%	0.7%	1.4%	0.27
Electricity and gas supply	1.7%	1.7%	2.0%	0.56
Water treatment and supply	0.2%	0.2%	0.3%	0.54
Construction	21.5%	20.5%	24.6%	0.55
Commerce	17.4%	19.0%	15.2%	0.63
Hotels and restaurants	4.0%	3.8%	4.3%	0.54
Transport by land	2.6%	2.5%	3.1%	0.54
Aquatic transport	0.8%	0.7%	0.9%	0.56
Air transport	3.1%	1.4%	6.4%	0.26
Travel agencies	0.3%	0.2%	0.4%	0.44
Complementary transport activities	0.7%	0.7%	0.7%	0.56
Panama Canal	3.2%	4.8%	0.8%	0.87
Mail and telecommunications	2.3%	2.1%	2.4%	0.53
Financial and insurance activities	5.9%	6.2%	5.1%	0.61
Real estate activities and rentals	6.2%	8.6%	3.0%	0.80
Business services	4.2%	5.0%	2.9%	0.68
Teaching	2.4%	3.0%	1.0%	0.70
Health and social services	4.3%	4.2%	3.9%	0.57
Public administration	3.2%	3.0%	3.2%	0.53

Community services	1.1%	1.2%	0.6%	0.64
Domestic services	0.3%	0.4%	0.0%	0.80
Total	102,426.79	58,743.66	35,839.20	0.57

Source: Own elaboration based on INEC.

Sectorial GPV is composed of GVA, IC and taxes. For the purpose of this table, we will center our attention on the first two concepts. Table A3.2 also presents the value-added intensity of these sectors. The Canal of Panama, domestic services and real estate activities are the most value-added intensive in the economy with 0.87, 0.80, and 0.80 respectively.

Value-Added and Factor Decomposition

This account decomposes GVA according to factor remuneration: labor (L), Capital (K), Public Capital (PK), and Gross Mixed Income (GMI). Formally speaking, total VA is equal to

$$VA = L + K + PK + GMI$$

A factor payment matrix was estimated with data provided by INEC, who published decomposed information for 17 economic activities. However, we must represent 28 sectors in the matrix and for that the VA decomposition for them keep that of the 17 activities (data restriction due lo limitation in official data sectoral disaggregation). This implies that many sectors in the matrix will have the same factorial distribution depending on the economic activity to which it belongs.

Estimates are presented in Table A3.3, which also shows the intensity of usage of each factor within the GVA. Sectors Exploiting of Mines and Quarries, Construction and Water treatment and supply are the most capital-intensive activities, with over 85% of net VA being composed by this factor. The Panama Canal is also a public capital-intensive sector, whose public capital to VA participation is 64.1%.

The most labor-intensive sector is Domestic Services with 99% of participation on net VA. Community Services, Public Administration, Teaching and Health and Social Services are other sectors with a prevalence of labor as the main factor. Finally, Real Estate Activities and Rentals is the only sector with GMI as its main factor, representing 78.9% of net VA.

Table A3.3. Sectoral labor, capital, public capital and Gross Mixed Income retributions for Panama 2019. In million balboas and percentages.

Sector		%			
	VA net of factor taxes	L	K	PK	GMI
Agriculture, Forestry and Fishing	1,353.31	15.0%	60.2%	0.0%	24.8%
Exploiting of mines and quarries	1,525.42	5.7%	93.8%	0.5%	0.0%
Food, beverages, and tobacco	1,760.64	19.0%	73.6%	0.0%	7.4%
Textiles and leather	27.40	19.0%	73.6%	0.0%	7.4%
Wood and paper	220.04	19.0%	73.6%	0.0%	7.4%
Chemicals and plastics	247.50	19.0%	73.6%	0.0%	7.4%
Non-metallic minerals	804.78	19.0%	73.6%	0.0%	7.4%
Other manufacturing industries	420.97	19.0%	73.6%	0.0%	7.4%
Electricity and gas supply	983.86	15.2%	76.8%	8.1%	0.0%
Water treatment and supply	126.82	15.2%	84.8%	0.0%	0.0%
Construction	12,068.67	11.7%	81.7%	0.0%	6.6%
Commerce	11,142.65	19.5%	73.8%	0.1%	6.5%
Hotels and restaurants	2,213.25	20.5%	73.5%	0.0%	6.0%
Transport by land	1,469.11	24.0%	61.1%	0.6%	14.3%
Aquatic transport	438.58	24.0%	55.8%	5.9%	14.3%
Air transport	815.47	24.0%	58.6%	3.1%	14.3%
Travel agencies	119.04	24.0%	43.3%	18.4%	14.3%
Complementary transport activities	381.92	24.0%	61.7%	0.0%	14.3%
Panama Canal	2,795.12	22.9%	0.0%	64.1%	12.9%
Mail and telecommunications	1,256.54	24.0%	60.5%	1.2%	14.3%
Financial and insurance activities	3,642.22	29.1%	60.5%	8.6%	1.8%
Real estate activities and rentals	5,052.53	5.0%	16.1%	0.0%	78.9%
Business services	2,943.29	20.6%	44.1%	11.4%	23.9%
Teaching	1,760.17	85.4%	12.6%	0.0%	2.0%
Health and social services	2,469.60	67.9%	14.0%	0.0%	18.1%

Public administration	1,752.93	97.7%	2.3%	0.0%	0.0%
Community services	717.93	97.7%	2.3%	0.0%	0.0%
Domestic services	233.88	99.9%	0.1%	0.0%	0.0%
Total	58,743.66	24.9%	56.2%	4.5%	14.5%

Source: Own elaboration based on INEC.

Imports

Imports data was first obtained from INEC. However, given the sectoral disaggregation attempted for Panama's 2019 SAM, further assumptions where necessary. Particularly, aggregated import data was separated according to their use. In this work, we distinguish four destinations for imports: intermediate consumption, private final consumption, exports, and investment. The category determined as "exports' ' corresponds to re-exports. Such transactions are imports that are either used for a limited time and then returned, or goods imported only as means of exporting it for use elsewhere. This is particularly important to take away the import content from total demand to get the national demand.

Import distribution by use destination was constructed using INEC's Balance of Payments information, as well as the 2019 SUTs. Given the constraint presented by the absence of an official Imports matrix, we had to estimate one. To do so, we used the Use Table of Panama from the 2019 SUTs. This table contains the total transactions between sectors and the total final demand (national + imports). To generate the Imports Table, we updated the Use Table with a national-versus-imported supply coefficient. Such coefficient records, for each sector, how much of its total supply was either national or foreign (imported). Then, we used the resultant matrix to distribute total imports between the destinations that we previously defined.

The following tables show the structure of imports. Table A3.4 presents the composition, as a percentage of total, of the bundle of imports by destination and total imports.

Table A3.4. Sector participation on imports by use for Panama 2019. Percentage of total imports.

Sector	Imports
Agriculture, Forestry and Fishing	1.0%
Exploiting of mines and quarries	0.6%
Food, beverages and tobacco	1.8%
Textiles and leather	0.1%
Wood and paper	0.2%
Chemicals and plastics	0.4%
Non-metallic minerals	0.6%
Other manufacturing industries	0.7%
Electricity and gas supply	0.5%
Water treatment and supply	0.0%
Construction	8.1%
Commerce	2.9%
Hotels and restaurants	0.8%
Transport by land	1.0%
Aquatic transport	0.3%
Air transport	2.9%
Travel agencies	0.1%
Complementary transport activities	0.1%
Panama Canal	0.3%
Mail and telecommunications	0.4%
Financial and insurance activities	0.6%
Real estate activities and rentals	0.5%
Business services	0.6%
Teaching	0.2%
Health and social services	1.3%
Public administration	0.7%
Community services	0.1%

Domestic services	0.0%
Investment	11.3%
Household consumption	31.8%
Exports	30.1%
Total	**29,322**

Source: Own elaboration based on INEC and 2019 SUTs.

The structure of imports by destination reflects that 31.8% of total imports are for private consumption, 11.3% for investment, 30.1% for re-exports and 26.7% for intermediate consumption. In terms of sectoral demand for imports, Construction (8.1%), Commerce (2.9%) and Air transport (2.9%) are the activities that occupy a greater share of total imports.

A 3.3. Agents and institutions account

This subsection presents the demand accounts, as well as accounts that are specific to institutions, such as households, government, or the rest of the world.

Demand

Generally speaking, demand for national products is obtained by subtracting imports and import taxes from total demands. The following table presents the participation of each sector on the different types of national demands.

Table A3.5. National demand distribution within sectors for Panama 2019. As percentages of the totals and million balboas.

Sector	Intermediate	Households	Government	Investment	Exports	Total
Agriculture, Forestry and Fishing	6.4%	2.4%	0.0%	0.0%	1.0%	2.5%
Exploiting of mines and quarries	6.7%	0.1%	0.0%	0.0%	2.3%	2.3%
Food, beverages, and tobacco	4.6%	13.3%	0.6%	0.9%	2.2%	5.2%
Textiles and leather	0.0%	0.3%	0.0%	0.0%	0.5%	0.2%
Wood and paper	1.5%	0.4%	0.0%	0.0%	0.2%	0.6%
Chemicals and plastics	0.9%	0.5%	0.2%	0.2%	1.2%	0.7%
Non-metallic minerals	6.4%	0.1%	0.0%	0.0%	0.3%	1.8%
Other manufacturing industries	2.1%	1.7%	0.0%	0.5%	2.3%	1.5%
Electricity and gas supply	3.8%	2.7%	0.0%	0.0%	0.0%	1.7%
Water treatment and supply	0.5%	0.4%	0.0%	0.0%	0.0%	0.2%
Construction	3.3%	0.6%	0.0%	93.6%	0.0%	21.5%

Commerce	19.8%	23.5%	3.7%	4.7%	26.5%	17.4%
Hotels and restaurants	2.4%	10.4%	0.0%	0.0%	4.1%	4.0%
Transport by land	1.6%	1.4%	0.0%	0.0%	10.2%	2.6%
Aquatic transport	0.5%	0.4%	0.0%	0.0%	3.0%	0.8%
Air transport	1.9%	1.7%	0.0%	0.0%	11.8%	3.1%
Travel agencies	0.2%	0.1%	0.0%	0.0%	1.0%	0.3%
Complementary transport activities	0.4%	0.3%	0.0%	0.0%	2.6%	0.7%
Panama Canal	1.9%	1.6%	0.0%	0.1%	12.1%	3.2%
Mail and telecommunications	3.3%	2.7%	0.0%	0.0%	4.0%	2.3%
Financial and insurance activities	11.0%	4.5%	0.0%	0.0%	9.6%	5.9%
Real estate activities and rentals	6.1%	18.0%	0.0%	0.0%	0.3%	6.2%
Business services	12.5%	0.2%	0.0%	0.0%	4.1%	4.2%
Teaching	0.6%	3.1%	19.4%	0.0%	0.0%	2.4%
Health and social services	1.2%	8.2%	22.8%	0.0%	0.7%	4.3%
Public administration	0.5%	0.1%	39.5%	0.0%	0.1%	3.2%
Community services	0.1%	0.0%	13.8%	0.0%	0.0%	1.1%
Domestic services	0.0%	1.1%	0.0%	0.0%	0.0%	0.3%
Total	28,000	25,429	7,975	22,319	18,704	102,427

Source: Own elaboration based on INEC and 2019 SUTs.

The sectors with significant shares in the total intermediate demand are Commerce (19.8%), Business Services (12.5%) and Financial and Insurance Activity (11.0%). In terms of investment, Construction plays a major role with 93.6% of total investment. For final consumption, Commerce (23.5%), Real estate and rentals (18.0%), Food and beverage (13.3%) and Health and social services (8.2%) concentrate most of the total private consumption. The government mainly demands Public Administration (39.5), Health and Social Services (22.8%) and Teaching (19.4%). Finally, Commerce, the Panama Canal and Air transportation services are the main exporting sectors with export shares of 26.5%, 12.1% and 11.8% respectively.

Households: Consumption and Income patterns

Households spend on domestic and imported goods and they also save. Their incomes correspond to the retribution to production factors minus net-taxes. The result is the net financial status, a financial account used to ensure consistency in the SAM.

Table A3.6. Structure of Household's national consumption in Panama 2019. As percentages of total household consumption.

Sector	Households
Agriculture, Forestry and Fishing	2.4%
Exploiting of mines and quarries	0.1%
Food, beverages, and tobacco	13.3%
Textiles and leather	0.3%
Wood and paper	0.4%
Chemicals and plastics	0.5%
Non-metallic minerals	0.1%
Other manufacturing industries	1.7%
Electricity and gas supply	2.7%
Water treatment and supply	0.4%
Construction	0.6%
Commerce	23.5%
Hotels and restaurants	10.4%
Transport by land	1.4%
Aquatic transport	0.4%
Air transport	1.7%
Travel agencies	0.1%
Complementary transport activities	0.3%
Panama Canal	1.6%
Mail and telecommunications	2.7%
Financial and insurance activities	4.5%
Real estate activities and rentals	18.0%

Business services	0.2%
Teaching	3.1%
Health and social services	8.2%
Public administration	0.1%
Community services	0.0%
Domestic services	1.1%
Total (million balboas)	**25,429**

Source: Own elaboration based on INEC and 2019 SUTs.

On an aggregate level, households spend the most in Commerce (23.5%) and Real Estate Services (18.0%). In addition, the Panama Canal is responsible for 1.6% of total household consumption (tourism, personal & social services, communication services).

Households' income from factor remuneration sources (labor, capital, and mixed income) is obtained as a difference between total income and net transfers received from the rest of the world and/or the government. Table A3.7. presents households' income and expenditures on the SAM.

Table A3.7. Total Households' income and expenditure by concept. In million balboas and percentages.

Concept	Households
Total Income	**53,353**
Labor	27.1%
Mixed Income	15.9%
Capital	48.6%
Transfers	8.3%
Total Expenditures	**58,386**
Consumption	59.5%
Investment	39.2%
Direct Taxes	1.2%
Result	**-5,034**

Source: Own elaboration based on INEC and 2019 SUTs.

According to Table A3.7, 49.77% of households' total income comes from capital remuneration. Secondly, the labor income source constitutes 26.37% of the total. On the other hand, households' expenditure is almost equally divided between consumption (59.07%) and investment (39.89%). In the year 2019, households had a negative result, with a deficit of 5,034 million balboas.

Households: Consumption and Income distribution

This section presents the distribution of income and expenses across deciles of income per capita. The information required to perform this opening was obtained from the Income and Expenditure Survey of Households for Panamá for 2017/2018.

Table A3.8. presents the structure of income and expenditures per decile of income.

Table A3.8. Total Households' income and expenses by decile of per capita income. In million balboas and percentages.

	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10	Total
Incomes	1.2%	2.4%	3.5%	4.6%	5.9%	7.3%	9.1%	11.6%	16.3%	38.0%	53,353
Labor	0.3%	1.6%	3.0%	3.9%	5.7%	7.2%	9.5%	15.0%	19.1%	34.7%	14,468
GMI	0.4%	0.7%	1.1%	1.1%	2.4%	2.6%	4.9%	7.0%	14.0%	65.8%	8,495
Capital	1.6%	3.0%	4.3%	5.8%	6.9%	8.6%	10.3%	10.6%	15.8%	33.1%	25,942
Transfers	3.3%	5.1%	5.2%	6.4%	6.8%	9.1%	9.1%	15.3%	15.0%	24.6%	4,448
Expenses	2.0%	3.1%	4.2%	4.5%	5.2%	6.4%	9.0%	10.8%	13.1%	41.6%	58,386
Consumption	2.6%	4.2%	5.3%	6.2%	7.3%	8.5%	10.2%	12.1%	15.5%	28.1%	34,764
Investment	0.9%	1.5%	2.6%	2.0%	2.1%	3.3%	7.2%	8.7%	9.4%	62.3%	22,915
Taxes	1.8%	3.2%	4.3%	5.3%	6.5%	7.8%	9.6%	11.8%	16.0%	33.7%	708
Result	-513.6	-550.7	-593.9	-188.9	78.9	153.8	-395.3	-70.4	1,055.2	-4,008.6	-5,034

Source: Own elaboration based on INEC and 2019 SUTs.

In terms of income distribution, we can see that the three richest households accumulate 66.0% of total income and 65.5% of total expenditures. If we take a closer look at labor remuneration, we can see that the three poorest households only concentrate 4.9% while the three richest 68.8%. In terms of capital this wedge is minor since capital in the survey includes the impact of cooperatives on income. Therefore, we can see that the three poorest households accumulate 8.8% while the three richest 59.5%.

Table A3.9. presents the composition of national consumption for decile of income.

Table A3.9. Total Households' national consumption by decile of per capita income. In million balboas and percentages.

Sector	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10	Total
Agriculture, Forestry and Fishing	4.9%	4.3%	3.2%	2.9%	3.2%	2.8%	2.6%	2.8%	1.6%	1.4%	2.4%

Exploiting of mines and quarries	0.0%	0.0%	0.2%	0.0%	0.0%	0.0%	0.2%	0.1%	0.1%	0.1%	0.1%
Food, beverages, and tobacco	27.0%	26.3%	19.6%	17.5%	18.9%	15.5%	15.4%	15.3%	8.8%	6.6%	13.3%
Textiles and leather	0.3%	0.4%	0.3%	0.4%	0.4%	0.3%	0.4%	0.4%	0.2%	0.3%	0.3%
Wood and paper	0.6%	0.6%	0.4%	0.4%	0.5%	0.4%	0.4%	0.5%	0.3%	0.5%	0.4%
Chemicals and plastics	0.5%	0.5%	0.5%	0.4%	0.5%	0.5%	0.6%	0.6%	0.5%	0.6%	0.5%
Non-metallic minerals	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.2%	0.2%	0.1%	0.2%	0.1%
Other manufacturing industries	0.0%	0.3%	2.7%	0.3%	0.6%	0.7%	3.1%	2.1%	1.0%	2.3%	1.7%
Electricity and gas supply	5.0%	4.4%	3.3%	3.1%	3.2%	2.8%	2.9%	3.0%	1.9%	2.1%	2.7%
Water treatment and supply	0.7%	0.7%	0.5%	0.5%	0.5%	0.4%	0.4%	0.5%	0.3%	0.3%	0.4%
Construction	0.3%	0.3%	0.4%	0.4%	0.6%	0.5%	0.8%	0.7%	0.6%	0.8%	0.6%
Commerce	16.9%	14.0%	20.5%	22.4%	18.8%	22.3%	20.9%	18.8%	32.0%	26.3%	23.5%
Hotels and restaurants	9.4%	11.2%	8.1%	9.6%	10.7%	10.6%	9.8%	12.2%	7.4%	11.9%	10.4%
Transport by land	1.8%	2.1%	2.0%	2.0%	2.0%	1.7%	1.7%	1.6%	0.9%	0.7%	1.4%
Aquatic transport	0.5%	0.6%	0.6%	0.6%	0.6%	0.5%	0.5%	0.5%	0.3%	0.2%	0.4%
Air transport	2.3%	2.6%	2.5%	2.5%	2.5%	2.2%	2.1%	2.0%	1.2%	0.8%	1.7%
Travel agencies	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.1%	0.0%	0.1%	0.4%	0.1%
Complementary transport activities	0.4%	0.5%	0.5%	0.5%	0.5%	0.4%	0.4%	0.4%	0.2%	0.2%	0.3%
Panama Canal	2.1%	2.5%	2.3%	2.3%	2.4%	2.1%	2.0%	1.9%	1.1%	0.8%	1.6%
Mail and telecommunications	1.6%	3.0%	2.3%	3.0%	3.2%	3.0%	3.6%	3.6%	2.1%	2.2%	2.7%
Financial and insurance activities	3.2%	4.4%	4.5%	3.2%	4.6%	3.7%	5.1%	4.8%	3.7%	5.3%	4.5%
Real estate activities and rentals	13.0%	10.8%	15.7%	17.2%	14.3%	17.1%	15.8%	14.3%	24.5%	20.0%	18.0%
Business services	0.2%	0.1%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.3%	0.3%	0.2%
Teaching	0.8%	1.5%	1.4%	1.7%	2.2%	2.5%	2.9%	3.9%	3.2%	4.3%	3.1%

Health and social services	7.5%	8.1%	7.0%	7.3%	8.2%	8.6%	6.9%	8.7%	5.7%	10.2%	8.2%
Public administration	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Community services	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Domestic services	0.8%	0.7%	1.0%	1.1%	0.9%	1.1%	1.0%	0.9%	1.6%	1.3%	1.1%
Total	673.6	1,074.2	1,349.4	1,574.8	1,843.8	2,153.5	2,595.9	3,065.4	3,943.8	7,154.7	25,429.2

Source: Own elaboration based on INEC and 2019 SUTs.

As we can see, the three main expenditures of households are food and beverage, Commerce and Real Estate Activities and Rentals. The importance of food and beverages decreases with the decils while for Commerce and Real Estate Activities and Rentals increases. Other significant activities for all households are Health and Social Services and Financial and Insurance activities. Finally, it is remarkable that for the poorest households, Electricity and gas supply and agricultural products occupy a significant part of their consumption.

Investment

Gross Capital Formation data is drawn from INEC and equals 25,657 million balboas in 2019, from which private investment represents 76.3%.

Sectoral distribution is constructed using the 2019 SUTs. Most of the investment is placed on Construction (93.6%) (see Table A3.10). Additionally, the total private investment in the Panama Canal only represents 0.1%. Investment in the remaining sectors is noticeably small amounts.

Table A3.10. Sectorial private investment. As a percentage of total private investment.

Sector	Private investment
Agriculture, Forestry and Fishing	0.0%
Exploiting of mines and quarries	0.0%
Food, beverages and tobacco	0.9%
Textiles and leather	0.0%
Wood and paper	0.0%
Chemicals and plastics	0.2%
Non-metallic minerals	0.0%
Other manufacturing industries	0.5%
Electricity and gas supply	0.0%

Water treatment and supply	0.0%
Construction	93.6%
Commerce	4.7%
Hotels and restaurants	0.0%
Transport by land	0.0%
Aquatic transport	0.0%
Air transport	0.0%
Travel agencies	0.0%
Complementary transport activities	0.0%
Panama Canal	0.1%
Mail and telecommunications	0.0%
Financial and insurance activities	0.0%
Real estate activities and rentals	0.0%
Business services	0.0%
Teaching	0.0%
Health and social services	0.0%
Public administration	0.0%
Community services	0.0%
Domestic services	0.0%
Total (million balboas)	**19,577**

Source: Own elaboration based on INEC and 2019 SUTs.

Government: Income and Expenditure

Government's resources come from tax collection, social contributions, and other non-tax income. Their expenditure corresponds to the acquisition of goods and services for consumption and investment as well as transfers given to households. The result is the net financial status, an account used to ensure consistency between income and expenditure in the SAM. The construction of the government was based on the public consolidated budget.

The SAM considers the consolidated general government (central, regional, and local). Table A3.11 shows the details of the government's income and expenditure.

Consumption of goods and services was obtained from the 2019 SUTs. For Public Investment, information comes from government budgets.

Table A3.11. Consolidated public sector for Panama 2019. In million balboas and as a percentage of total GDP.

Concept	Mill. Balboas	% GDP
Income	**12,491.1**	**18.6%**
Tax Revenue	5,338.8	8.0%
Social Security	3,574.8	5.3%
Others	3,577.5	5.3%
Expenditure	**14,594.4**	**21.8%**
Public Consumption	7,975.1	11.9%
Public Investment	2,742.0	4.1%
Subsidies	272.8	0.4%
Transfers	793.4	1.2%
Other expenses	-843.7	-1.3%
Results	**-2,103.3**	**-3.1%**

Source: Own elaboration based on INEC, GID and MEF.

Concerning household transfers, these refer both to social aid as well as retirement pensions, tax collection is carried out by the central government, and retirement funds are collected by the Social Security Fund. "Others" category is defined as non-tax income, including benefits from state-owned or licensed companies such as the Panama Canal.

The tax distribution among productive sectors belongs to the cost structure of the economy. For this work, a matrix of taxes was estimated. This matrix assigns a value for each sector that accounts for the sectorial tax payment. In the following paragraphs, we describe those taxes included in the matrix and the corresponding information sources:

- Import taxes: two types of import taxes are included, VAT and tariffs (payment of selective consumption taxes are included on tariffs)
  - Sector distribution of the VAT for imported goods is obtained by applying the VAT rate over imports (households' consumption) in the 2019 SUTs.
  - Tariff rates are obtained by dividing the total tariff collection for each sector by the total import of the sector, both obtained from the 2019 SUTs.
- Net VAT is obtained as the difference between total VAT and the estimated VAT on imports for final consumption. Said amount was applied to final household consumption. Sector

distribution of the tax comes from the rates applied over final household consumption obtained from the 2019 SUTs.

- Panama has no specific tax placed on exports.
- Other tax income includes other direct taxes, such as the "education insurance"[26], taxes to capital gains and real estate transfers, among others. Information from these taxes comes from the GID and is distributed according to production value.

Additionally, the SAM also specifies income taxes and social contributions. While income tax information is also provided by the GID, social contributions information comes from the MEF based on SSF information.

Table A3.12 shows detailed information on tax collection for 2019. Factor taxes are the most important sources of income for the government, followed by the national VAT. These taxes collected 7,578 million balboas in 2019.

Table A3.12. Detailed Tax Collection for Panama 2019. In million balboas and as a percentage of total GDP.

Tax	Mill. Balboas	% GDP
Tariffs	319	0.5%
National VAT	1,457	2.2%
Production	617	0.9%
Factors	6,121	9.1%
Direct	400	0.6%
Total	8,914	13.3%

Source: Own elaboration based on INEC, GID and MEF.

Moreover, Table A3.13 shows the main economic subsidies granted during 2019, with a total of 273 million Balboas. It is notable that the Panama Canal concentrates almost 12.5% of total subsidies. Thus, the development of the Canal has an impact on the government's financial situation not only through taxes but also due to subsidies. In other words, the increase in the Canal's activity may require the corresponding increase in subsidies, with consequences on the fiscal accounts.

Table A3.13. Detailed Subsidy structure for Panama 2019. In million balboas and as a percentage of total GDP.

Sector	Mill. Balboas	% GDP
Industries	85	0.13%

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[26] The "education insurance" is a direct tax on all agents of the economy. Employees pay 1.25% of their salary and employers will match with a 1.5%. The collected funds are destined to the national education system.

Electricity, gas, and water supply	69	0.10%
Panama Canal	34	0.05%
Rest	85	0.13%
Total	273	0.41%

Source: Own elaboration based on INEC, GID and MEF.

Rest of the world

Import and export data can be observed in table A3.14. While the imports have already been presented, export data is obtained from INEC and the balance of payments. Inbound and outbound transfers due to remuneration (capital benefits and remittances) are also obtained from this source. In 2019, imports were higher than exports in 1,719 million balboas.

Table A3.14. Foreign accounts for Panama 2019. In million balboas and as a percentage of total GDP.

Type	Mill. Balboas	% GDP
Credit	**27,603**	**41.2%**
Exports	27,603	41.2%
Goods	14,365	21.4%
Services	13,238	19.8%
Debit	**34,740**	**51.9%**
Imports	29,322	43.8%
Goods	23,840	35.6%
Services	5,482	8.2%
Net Remunerations	**151**	**0.2%**
Net returns from investment	**5,267**	**7.9%**
Results	**-7,137**	**-10.7%**

Source: Own elaboration based on INEC.

A 3.4. Compatibilization

Table A3.15. presents the composition in terms of activities of the 28 sectors represented in this SAM. For this work, we considered the 70 sectors that are being considered in the national accounts of Panama.

Table A3.15. Compatibilization between activities in the Supply and Use Tables and SAM.

Nation Accounts Activity	SAM Sector
Cultivation of cereals	Agriculture, Forestry and Fishing
Cultivation of legumes, roots, and tubers	Agriculture, Forestry and Fishing
Banana Cultivation	Agriculture, Forestry and Fishing
Growing other fruits and nuts	Agriculture, Forestry and Fishing
Other crops, n.e.c.	Agriculture, Forestry and Fishing
Animal husbandry and ordinary hunting	Agriculture, Forestry and Fishing
Agricultural service activities	Agriculture, Forestry and Fishing
Forestry, timber harvesting and related service activities	Agriculture, Forestry and Fishing
Sea and freshwater fisheries	Agriculture, Forestry and Fishing
Marine and freshwater aquaculture and fisheries-related service activities	Agriculture, Forestry and Fishing
Mining and quarrying	Exploiting of mines and quarries
Production, processing and preservation of meat and fish	Food, beverages and tobacco
Processing and preservation of fruits, legumes, and vegetables; Manufacture of oils and fat of vegetable or animal origin	Food, beverages and tobacco
Milk products	Food, beverages and tobacco
Other food products	Food, beverages and tobacco
Beverage and tobacco	Food, beverages and tobacco
Textiles and clothing products	Textiles and leather
Tanning and marinating of leather, leather products; footwear	Textiles and leather
Food and food products	Wood and paper
Paper and paper products	Wood and paper
Substances and chemicals	Chemicals and plastics
Manufacture of pharmaceuticals, medicinal chemicals, and botanicals	Chemicals and plastics
Manufacture of rubber and plastic products.	Chemicals and plastics
Manufacture of cement, lime, and gypsum	Non-metallic minerals
Manufacture of other non-metallic mineral products n.e.c.	Non-metallic minerals
Manufacture of base metals.	Other manufacturing industries
Other manufacturing industries	Other manufacturing industries

Electricity, gas, steam, and air conditioning supply	Electricity and gas supply
Water collection, distribution, and purification	Water treatment and supply
Construction	Construction
Wholesale trade in free zone	Commerce
Wholesale and commission trade	Commerce
Retail trade	Commerce
Repair and maintenance service activities for motor vehicles and motorcycles	Commerce
Hotels	Hotels and restaurants
Restaurants	Hotels and restaurants
Ground transportation; Pipeline transport	Transport by land
Water transport	Aquatic transport
Air transport	Air transport
Secondary air transport activities: airports	Air transport
Activities of travel agencies, tour operators and related booking services	Travel agencies
Complementary and transport-aiding storage and storage	Complementary transport activities
Other complementary and ancillary activities to transport	Complementary transport activities
Panama Canal	Panama Canal
Other secondary water transport activities	Aquatic transport
Postal, courier and telecommunications activities	Mail and telecommunications
Financial activities, except insurance and pension funds	Financial and insurance activities
Insurance, Reinsurance and Pension Funds, except compulsory social security schemes	Financial and insurance activities
Activities ancillary to financial services, insurance, and pension funds	Financial and insurance activities
Rental housing	Real estate activities and rentals
Other real estate activities	Real estate activities and rentals
Rental of machinery and equipment without operators, household effects and appliances and licensing	Real estate activities and rentals
Informatics and related activities	Business services
Legal and Accounting Activities	Business services

Research and development, business advice and market research activities	Business services
Advertising	Business services
Other business activities	Business services
Teaching	Teaching
Health and Social Services Activities	Health and social services
Other social and personal service activities	Health and social services
Construction	Construction
Rental housing	Real estate activities and rentals
Private households with domestic service	Domestic services
Research and development, business advice and market research activities	Business services
State administration and implementation of the Community's economic and social policy	Public administration
Provision of services to the community at large	Community services
Activities of Social Security Plans of Compulsory Affiliation	Community services
Teaching	Teaching
Health and Social Services Activities	Health and social services
Other social and personal service activities	Health and social services

A4. Step by step elaboration of the 2019 Panama SAE

In this section, the main assumptions and methods used to construct the SAE will be developed. The main sources of information used were the Labor Market Survey for 2019 provided by INEC and the National Economic Census of 2011. Additionally, the Authorities of the Panama Canal also supplied valuable information.

One of the main purposes of this account is to provide complementary information regarding total employment at a sectoral level. In this sense, the data disaggregation for employment must be analogous to the SAM's sectoral disaggregation.

Additionally, these types of tables also provide qualitative information connected to occupational categories, sex, age, and educational background.

For this work, we first consulted the INEC authorities to gain access to the Labor Market Survey for 2019. By working with this database, we were able to extract the total amount of workers in 21 main economic activities. These results are presented in the following table[27].

Table A4.1. Total employment for Panama in 2019.

	Sector	Total Employment
1	Agriculture, cattle raising, forestry & fishing	299,786
2	Mining	7,505
3	Manufacturing Industry	145,811
4	Electricity & gas	5,092
5	Water & sanitization	10,074
6	Construction	172,960
7	Commerce	352,356
8	Hotels & restaurants	144,589
9	Transport & Storage	101,757
10	Information & Communications	27,443
11	Financial intermediation & Insurance	46,533
12	Real estate activities	14,368
13	Business & research activities	45,045
14	Administrative and support service activities	71,899
15	Public administration	117,627
16	Education	105,624
17	Health & social services	91,729
18	Arts, entertainment & recreation	19,957
19	Other services	79,373
20	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	88,656

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[27] These results may slightly differ from the official data published by INEC. This is because some inconsistencies were identified in the official data.

21	Activities of extra-territorial organizations & bodies	1,841
	Total	**1,950,025**

Source: Labor Market Survey 2019, INEC.

Additionally, the Labor Market Survey also allowed to disaggregate the employment vector according to the following criteria:

By occupational categories:

- Public sector workers

- Private sector workers

- Independent workers

- Managers

- Family workers

By sex:

- Male

- Female

By Age[28]:

- Up to 24 years of age

- Older than 24 years of age

By educational background:

- No education

- Only Primary Education (complete and incomplete)[29]

- Only Secondary Education (complete and incomplete)[30]

- Tertiary Education

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[28] The age threshold was chosen following the "youth employment" definition provided by the ILO (2022). Specifically, youth employment involves workers between 16 and 24 years of age.

[29] The database available did not provide enough information to distinguish between and completed primary education and an incomplete one.

[30] The database available did not provide enough information to distinguish between a completed secondary education and an incomplete one.

- University Education

- Vocational[31]

Even though the information provided by this database is a solid starting point, additional data was needed so as to achieve the same sectoral disaggregation as the SAM. Specifically, the manufacturing industry sector, the transport sector and service sector need to be further expanded. For this reason, we used the available data from the 2011 National Economic Census. In this specific dataset, employment information is presented at a 4-digit detail. In the following tables, sector participation for the Manufacturing industry, Transport & Storage and Administrative and Support service activities is presented.

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[31] This type of education makes reference to people who received technical skills such as carpentry, plumbing, culinary arts, etc.

Table A4.2 Labor participation of 4-digit disaggregation of manufacturing activities in the overall Manufacturing sector

Sector	Total Labor Participation
Processing and preserving of meat and production of meat products	13.5%
Processing and preserving of fish, crustaceans and mollusks	3.8%
Processing and preserving of fruit and vegetables	0.6%
Manufacture of dairy products	6.2%
Manufacture of grain mill products, starches and starch products	4.1%
Manufacture of bakery and farinaceous products	10.3%
Manufacture of sugar	8.8%
Manufacture of cocoa, chocolate and sugar confectionery	0.1%
Manufacture of macaroni, noodles, couscous and similar farinaceous products	0.4%
Manufacture of other food products n.e.c.	3.7%
Manufacture of prepared animal feeds	1.2%
Distilling, rectifying and blending of spirits	1.1%
Manufacture of soft drinks; production of mineral waters and other bottled waters	1.5%
Finishing of textiles	1.1%
Manufacture of other textiles	0.3%
Manufacture of wearing apparel, except fur apparel	2.3%
Tanning and dressing of leather; manufacture of luggage, handbags, saddlery and harness; dressing and dyeing of fur	0.6%
Manufacture of footwear	0.1%
Sawmilling and planing of wood	0.4%
Manufacture of other builders' carpentry and joinery	0.1%
Manufacture of wooden containers	0.2%
Manufacture of pulp, paper and paperboard	0.4%
Manufacture of corrugated paper and paperboard and of containers of paper and paperboard	1.1%
Manufacture of other articles of paper and paperboard	0.8%
Printing and reproduction of recorded media	3.9%
Printing and service activities related to printing	0.4%

Manufacture of basic chemicals, fertilizers and nitrogen compounds, plastics and synthetic rubber in primary forms	1.2%
Manufacture of paints, varnishes and similar coatings, printing ink and mastics	0.4%
Manufacture of soap and detergents, cleaning and polishing preparations, perfumes and toilet preparations	1.0%
Manufacture of other chemical products n.e.c.	0.1%
Manufacture of basic pharmaceutical products and pharmaceutical preparations	1.2%
Manufacture of rubber and plastic products	3.6%
Manufacture of glass and glass products	0.9%
Manufacture of clay building materials	0.5%
Manufacture of cement, lime and plaster	1.5%
Manufacture of bricks, tiles and construction products, in baked clay	3.1%
Cutting, shaping and finishing of stone	0.1%
Manufacture of basic iron and steel and of ferro-alloys	1.2%
Manufacture of structural metal products	2.5%
Manufacture of tanks, reservoirs and containers of metal	0.1%
Manufacture of other fabricated metal products n.e.c.	1.6%
Manufacture of electrical equipment	0.8%
Manufacture of machinery and equipment n.e.c.	0.2%
Manufacture of bodies (coachwork) for motor vehicles; manufacture of trailers and semi-trailers	0.2%
Manufacture of parts and accessories for motor vehicles	0.1%
Building of ships and floating structures	0.2%
Manufacture of furniture	3.0%
Manufacture of jewelry, bijouterie and related articles	0.2%
Manufacture of medical and dental instruments and supplies	0.1%
Other manufacturing n.e.c	5.5%
Repair of other equipment	0.3%
Repair and installation of machinery and equipment	0.3%
Repair of electronic and optical equipment	0.1%
Repair of electrical equipment	0.2%

Repair and maintenance of other transport equipment	2.9%

Source: National Economic Census 2011, INEC.

Table A4.3. Labor participation of 4-digit disaggregation of transport sectors in the overall Transport & Storage sector

Sector	Total Labor Participation
Passenger rail transport, interurban	8.7%
Other passenger land transport	1.4%
Freight transport by road, rail and removal services	11.7%
Sea and coastal passenger water transport	0.3%
Sea and coastal freight water transport	4.1%
Passenger air transport	17.8%
Freight air transport and space transport	1.8%
Warehousing and storage	4.1%
Service activities incidental to land transportation	3.9%
Service activities incidental to water transportation	15.9%
Service activities incidental to air transportation	3.8%
Cargo handling	7.4%
Other transportation support activities	16.0%
Postal and courier activities	3.1%
Transportation and Storage	100%

Source: National Economic Census 2011, INEC.

Table A4.4. Labor participation of 4-digit disaggregation of travel agencies in the overall Administrative and support service activity sector

Sector	Total Labor Participation
Renting and leasing of cars and light motor vehicles	2.1%
Renting and leasing of recreational and sports goods	0.3%
Renting of video tapes and disks	0.1%
Renting and leasing of other personal and household goods	0.3%
Renting and leasing of other machinery, equipment and tangible goods n.e.c.	5.0%
Activities of employment placement agencies	1.1%
Temporary employment agency activities	3.2%
Other human resources provision	1.0%
Travel agency activities	1.4%
Tour operator activities & Other reservation service and related activities	1.3%
Private security activities	33.9%
Security systems service activities	2.3%
General cleaning of buildings	7.1%
Other building and industrial cleaning activities	2.2%
Other cleaning activities	1.7%
Combined office administrative service activities	1.3%
Photocopying, document preparation and other specialized office support activities	0.4%
Activities of call centers	31.4%
Organization of conventions and trade shows	1.3%
Activities of collection agencies and credit bureaus	2.3%
Other business support service activities n.e.c.	0.2%
Administrative and support service activity	100%

Source: National Economic Census 2011, INEC.

The structures presented in tables A.4.2, A4.3 and A4.4 were used to expand the employment vector.

However, it should be noted that the information provided in the National Economic Census results insufficient when it comes to the Canal's employment. For this reason, the Canal Authority provided detailed information for this sector. This can be viewed in the following table.

Table A4.5 Employment information for the Panama Canal-2019.

		Total Employment
Occupational Category	Public Sector worker	9,494
	Private Sector worker	0
	Independent worker	0
	Manager	81
	Family worker	0
Sex	Male	8,427
	Female	1,148
Age	Up to 24 years of age	413
	Older than 24 years of age	9,162
Educational Background	No Education	0
	Only Primary Education	252
	Only Secondary Education	12
	Tertiary	0
	University Education	5,218
	Vocational	4,093
	Total	**9,575**

Source: Panama Canal Authority.

Given all the aforementioned data, the SAE was constructed by applying the sectorial structures extracted from the National Economic Census to the Labor Market Survey of 2019. In addition, Transport & Storage disaggregation was ultimately achieved by including the Canal's data.

The results of the SAE are fully available in the Excel attached. As it can be appreciated, by working with all datasets we were able to achieve the 28 sector disaggregation of employment

A5. Quantity-based IO model: technical notes

According to Miller & Blair (2009), a quantity-based IO model consists of a system of n linear equations with n unknowns whose main goal is to analyze changes in demand and intersectoral relationships. Each and every of these equations describes the distribution of a product through the whole economy. The linear nature of this system allows for a direct matrix representation making it easier to reach a solution of a given exercise.

These types of models are constructed from the information provided by the IO matrix embedded in the SAM. As it was previously mentioned, such a matrix contains information of the intersectoral flows, the final demand structure and value added from the different activities of the economy. One of the main characteristics of this matrix is the fact that all information must meet the budget constraints conditions (i.e. all that is produced must be demanded).

To describe an IO model considering an economy with n sectors, the starting point is the fact that all sales from a given sector i are equal to the sum of sales that this specific sector makes to others in the concept of intermediate consumption and the sum of final demand sales (i.e. Private and/or Public consumption, Investment and Exports). In mathematical terms:

(1) $\qquad x_i = z_{i1} + \ldots + z_{in} + f_i = \sum_{j=1}^{n} z_{ij} + f_i$

Where x_i are the sectors' total sales, f_i represents a sector's final demand and, finally, z_{ij} represent inter industry sales by sector i to all sectors j (including itself, when $i=j$). The fixed coefficient assumption is vital to this theory and implies that interindustry flows from i to j depend completely on sector j total output. In this way, the IO model assumes that intersectoral purchases are a proportion of the buyer sector's total output.

Fixed coefficients are a result of the ratio of the sales between two sectors and the total output of the buying sector. These "technical coefficients" represent the proportion of total product that corresponds to the input that is being purchased. Mathematically: $a_{ij} = \frac{z_{ij}}{x_j}$. Hence, we can conclude that $z_{ij} = a_{ij} x_j$.

At the same time, we can use the previous conclusions and update equation (1) replacing every z_{ij} with its corresponding fixed coefficients:

(2) $\qquad x_i = a_{i1} x_1 + \ldots + a_{in} x_n + f_i = \sum_{j=1}^{n} a_{ij} x_j + f_i$

By reproducing equation (2) for each sector of the economy, we can obtain the aforementioned system of equations.

$$x_1 = a_{11} x_1 + \ldots + a_{1n} x_n + f_1$$

$$x_2 = a_{21} x_1 + \ldots + a_{2n} x_n + f_2$$

$$\vdots$$

$$x_n = a_{n1}x_1 + \ldots + a_{nn}x_n + f_i$$

Additionally, said system can be expressed in the following matrix form:

(3) $\begin{bmatrix} x_1 \, x_2 \vdots x_n \end{bmatrix} = \begin{bmatrix} a_{11} \, a_{12} \ldots a_{1n} \, a_{21} \, a_{22} \ldots a_{2n} \vdots \vdots \ddots \vdots a_{n1} \, a_{n2} \ldots a_{nn} \end{bmatrix} \begin{bmatrix} x_1 \, x_2 \vdots x_n \end{bmatrix} + \begin{bmatrix} f_1 \, f_2 \vdots f_n \end{bmatrix}$

To simplify the notation, equation (3) will be expressed in the following way:

(4) $X = AX + f$

Where X is the vector that contains each sector's output, A is the technical coefficient matrix and f is the vector that contains the final demands for all sectors. It is important to note that from equation (4) we can express X in terms of the other variables. Thus, we obtain:

(5) $X = (I - A)^{-1}f = Lf$

Where $(I - A)^{-1} = L$ is known as *Leontief Inverse Matrix.* Note that L is a matrix that is created from the available data in the technical coefficient matrix. In this way, we can modify vector f and measure the change on each element of X (i.e., the output levels in each sector). Similarly, the direct and indirect impact on labor can be estimated by considering the employment requirements for each sector provided in the SAE.

From a technical standpoint, the way the scenarios are introduced in this IO model is by modifying some or all the elements of vector f (assuming that the Leontief matrix remains unchanged). Said modifications will eventually spread across the IO structure of the economy bringing about the final total effect on the productive system.

The total effects are a result of the direct effects (generated by the specific shock simulated) and the indirect effects (generated by the linkages with other sectors of the economy). In terms of the previously presented model, carrying out simulations in an IO model imply:

$$\Delta X = (I - A)^{-1}\Delta f = L\Delta f.$$

As it was mentioned in section 3, we also consider a "Closed" version of the IO model so as to capture the induced effects brought about by variations in household income and consumption. From a technical perspective, this can be easily achieved by moving the household sector from the final-demand column and labor input row and placing it inside the technically interrelated A matrix, making households an endogenous sector. This goes in line with Round (2003) who uses the "SAM-based" models that incorporates the household income and expenditure presented in a SAM to study how different scenarios may impact income distribution.

From a mathematical perspective:

(6) $x_i = z_{i1} + \ldots + z_{in} + z_{i,h1} + \ldots + z_{i,h10} + f_i{}^* = \sum\limits_{j=1}^{n} z_{ij} + \sum\limits_{j=1}^{10} z_{i,hj} + f_i{}^*$

The $f_i{}^*$ now represents the remaining final demand for sector i output exclusive of that of households which are now captured in $\sum\limits_{j=1}^{10} z_{i,hj}$. In addition, to this kind of modification on each equation there would be 10 new equations for total "output" of each household sector, defined to be the total value of its sale of labor services to the various sectors (i.e. total earnings). Formally,

$$(7) \quad x_{hi} = z_{hi,1} + \ldots + z_{hi,n} + z_{hi,h1} + \ldots + z_{hi,h10} + f_i{}^* = \sum\limits_{j=1}^{n} z_{hi,j} + \sum\limits_{j=1}^{10} z_{hi,hj} + f_{hi}{}^*$$

At this point it is important to state the assumptions made to construct the last set of equations. The SAM for Panama 2019 presents each sector's labor remunerations without distinguishing between decile groups. In order to achieve this, we have used the structure of labor income presented in the SAM. Specifically, these values are presented in the following table.

Table A5.1. Percentage of total labor remunerations received by each household decile.

Decile	Percentage
H1	0,32%
H2	1,56%
H3	3,02%
H4	3,94%
H5	5,73%
H6	7,17%
H7	9,46%
H8	14,98%
H9	19,08%
H10	34,72%

Source: Own elaboration.

Using the information presented in Table A5.1 we can perform the following interpretation: 0,32% of labor remunerations from sector *i* belong to the first household decile. The same analysis can be carried out for the rest of sectors and households.

From the expenditure perspective, household "consumption coefficients" are incorporated into the A matrix. Formally speaking,

$$a_{i,hj} = \frac{z_{i,hj}}{x_{hj}}$$

Where $a_{i,hj}$ refers to a technical coefficient that shows the proportion of expenditure of household *j* to sector *i* in relation to that household total expenditure. From an Income point of view, household input coefficients are found in the same manner: the value of sector *j* purchases of labor divided by the value of total output of sector *j*. Formally,

$$a_{hi,j} = \frac{z_{hi,j}}{x_j}$$

At this point, the complete Closed model can be expressed in the following manner:

$$x_1 = a_{11}x_1 + \dots + a_{1n}x_n + a_{1,h1}x_{h1} + \dots + a_{1,h10}x_{h10} + f_1{}^*$$

$$x_2 = a_{21}x_1 + \dots + a_{2n}x_n + a_{2,h1}x_{h1} + \dots + a_{2,h10}x_{h10} + f_2{}^*$$

$$\vdots$$

$$x_n = a_{n1}x_1 + \dots + a_{nn}x_n + a_{n,h1}x_{h1} + \dots + a_{n,h10}x_{h10} + f_n{}^*$$

$$x_{h1} = a_{h1,1}x_1 + \dots + a_{h1,n}x_n + a_{h1,h1}x_{h1} + \dots + a_{h1,h10}x_{h10} + f_{h1}{}^*$$

$$\vdots$$

$$x_{h10} = a_{h10,1}x_1 + \dots + a_{h10,n}x_n + a_{h10,h1}x_{h1} + \dots + a_{h10,h10}x_{h10} + f_{h10}{}^*$$

From a matricial point of view, this can now be reduced to:

$$X = A * X + f *$$

At this point the inversion procedure works exactly the same as in the "Open" model. In this case, the results of a given simulation will not only include the direct and indirect effects but also the induced ones brought about by the inclusion of households.

One final comment is related to the role the dividends of the Panama Canal play in this model. As it was mentioned in section 3, the methodological decision of this model is to also include the proportion of dividends from the Canal to the government that are destined for current expenditure. In order to achieve this, we solely modified the aforementioned technique for the Panama Canal sector. Specifically, instead of only considering labor remuneration paid to households from the Canal we also included said proportion of dividends. In this case, we also applied the decile structure presented in Table A5.1.

A5.1 Hypothetical Extraction Method

In this section we present the technical singularities applied to the IO model so as to achieve a Hypothetical Extraction of the Panama Canal from the economy.

Extracting one specific sector from the economy implies modifying the IO matrix embedded in the SAM. For this reason, this simulation supposes not only a modification of the *X* vector (fewer sectors means fewer output demanded) but also of the technical coefficients. In this sense, matrix *A* adopts the following form:

$$A = \begin{bmatrix} a_{11} & a_{12} & \cdots & 0 & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & 0 & \cdots & a_{2n} \\ \vdots & \vdots & \cdots & \vdots & \cdots & \vdots \\ 0 & 0 & \cdots & 0 & \cdots & 0 \\ \vdots & \vdots & \cdots & \vdots & \cdots & \vdots \\ a_{n1} & a_{n2} & \cdots & 0 & \cdots & a_{nn} \end{bmatrix}$$

In other words, if sector *j* is extracted from the economy, its technical coefficients associated to both purchases and sales must be 0.

A6. Production and Employment Multipliers

The following table shows the sectoral production multipliers for the 28 sectors in the economy. Results are presented for all the model configurations considered.

Table A6.1. Sectoral production multipliers for Panama. Year 2019.

Sector	Open Model		Closed Model	
	BL	FL	BL	FL
Agriculture, cattle, forestry & fishing	1.48	1.77	1.57	2.04
Mining	1.26	1,37	1.31	1.39
Food, beverage & tobacco	1.72	1.56	1.82	2.14
Textiles, leather & clothing	1.36	1.01	1.42	1.02
Wood & wood products	1.54	1.22	1.63	1.26
Chemicals & plastic products	1.35	1,13	1.43	1.16
Non-metallic minerals	1.48	1.19	1.57	1.20
Rest of industry	1.27	1.20	1.34	1.28
Electricity & gas	1.45	1.65	1.55	1.81
Water & sanitization	1.53	1,08	1.63	1.10
Construction	1.40	1.30	1.47	1.36
Commerce	1.35	3.02	1.47	4.10
Hotels & restaurants	1.49	1.33	1.60	1.72
Road & pipeline transport	1.40	1,22	1.53	1.29
Water transport	1.39	1.06	1.52	1.08
Air transport	1.60	1.26	1.71	1.34
Travel agencies	1.55	1.02	1.69	1.03
Other transport complementary & auxiliary	1.45	1.05	1.60	1.07
Services supplied by the Panama Canal	1.09	1.26	1.57	1.34
Information & Communications	1.43	1.49	1.57	1.65
Financial intermediation & Insurance	1.37	2.07	1.54	2.41
Real estate activities	1.20	1.62	1.25	2.35
Business & research activities	1.26	2.42	1.39	2.61
Education	1.16	1.06	1.61	1.18
Health & social services	1.32	1.11	1.62	1.42
Public administration	1.38	1.05	1.79	1.05
General services to community	1.25	1.01	1.71	1.01
Domestic services (cleaning, caring, etc.)	1.00	1.00	1.57	1.04

Source: Own elaboration.

As far as the employment multipliers are concerned, the following table indicates the sectoral employment multipliers.

Table A6.2. Sectoral employment multipliers for Panama. Year 2019.

Sector	Open Model	Closed Model
Agriculture, cattle, forestry & fishing	1.14	1.15
Mining	2.45	2.83
Food, beverage & tobacco	3.86	4.01
Textiles, leather & clothing	1.38	1.42
Wood & wood products	2.44	2.59
Chemicals & plastic products	3.96	4.66
Non-metallic minerals	2.04	2.42
Rest of industry	1.21	1.27
Electricity & gas	2.88	3.69
Water & sanitization	1.16	1.21
Construction	1.60	1.82
Commerce	1.29	1.44
Hotels & restaurants	1.59	1.70
Road & pipeline transport	1.64	1.91
Water transport	1.18	1.27
Air transport	2.20	2.48
Travel agencies	1.61	2.68
Other transport complementary & auxiliary	1.18	1.16
Services supplied by the Panama Canal	1.50	5.31
Information & Communications	1.60	1.87
Financial intermediation & Insurance	1.66	2.17
Real estate activities	2.25	2.75
Business & research activities	1.16	1.29
Education	1.06	1.31
Health & social services	1.28	1.62
Public administration	1.18	1.44
General services to community	1.04	1.17
Domestic services (cleaning, caring, etc.)	1.00	1.04

Source: Own elaboration.

A7. Hypothetical extraction results

Table A7.1. Direct, Indirect and induced sectoral effects on GDP of the existence of the Panama Canal in the Panamanian economy. 2019. In a million balboas.

Sector	Direct effects	Indirect effects	Induced effects by labor remunerations	Induced effects by government transfers	Total effect
Agriculture, cattle, forestry & fishing	0	1	15	33	49
Mining	0	6	2	3	11
Food, beverage & tobacco	0	1	24	52	76
Textiles, leather & clothing	0	0	1	2	2
Wood & wood products	0	3	2	4	8
Chemicals & plastic products	0	1	2	4	7
Non-metallic minerals	0	8	1	2	10
Rest of industry	0	6	5	11	23
Electricity & gas	0	29	9	19	57
Water & sanitization	0	3	1	3	7
Construction	0	2	4	9	14
Commerce	0	30	73	159	261
Hotels & restaurants	0	2	24	53	79
Road & pipeline transport	0	3	4	9	15
Water transport	0	1	1	3	5
Air transport	0	1	2	5	9
Travel agencies	0	0	0	1	1
Other transport complementary & auxiliary	0	1	1	2	4
Services supplied by the Panama Canal	2,925	0	0	0	2,925
Information & Communications	0	12	9	20	41
Financial intermediation & Insurance	0	18	23	50	91
Real estate activities	0	6	59	128	192
Business & research activities	0	49	14	30	93
Education	0	7	10	22	39
Health & social services	0	2	21	45	67
Public administration	0	1	0	1	2
General services to community	0	0	0	0	1
Domestic services (cleaning, caring, etc.)	0	0	4	9	13
Total	**2,925**	**191**	**310**	**677**	**4,102**

Source: Own elaboration.

Table A7.2. Direct, Indirect and induced sectoral effects on Government Revenue of the existence of the Panama Canal in the Panamanian economy. 2019. In a million balboas.

Sector	Direct effects	Indirect effects	Induced effects by labor remunerations	Induced effects by government transfers	Total effect
Agriculture, cattle, forestry & fishing	0	0	1	3	4
Mining	0	1	0	0	1
Food, beverage & tobacco	0	0	5	10	15
Textiles, leather & clothing	0	0	1	1	2
Wood & wood products	0	1	0	1	2
Chemicals & plastic products	0	0	1	2	3
Non-metallic minerals	0	2	0	0	2
Rest of industry	0	4	3	7	14
Electricity & gas	0	3	1	2	6
Water & sanitization	0	0	0	0	0
Construction	0	0	0	1	1
Commerce	0	3	7	16	26
Hotels & restaurants	0	0	3	7	10
Road & pipeline transport	0	0	0	1	1
Water transport	0	0	0	0	1
Air transport	0	0	0	0	1
Travel agencies	0	0	0	0	0
Other transport complementary & auxiliary	0	0	0	0	0
Services supplied by the Panama Canal	1,922	0	0	0	1,922
Information & Communications	0	2	2	3	7
Financial intermediation & Insurance	0	4	5	10	18
Real estate activities	0	0	2	5	7
Business & research activities	0	10	3	6	19
Education	0	1	2	4	7
Health & social services	0	0	3	8	11
Public administration	0	0	0	0	0
General services to community	0	0	0	0	0
Domestic services (cleaning, caring, etc.)	0	0	1	2	3
Total	**1,922**	**32**	**41**	**90**	**2,084**

Source: Own elaboration.

Table A7.3. Direct, Indirect and Induced sectoral effects on Exports of the existence of the Panama Canal in the Panamanian economy. 2019. In a million balboas.

Sector	Direct effects	Indirect effects	Induced effects by labor remunerations	Induced effects by government transfers	Total effect
Agriculture, cattle, forestry & fishing	0	0	2	4	6
Mining	0	2	0	1	3
Food, beverage & tobacco	0	0	4	10	14
Textiles, leather & clothing	0	0	1	1	2
Wood & wood products	0	0	0	0	1
Chemicals & plastic products	0	1	1	2	4
Non-metallic minerals	0	0	0	0	1
Rest of industry	0	2	2	5	9
Electricity & gas	0	0	0	0	0
Water & sanitization	0	0	0	0	0
Construction	0	0	0	0	0
Commerce	0	12	29	64	105
Hotels & restaurants	0	1	7	16	24
Road & pipeline transport	0	3	5	11	19
Water transport	0	1	1	3	5
Air transport	0	3	6	13	22
Travel agencies	0	0	0	1	2
Other transport complementary & auxiliary	0	1	1	3	5
Services supplied by the Panama Canal	2,269	0	0	0	2,269
Information & Communications	0	6	5	10	21
Financial intermediation & Insurance	0	8	10	21	39
Real estate activities	0	0	1	1	2
Business & research activities	0	11	3	7	22
Education	0	0	0	0	0
Health & social services	0	0	1	2	3
Public administration	0	0	0	0	0
General services to community	0	0	0	0	0
Domestic services (cleaning, caring, etc.)	0	0	0	0	0
Total	**2,269**	**52**	**80**	**175**	**2,577**

Source: Own elaboration.

Table A7.4. Direct, Indirect and induced sectoral effects on Labor of the existence of the Panama Canal in the Panamanian economy. 2019. In job positions.

Sector	Direct effects	Indirect effects	Induced effects by labor remunerations	Induced effects by government transfers	Total effect
Agriculture, cattle, forestry & fishing	0	128	3,100	6,769	9,997
Mining	0	27	7	15	49
Food, beverage & tobacco	0	19	867	1,893	2,779
Textiles, leather & clothing	0	1	40	88	129
Wood & wood products	0	78	49	108	235
Chemicals & plastic products	0	5	8	18	31
Non-metallic minerals	0	77	9	19	105
Rest of industry	0	217	188	411	816
Electricity & gas	0	146	43	93	282
Water & sanitization	0	262	88	192	542
Construction	0	22	51	112	185
Commerce	0	846	2,074	4,530	7,451
Hotels & restaurants	0	93	961	2,100	3,154
Road & pipeline transport	0	50	80	175	306
Water transport	0	44	74	162	281
Air transport	0	43	75	165	283
Travel agencies	0	3	5	11	19
Other transport complementary & auxiliary	0	68	115	251	434
Services supplied by the Panama Canal	9,575	0	0	0	9,575
Information & Communications	0	214	171	374	760
Financial intermediation & Insurance	0	206	254	555	1,015
Real estate activities	0	16	160	350	527
Business & research activities	0	1,709	488	1,066	3,263
Education	0	339	495	1,080	1,914
Health & social services	0	63	634	1,385	2,083
Public administration	0	34	27	60	121
General services to community	0	14	16	34	64
Domestic services (cleaning, caring, etc.)	0	0	1,230	2,687	3,917
Total	**9,575**	**4,728**	**11,311**	**24,702**	**50,316**

Source: Own elaboration.

A8. COVID-19 scenario results

Table A8.1. Direct, Indirect and induced sectoral effects on GDP of the Covid-19 outbreak of 2020. In a million balboas.

Sector	Direct Effect		Indirect Effect		Induced Effect from Labor remunerations		Induced Effect from Government transfers	Total Effect	
Agriculture, cattle, forestry & fishing	-		-	0.1	-	1.3	-2.8	-	4.13
Mining	-		-	0.5	-	0.1	-0.3	-	0.94
Food, beverage & tobacco	-		-	0.0	-	2.0	-4.4	-	6.37
Textiles, leather & clothing	-		-	0.0	-	0.1	-0.1	-	0.20
Wood & wood products	-		-	0.2	-	0.1	-0.3	-	0.65
Chemicals & plastic products	-		-	0.1	-	0.2	-0.3	-	0.59
Non-metallic minerals	-		-	0.6	-	0.1	-0.2	-	0.86
Rest of industry	-		-	0.5	-	0.4	-1.0	-	1.91
Electricity & gas	-		-	2.4	-	0.8	-1.6	-	4.76
Water & sanitization	-		-	0.3	-	0.1	-0.2	-	0.60
Construction	-		-	0.1	-	0.3	-0.7	-	1.19
Commerce	-		-	2.4	-	6.1	-13.4	-	22.00
Hotels & restaurants	-		-	0.2	-	2.0	-4.4	-	6.65
Road & pipeline transport	-		-	0.2	-	0.3	-0.8	-	1.30
Water transport	-		-	0.1	-	0.1	-0.2	-	0.38
Air transport	-		-	0.1	-	0.2	-0.4	-	0.74
Travel agencies	-		-	0.0	-	0.0	-0.1	-	0.10
Other transport complementary & auxiliary	-		-	0.1	-	0.1	-0.2	-	0.33
Services supplied by the Panama Canal	-	120.31	-	0.4	-	4.7	-1.8	-	127.11
Information & Communications	-		-	1.0	-	0.8	-1.7	-	3.46
Financial intermediation & Insurance	-		-	1.5	-	1.9	-4.2	-	7.66
Real estate activities	-		-	0.5	-	4.9	-10.8	-	16.17
Business & research activities	-		-	4.0	-	1.2	-2.6	-	7.83
Education	-		-	0.6	-	0.8	-1.9	-	3.26
Health & social services	-		-	0.2	-	1.7	-3.8	-	5.67
Public administration	-		-	0.1	-	0.0	-0.1	-	0.19
General services to community	-		-	0.0	-	0.0	0.0	-	0.05
Domestic services (cleaning, caring, etc.)	-			-	-	0.3	-0.7	-	1.08
Total	-	120.31	-	16.02	-	30.86	- 59.0	-	226.2

Source: Own elaboration.

Table A8.2. Direct, Indirect and induced sectoral effects on Government Revenue of the Covid-19 outbreak of 2020. In a million balboas.

Sector	Direct Effect	Indirect Effect	Induced Effect from Labor remunerations	Induced Effect from Government transfers	Total Effect
Agriculture, cattle, forestry & fishing	-	- 0.00	- 0.10	- 0.23	- 0.33
Mining	-	- 0.06	- 0.02	- 0.03	- 0.11
Food, beverage & tobacco	-	- 0.01	- 0.39	- 0.86	- 1.26
Textiles, leather & clothing	-	- 0.00	- 0.05	- 0.10	- 0.15
Wood & wood products	-	- 0.05	- 0.03	- 0.07	- 0.16
Chemicals & plastic products	-	- 0.04	- 0.06	- 0.13	- 0.22
Non-metallic minerals	-	- 0.14	- 0.02	- 0.04	- 0.19
Rest of industry	-	- 0.29	- 0.27	- 0.58	- 1.14
Electricity & gas	-	- 0.28	- 0.09	- 0.17	- 0.53
Water & sanitization	-	- 0.01	- 0.00	- 0.01	- 0.03
Construction	-	- 0.01	- 0.03	- 0.06	- 0.10
Commerce	-	- 0.24	- 0.61	- 1.34	- 2.20
Hotels & restaurants	-	- 0.03	- 0.27	- 0.59	- 0.88
Road & pipeline transport	-	- 0.02	- 0.03	- 0.07	- 0.11
Water transport	-	- 0.01	- 0.01	- 0.03	- 0.05
Air transport	-	- 0.01	- 0.02	- 0.04	- 0.07
Travel agencies	-	- 0.00	- 0.01	- 0.01	- 0.02
Other transport complementary & auxiliary	-	- 0.00	- 0.01	- 0.02	- 0.03
Services supplied by the Panama Canal	- 79.05	- 0.24	- 3.07	- 1.14	- 83.50
Information & Communications	-	- 0.16	- 0.13	- 0.28	- 0.57
Financial intermediation & Insurance	-	- 0.31	- 0.39	- 0.85	- 1.54
Real estate activities	-	- 0.02	- 0.18	- 0.39	- 0.58
Business & research activities	-	- 0.81	- 0.25	- 0.50	- 1.57
Education	-	- 0.10	- 0.15	- 0.33	- 0.58
Health & social services	-	- 0.03	- 0.29	- 0.64	- 0.96
Public administration	-	- 0.01	- 0.01	- 0.02	- 0.04
General services to community	-	- 0.00	- 0.00	- 0.01	- 0.01
Domestic services (cleaning, caring, etc.)	-	-	- 0.07	- 0.15	- 0.21
Total	- 79.05	- 2.88	- 6.55	- 8.66	- 97.15

Source: Own elaboration.

Table A8.3. Direct, Indirect and Induced sectoral effects on Exports of the Covid-19 outbreak of 2020. In a million balboas.

Sector	Direct Effect	Indirect Effect	Induced Effect from Labor remunerations	Induced Effect from Government transfers	Total Effect
Agriculture, cattle, forestry & fishing	-	- 0.01	- 0.16	- 0.35	- 0.51
Mining	-	- 0.13	- 0.04	- 0.06	- 0.23
Food, beverage & tobacco	-	- 0.01	- 0.36	- 0.80	- 1.18
Textiles, leather & clothing	-	- 0.00	- 0.04	- 0.10	- 0.14
Wood & wood products	-	- 0.03	- 0.02	- 0.04	- 0.09
Chemicals & plastic products	-	- 0.06	- 0.09	- 0.19	- 0.34
Non-metallic minerals	-	- 0.03	- 0.00	- 0.01	- 0.04
Rest of industry	-	- 0.20	- 0.18	- 0.38	- 0.76
Electricity & gas	-	- 0.02	- 0.01	- 0.01	- 0.03
Water & sanitization	-	- 0.01	- 0.00	- 0.00	- 0.01
Construction	-	-	-	-	-
Commerce	-	- 0.97	- 2.45	- 5.31	- 8.74
Hotels & restaurants	-	- 0.06	- 0.60	- 1.33	- 1.99
Road & pipeline transport	-	- 0.25	- 0.41	- 0.88	- 1.54
Water transport	-	- 0.07	- 0.12	- 0.25	- 0.44
Air transport	-	- 0.27	- 0.49	- 1.06	- 1.83
Travel agencies	-	- 0.02	- 0.04	- 0.08	- 0.15
Other transport complementary & auxiliary	-	- 0.06	- 0.10	- 0.22	- 0.38
Services supplied by the Panama Canal	- 93.37	- 0.29	- 3.62	- 1.34	- 98.62
Information & Communications	-	- 0.48	- 0.40	- 0.83	- 1.71
Financial intermediation & Insurance	-	- 0.65	- 0.83	- 1.75	- 3.23
Real estate activities	-	- 0.01	- 0.05	- 0.12	- 0.18
Business & research activities	-	- 0.93	- 0.29	- 0.53	- 1.75
Education	-	- 0.00	- 0.00	- 0.00	- 0.01
Health & social services	-	- 0.01	- 0.08	- 0.17	- 0.26
Public administration	-	- 0.00	- 0.00	- 0.00	- 0.00
General services to community	-	- 0.00	- 0.00	- 0.00	- 0.00
Domestic services (cleaning, caring, etc.)	-	-	-	-	-
Total	- 93.37	- 4.54	- 10.40	- 15.83	- 124.14

Source: Own elaboration.

Table A8.4. Direct, Indirect and induced sectoral effects on Labor of the Covid-19 outbreak of 2020. In job positions.

Sector	Direct Effect		Indirect Effect		Induced Effect from Labor remunerations		Induced Effect from Government transfers		Total Effect	
Agriculture, cattle, forestry & fishing	-		-	11	-	259	-	571	-	841
Mining	-		-	2	-	1	-	1	-	4
Food, beverage & tobacco	-		-	2	-	72	-	160	-	234
Textiles, leather & clothing	-		-	0	-	3	-	7	-	11
Wood & wood products	-		-	6	-	4	-	9	-	20
Chemicals & plastic products	-		-	0	-	1	-	1	-	3
Non-metallic minerals	-		-	6	-	1	-	2	-	9
Rest of industry	-		-	18	-	16	-	35	-	69
Electricity & gas	-		-	12	-	4	-	8	-	24
Water & sanitization	-		-	21	-	8	-	16	-	46
Construction	-		-	2	-	4	-	9	-	16
Commerce	-		-	69	-	175	-	383	-	627
Hotels & restaurants	-		-	8	-	80	-	177	-	265
Road & pipeline transport	-		-	4	-	7	-	15	-	26
Water transport	-		-	4	-	6	-	14	-	24
Air transport	-		-	4	-	6	-	14	-	24
Travel agencies	-		-	0	-	0	-	1	-	2
Other transport complementary & auxiliary	-		-	6	-	10	-	21	-	37
Services supplied by the Panama Canal	-	394	-	1	-	15	-	6	-	416
Information & Communications	-		-	18	-	15	-	32	-	64
Financial intermediation & Insurance	-		-	17	-	22	-	47	-	85
Real estate activities	-		-	1	-	13	-	30	-	44
Business & research activities	-		-	140	-	43	-	91	-	275
Education	-		-	28	-	42	-	91	-	161
Health & social services	-		-	5	-	53	-	117	-	175
Public administration	-		-	3	-	2	-	5	-	10
General services to community	-		-	1	-	1	-	3	-	5
Domestic services (cleaning, caring, etc.)	-			-	-	103	-	227	-	330
Total	-	394	-	389	-	968	-	2,093	-	3,844

Source: Own elaboration.

A9. World demand trends scenario results

Table A9.1. Direct, Indirect and induced sectoral effects on GDP of World demand trends . 2019. In a million balboas.

	Direct Effect	Indirect Effect	Induced Effect from Labor remunerations	Induced Effect from Government transfers	Total Effect
Agriculture, cattle, forestry & fishing	0.00	0.98	23.64	52.05	76.67
Mining	0.00	9.70	2.44	5.37	17.51
Food, beverage & tobacco	0.00	0.81	36.71	80.82	118.34
Textiles, leather & clothing	0.00	0.03	1.13	2.49	3.65
Wood & wood products	0.00	3.95	2.53	5.58	12.06
Chemicals & plastic products	0.00	1.80	2.83	6.24	10.88
Non-metallic minerals	0.00	11.63	1.36	2.99	15.99
Rest of industry	0.00	9.33	8.15	17.94	35.42
Electricity & gas	0.00	45.41	13.42	29.55	88.38
Water & sanitization	0.00	5.36	1.82	4.00	11.18
Construction	0.00	2.63	6.06	13.34	22.04
Commerce	0.00	46.01	113.21	249.24	408.46
Hotels & restaurants	0.00	3.61	37.44	82.43	123.47
Road & pipeline transport	0.00	3.96	6.32	13.92	24.20
Water transport	0.00	1.12	1.87	4.12	7.11
Air transport	0.00	2.05	3.63	7.99	13.67
Travel agencies	0.00	0.30	0.49	1.09	1.88
Other transport complementary & auxiliary	0.00	0.96	1.62	3.58	6.17
Services supplied by the Panama Canal	4,524.58	7.03	11.47	25.25	4,568.33
Information & Communications	0.00	18.00	14.47	31.85	64.32
Financial intermediation & Insurance	0.00	28.64	35.46	78.08	142.18
Real estate activities	0.00	9.10	90.93	200.19	300.22
Business & research activities	0.00	75.49	21.81	48.01	145.32
Education	0.00	10.66	15.60	34.33	60.59
Health & social services	0.00	3.17	31.91	70.24	105.32
Public administration	0.00	0.97	0.78	1.71	3.45
General services to community	0.00	0.20	0.22	0.49	0.90
Domestic services (cleaning, caring, etc.)	0.00	0.00	6.27	13.81	20.09
Total	4,524.58	302.90	493.61	1,086.70	6,407.79

Source: Own elaboration.

Table A9.2. Direct, Indirect and induced sectoral effects on Government Revenue of World demand trends. In a million balboas.

	Direct Effect	Indirect Effect	Induced Effect from Labor remunerations	Induced Effect from Government transfers	Total Effect
Agriculture, cattle, forestry & fishing	0.00	0.08	1.90	4.19	6.17
Mining	0.00	1.12	0.28	0.62	2.02
Food, beverage & tobacco	0.00	0.16	7.26	15.97	23.39
Textiles, leather & clothing	0.00	0.02	0.87	1.91	2.80
Wood & wood products	0.00	0.98	0.63	1.39	3.00
Chemicals & plastic products	0.00	0.68	1.07	2.35	4.10
Non-metallic minerals	0.00	2.61	0.31	0.67	3.59
Rest of industry	0.00	5.56	4.85	10.68	21.10
Electricity & gas	0.00	5.21	1.54	3.39	10.13
Water & sanitization	0.00	0.25	0.09	0.19	0.52
Construction	0.00	0.22	0.51	1.12	1.85
Commerce	0.00	4.60	11.33	24.94	40.87
Hotels & restaurants	0.00	0.48	4.95	10.90	16.32
Road & pipeline transport	0.00	0.34	0.55	1.21	2.10
Water transport	0.00	0.15	0.25	0.56	0.97
Air transport	0.00	0.20	0.36	0.78	1.34
Travel agencies	0.00	0.07	0.12	0.27	0.47
Other transport complementary & auxiliary	0.00	0.08	0.13	0.29	0.50
Services supplied by the Panama Canal	2,972.90	4.62	7.54	16.59	3,001.65
Information & Communications	0.00	2.96	2.38	5.24	10.57
Financial intermediation & Insurance	0.00	5.81	7.19	15.83	28.82
Real estate activities	0.00	0.33	3.27	7.19	10.79
Business & research activities	0.00	15.40	4.45	9.79	29.64
Education	0.00	1.89	2.77	6.10	10.76
Health & social services	0.00	0.53	5.37	11.83	17.73
Public administration	0.00	0.19	0.15	0.34	0.68
General services to community	0.00	0.04	0.04	0.09	0.18
Domestic services (cleaning, caring, etc.)	0.00	0.00	1.23	2.71	3.94
Total	2,972.90	54.58	71.38	157.14	3,256.00

Source: Own elaboration.

Table A9.3. Direct, Indirect and Induced sectoral effects on Exports of World demand trends. In a million balboas.

	Direct Effect	Indirect Effect	Induced Effect from Labor remunerations	Induced Effect from Government transfers	Total Effect
Agriculture, cattle, forestry & fishing	0.00	0.12	2.94	6.47	9.53
Mining	0.00	2.44	0.61	1.35	4.41
Food, beverage & tobacco	0.00	0.15	6.78	14.93	21.87
Textiles, leather & clothing	0.00	0.02	0.81	1.78	2.61
Wood & wood products	0.00	0.56	0.36	0.78	1.70
Chemicals & plastic products	0.00	1.06	1.66	3.66	6.38
Non-metallic minerals	0.00	0.61	0.07	0.16	0.84
Rest of industry	0.00	3.78	3.30	7.26	14.33
Electricity & gas	0.00	0.32	0.09	0.21	0.62
Water & sanitization	0.00	0.10	0.03	0.08	0.22
Construction	0.00	0.00	0.00	0.00	0.00
Commerce	0.00	18.42	45.33	99.79	163.54
Hotels & restaurants	0.00	1.08	11.20	24.67	36.95
Road & pipeline transport	0.00	4.74	7.55	16.63	28.92
Water transport	0.00	1.31	2.18	4.81	8.30
Air transport	0.00	5.15	9.11	20.06	34.32
Travel agencies	0.00	0.44	0.73	1.60	2.77
Other transport complementary & auxiliary	0.00	1.12	1.88	4.14	7.14
Services supplied by the Panama Canal	3,511.17	5.46	8.90	19.60	3,545.12
Information & Communications	0.00	9.06	7.29	16.04	32.39
Financial intermediation & Insurance	0.00	12.26	15.18	33.41	60.84
Real estate activities	0.00	0.10	1.01	2.23	3.35
Business & research activities	0.00	17.49	5.05	11.12	33.67
Education	0.00	0.02	0.03	0.07	0.13
Health & social services	0.00	0.14	1.44	3.17	4.75
Public administration	0.00	0.01	0.01	0.02	0.04
General services to community	0.00	0.00	0.00	0.00	0.00
Domestic services (cleaning, caring, etc.)	0.00	0.00	0.00	0.00	0.00
	3,511.17	85.94	133.56	294.04	4,024.71

Source: Own elaboration.

Table A9.4. Direct, Indirect and induced sectoral effects on Labor of World demand trends. In job positions.

	Direct Effect	Indirect Effect	Induced Effect from Labor remunerations	Induced Effect from Government transfers	Total Effect
Agriculture, cattle, forestry & fishing	0	199	4,815	10,602	15,616
Mining	0	42	11	23	77
Food, beverage & tobacco	0	30	1,347	2,965	4,341
Textiles, leather & clothing	0	1	62	137	201
Wood & wood products	0	120	77	170	367
Chemicals & plastic products	0	8	13	28	48
Non-metallic minerals	0	119	14	31	164
Rest of industry	0	336	293	646	1,275
Electricity & gas	0	226	67	147	441
Water & sanitization	0	406	137	303	846
Construction	0	35	80	175	289
Commerce	0	1,311	3,226	7,102	11,639
Hotels & restaurants	0	144	1,494	3,289	4,926
Road & pipeline transport	0	78	125,	275	477
Water transport	0	69	115	254	438
Air transport	0	66	117	258	442
Travel agencies	0	5	8	17	29
Other transport complementary & auxiliary	0	106	179	393	678
Services supplied by the Panama Canal	14,814	23	38	83	14,957
Information & Communications	0	332	267	588	1,188
Financial intermediation & Insurance	0	319	395	870	1,585
Real estate activities	0	25	249	549	823
Business & research activities	0	2,648	765	1,684	5,097
Education	0	526	770	1,694	2,990
Health & social services	0	98	986	2,170	3,253
Public administration	0	53	43	94	189
General services to community	0	22	25	54	100
Domestic services (cleaning, caring, etc.)	0	0	1911	4,207	6,118
	14,814	7,349	17,628	38,808	78,598

Source: Own elaboration.

A10. Infrastructure Investments-water management infrastructure results

Table A9.1. Direct, Indirect and induced sectoral effects on GDP after an Infrastructure project (water management project - construction phase) . In a million balboas.

	Direct Effect	Indirect Effect	Induced Effect from Labor remunerations	Induced Effect from Government transfers	Total Effect
Agriculture, cattle, forestry & fishing	0.00	1.73	9.52	0.09	11.34
Mining	0.00	8.42	0.98	0.01	9.41
Food, beverage & tobacco	0.00	0.80	14.79	0.13	15.72
Textiles, leather & clothing	0.00	0.05	0.46	0.00	0.51
Wood & wood products	2.35	3.62	1.02	0.01	7.00
Chemicals & plastic products	0.00	1.12	1.14	0.01	2.27
Non-metallic minerals	40.79	3.80	0.55	0.00	45.14
Rest of industry	233.58	5.79	3.28	0.03	242.69
Electricity & gas	0.00	4.58	5.41	0.05	10.03
Water & sanitization	0.00	0.54	0.73	0.01	1.28
Construction	0.00	2.98	2.44	0.02	5.44
Commerce	59.79	28.57	45.60	0.41	134.38
Hotels & restaurants	0.00	3.60	15.08	0.14	18.82
Road & pipeline transport	0.00	1.55	2.55	0.02	4.12
Water transport	0.00	0.46	0.75	0.01	1.22
Air transport	0.00	0.86	1.46	0.01	2.34
Travel agencies	0.00	0.12	0.20	0.00	0.33
Other transport complementary & auxiliary	0.00	0.40	0.65	0.01	1.06
Services supplied by the Panama Canal	0.00	2.82	4.62	0.04	7.49
Information & Communications	0.00	3.60	5.83	0.05	9.48
Financial intermediation & Insurance	40.12	23.43	14.29	0.13	77.96
Real estate activities	35.73	9.04	36.63	0.33	81.72
Business & research activities	0.00	20.38	8.79	0.08	29.25
Education	0.00	0.75	6.28	0.06	7.08
Health & social services	0.00	1.39	12.85	0.12	14.36
Public administration	0.00	0.55	0.31	0.00	0.86
General services to community	0.00	0.14	0.09	0.00	0.23
Domestic services (cleaning, caring, etc.)	0.00	0.00	2.53	0.02	2.55
Total	412.36	131.10	198.84	1.78	744.09

Source: Own elaboration.

Table A10.2. Direct, Indirect and induced sectoral effects on Government Revenue after an Infrastructure project (water management project - construction phase). In a million balboas.

	Direct Effect	Indirect Effect	Induced Effect from Labor remunerations	Induced Effect from Government transfers	Total Effect
Agriculture, cattle, forestry & fishing	0.00	0.14	0.77	0.01	0.91
Mining	0.00	0.97	0.11	0.00	1.09
Food, beverage & tobacco	0.00	0.16	2.92	0.03	3.11
Textiles, leather & clothing	0.00	0.04	0.35	0.00	0.39
Wood & wood products	0.58	0.90	0.25	0.00	1.74
Chemicals & plastic products	0.00	0.42	0.43	0.00	0.86
Non-metallic minerals	9.16	0.85	0.12	0.00	10.14
Rest of industry	139.13	3.45	1.95	0.02	144.56
Electricity & gas	0.00	0.52	0.62	0.01	1.15
Water & sanitization	0.00	0.03	0.03	0.00	0.06
Construction	0.00	0.25	0.20	0.00	0.46
Commerce	5.98	2.86	4.56	0.04	13.45
Hotels & restaurants	0.00	0.48	1.99	0.02	2.49
Road & pipeline transport	0.00	0.13	0.22	0.00	0.36
Water transport	0.00	0.06	0.10	0.00	0.17
Air transport	0.00	0.08	0.14	0.00	0.23
Travel agencies	0.00	0.03	0.05	0.00	0.08
Other transport complementary & auxiliary	0.00	0.03	0.05	0.00	0.09
Services supplied by the Panama Canal	0.00	1.86	3.04	0.03	4.92
Information & Communications	0.00	0.59	0.96	0.01	1.56
Financial intermediation & Insurance	8.13	4.75	2.90	0.03	15.80
Real estate activities	1.28	0.32	1.32	0.01	2.94
Business & research activities	0.00	4.16	1.79	0.02	5.97
Education	0.00	0.13	1.12	0.01	1.26
Health & social services	0.00	0.23	2.16	0.02	2.42
Public administration	0.00	0.11	0.06	0.00	0.17
General services to community	0.00	0.03	0.02	0.00	0.04
Domestic services (cleaning, caring, etc.)	0.00	0.00	0.50	0.00	0.50
Total	164.28	23.59	28.75	0.26	216.88

Source: Own elaboration.

Table A10.3. Direct, Indirect and Induced sectoral effects on Exports after an Infrastructure project (water management project - construction phase). In a million balboas.

	Direct Effect	Indirect Effect	Induced Effect from Labor remunerations	Induced Effect from Government transfers	Total Effect
Agriculture, cattle, forestry & fishing	0.00	0.22	1.18	0.01	1.41
Mining	0.00	2.12	0.25	0.00	2.37
Food, beverage & tobacco	0.00	0.15	2.73	0.02	2.91
Textiles, leather & clothing	0.00	0.04	0.33	0.00	0.36
Wood & wood products	0.33	0.51	0.14	0.00	0.98
Chemicals & plastic products	0.00	0.66	0.67	0.01	1.33
Non-metallic minerals	2.14	0.20	0.03	0.00	2.36
Rest of industry	94.47	2.34	1.33	0.01	98.16
Electricity & gas	0.00	0.03	0.04	0.00	0.07
Water & sanitization	0.00	0.01	0.01	0.00	0.02
Construction	0.00	0.00	0.00	0.00	0.00
Commerce	23.94	11.44	18.26	0.16	53.80
Hotels & restaurants	0.00	1.08	4.51	0.04	5.63
Road & pipeline transport	0.00	1.85	3.04	0.03	4.92
Water transport	0.00	0.54	0.88	0.01	1.43
Air transport	0.00	2.17	3.67	0.03	5.87
Travel agencies	0.00	0.18	0.29	0.00	0.48
Other transport complementary & auxiliary	0.00	0.46	0.76	0.01	1.22
Services supplied by the Panama Canal	0.00	2.19	3.59	0.03	5.81
Information & Communications	0.00	1.81	2.93	0.03	4.77
Financial intermediation & Insurance	17.17	10.02	6.11	0.05	33.36
Real estate activities	0.40	0.10	0.41	0.00	0.91
Business & research activities	0.00	4.72	2.04	0.02	6.78
Education	0.00	0.00	0.01	0.00	0.02
Health & social services	0.00	0.06	0.58	0.01	0.65
Public administration	0.00	0.01	0.00	0.00	0.01
General services to community	0.00	0.00	0.00	0.00	0.00
Domestic services (cleaning, caring, etc.)	0.00	0.00	0.00	0.00	0.00
Total	138.45	42.91	53.80	0.48	235.64

Source: Own elaboration.

Table A9.4. Direct, Indirect and induced sectoral effects on Labor of World demand trends. In job positions.

	Direct Effect	Indirect Effect	Induced Effect from Labor remunerations	Induced Effect from Government transfers	Total Effect
Agriculture, cattle, forestry & fishing	0	353	1,940	17	2,310
Mining	0	37	4	0	41
Food, beverage & tobacco	0	29	543	5	577
Textiles, leather & clothing	0	3	25	0	28
Wood & wood products	72	110	31	0	213
Chemicals & plastic products	0	5	5	0	10
Non-metallic minerals	419	39	6	0	463
Rest of industry	8,408	209	118	1	8,736
Electricity & gas	0	23	27	0	50
Water & sanitization	0	41	55	0	97
Construction	0	39	32	0	71
Commerce	1,704	814	1,299	12	3,829
Hotels & restaurants	0	144	602	5	751
Road & pipeline transport	0	31	50	0	81
Water transport	0	29	46	0	75
Air transport	0	28	47	0	76
Travel agencies	0	2	3	0	5
Other transport complementary & auxiliary	0	44	72	1	116
Services supplied by the Panama Canal	0	9	15	0	25
Information & Communications	0	66	108	1	175
Financial intermediation & Insurance	447	261	159	1	869
Real estate activities	98	25	100	1	224
Business & research activities	0	715	308	3	1,026
Education	0	37	310	3	350
Health & social services	0	43	397	4	444
Public administration	0	30	17	0	47
General services to community	0	16	10	0	26
Domestic services (cleaning, caring, etc.)	0	0	770	7	777
Total	11,147	3,180	7,101	64	21,492

Source: Own elaboration.