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Analysis of alternative routes of public investment in agriculture and their impact on economic growth and rural poverty reduction in Nicaragua

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By

Marco V. Sánchez
Deputy Director, Agrifood Economics Division (ESA), FAO

Martin Cicowiez
International Consultant, Agrifood Economics Division (ESA), FAO

Janet Ramírez
International Consultant, Agrifood Economics Division (ESA), FAO

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Preface

In October 2018, the Food and Agriculture Organization of the United Nations (FAO) signed the 2018–2021 Country Programming Framework with the Government of Nicaragua. This set forth that sectoral studies and analyses should be carried out to provide evidence to strengthen public policy processes.

As part of the Week of Agriculture and Food held in Buenos Aires, Argentina, from 20 to 23 November 2018, a series of information exchanges and political dialogues took place among the highest levels of public and FAO stakeholders. The objective was to discuss and analyse the progress and challenges in terms of public policy processes, international cooperation and socio-economic indicators linked to rural poverty, productivity and employment, among others. The event included the participation of the Minister for Agriculture of Nicaragua, who engaged in exchanges of information with FAO officials regarding progress made and the challenges and requirements for strengthening agricultural development in Nicaragua.

As a result of the discussions held, the Agrifood Economics Division (ESA) of FAO in Rome and the FAO Office in Nicaragua (FAONI), with the support of the FAO Strategic Programme for reduction of rural poverty (SP3) and Nicaraguan Government authorities, agreed to manage and coordinate evidence-gathering actions to guide decision-making and contribute to the development of the country in the medium and long term.

Among the concrete actions to be implemented, the Ministry of Foreign Affairs, Ministry of Finance and Public Credit, Central Bank of Nicaragua and Ministry of Agriculture agreed that the present study would be elaborated beginning in March 2019, under the technical leadership of ESA and the national coordination of FAONI, with the support of SP3.

This study presents a prospective analysis of rural poverty in a challenging context of economic and foreign financing constraints, based on scenarios created by means of a multisector economy-wide model for Nicaragua. The analysis makes it possible to explore financing options to scale up public investments in certain agricultural sectors in order to promote growth and reduce rural poverty.

All of the scenarios developed were validated by the Nicaraguan authorities. Consequently, these authorities have taken the policy recommendations, analysis and conclusions into account to inform future investment decisions in agriculture that could result in economic and social gains for the population. In addition, the study provides the necessary evidence to perform a more detailed analysis of specific value chains such as livestock farming (among others) that show particular potential – by means of new investments – to reactivate the economy and reduce rural poverty.

Acknowledgements

This study marks the culmination of a rigorous process of analysis and dialogue with authorities of the Nicaraguan Government. It was completed under the technical direction and with the direct participation of Marco V. Sánchez, Deputy Director of ESA, and coordinated at the country level by Ivan León, FAO Representative in Nicaragua, with the financial support of funds from FAO Strategic Programme 3 (SP3) that had been assigned to ESA. In addition, the technical team was composed of two consultants, one international and the other national: Martín Cicowiez and Janet Ramírez, respectively. Support from FAONI officials (Daniel Barrios and Paola Valle) was fundamental in completing this process of policy analysis support for the country.

The preliminary idea for the study, its content, methodology and implementation plan, were presented to the Nicaraguan authorities during an initial FAO mission in March 2019. Subsequently, by means of a new mission in October of that year, the first results generated using simulated scenarios were validated with policymakers (including the President of the Central Bank of Nicaragua, Mr Ovidio Reyes, the Deputy Minister for Finance and Public Credit, Mr José A. Chavarría, and the Minister for Agriculture, Mr Edward Centeno Gadea, among others), as well as officials from different technical areas of the government. This mission was fundamental in adapting the scenarios simulated in terms of the amount of public investment to consider, production sectors to be targeted and potential sources of financing. After delivering the final technical report to the government in December 2019 – which is a previous, unedited version of the present study – some of the institutions provided very valuable comments in January 2020, leading to the improved version of the study presented here.

The authors sincerely thank Andrew Park for copy-editing the study and Daniela Verona for the design and publishing coordination.

Acronyms

ALMA	Managua Mayor's Office
BCN	Central Bank of Nicaragua
CES	constant elasticity of substitution
CGE	computable general equilibrium
EAAI	*Empresa Administradora de Aeropuertos Internacionales* (Administrative Company of International Airports)
EMNV	*Encuesta de Medición de Nivel de Vida* (National Survey of Living Standards)
ENABAS	*Empresa Nicaragüense de Alimentos Básicos* (Nicaraguan Staple Food Company)
ENACAL	*Empresa Nicaragüense de Acueductos y Alcantarillados Sanitarios* (Nicaraguan State Water and Sewage Utility)
ENATREL	*Empresa Nacional de Transmisión Eléctrica* (Electric Power Transmission Company)
ENEL	*Empresa Nicaragüense de Electricidad* (Nicaraguan State Electricity Company)
EPN	*Empresa Portuaria Nacional* (National Port Company)
ESA	Agrifood Economics Division (FAO)
FAO	Food and Agriculture Organization of the United Nations
FAONI	FAO Office in Nicaragua
FOB	free on board
GDP	gross domestic product
GFCF	gross fixed capital formation
GFSM	Government Finance Statistics Manual
ILO	International Labour Organization
IMF	International Monetary Fund
INIDE	Nicaraguan National Institute of Development Information
INSS	Nicaraguan Social Security Institute
NIO	Nicaraguan córdoba
NPISH	Non-Profit Institutions Serving Households
PETRONIC	*Empresa Nicaragüense de Petróleo* (Nicaraguan State Oil Company)
SAM	Social Accounting Matrix

SCT	Selective Consumption Tax
SP3	Strategic Programme for reduction of rural poverty (FAO)
SUT	Supply and Use Tables
TELCOR	*Instituto Nicaragüense de Telecomunicaciones y Correos* (Nicaraguan Institute of Telecommunications and Postal Services)
TFP	total factor productivity
USD	United States dollar
VAT	Value Added Tax

Executive summary

This study analyses various scenarios to evaluate the impact of increasing public investment on the productive infrastructure of the agricultural sector (roads, irrigation systems, storage systems, research and technology, etc.) in Nicaragua for the 2020–2028 period. Presuming the country would have access to additional financial resources, this investment is scaled up gradually until it represents half a percentage point of gross domestic product (GDP) in 2023–2025, and then lowered gradually as well.

The analysis shows that the increased public investment in productive infrastructure could boost economic growth by around 0.09 to 0.1 percentage points per year until 2030, on average, in those scenarios with the following investment focus: crops and livestock (i.e. the agricultural sector as a whole), livestock only, basic grains, and coffee farming. In comparative terms, for those sectors that receive independent investment, livestock is the sector that reveals the greatest impact. Although there would be a change in the average growth rate for the entire period, the increases in output would clearly tend to be much higher towards the end of the period. For example, it can be observed that in 2030 GDP would increase from 0.8 percent to 1.1 percent when particular sectors (livestock farming in this case) are targeted with investment, and 3.7 percent when the investment takes place in the agricultural sector as a whole – and, importantly, when it is also increased to 1 percent of GDP rather than 0.5 percent.

The expected result of these investments is that poverty would decrease much more in rural than in urban areas. From 2019 to 2030, depending on the investment scenario, total poverty in rural areas would decrease by 0.5 to 2.25 percentage points, while extreme poverty would decrease by 0.16 to 0.31 percentage points. The reduction in poverty at the national level, as well as in urban areas, would be relatively lower, but by no means insignificant.

The analysis suggests that livestock and meat production have the potential to expand, yielding positive effects on the rest of the economy. In particular, the forward linkages of livestock production with meat and dairy production, as well as the export-oriented nature of meat production, make the livestock value chain particularly attractive as a destination for productive public investment. The coffee sector also shows potential provided that the focus is on developing a local processing industry. Basic grains, on the other hand, should be promoted as a whole and not simply product by product, as this makes it possible to increase several components of the basic food basket of Nicaraguan households, thus promoting food security.

In addition, the feasibility of public investments in the productive infrastructure of the agricultural sector is also analysed, in terms of the source of financing that would have to be resorted to in order to make them a reality. External financing would seem to be the most feasible option for financing the additional investment amount (which in 2023–2025 represents 0.5 percent of GDP), for two reasons. First, it generates a higher economic growth rate than domestic borrowing (which reduces private savings, thus crowding out private investment). In addition, given the recent tax reform, tax revenues would not seem to be a politically feasible domestic financing source for new investments. Second, under external financing, the country's public debt only increases by around 2 points of GDP by 2030, thus remaining at sustainable levels.

As a subsequent step, one particular recommendation is to study productive chains such as livestock farming (among others) to define the phases (both in terms of the stages of the chain and the geographical level) where public investments should be made and which

types of specific investments and projects would be involved. Putting said investments into practice would give the government a concrete alternative to reactivate the economy and reduce rural poverty under existing economic constraints.

1 Introduction

Prior to 2018, Nicaragua showed considerable economic growth and a substantial poverty reduction trend. In 2018, the economy decelerated significantly due mainly to exogenous elements or disruptions, which led to a decrease in gross domestic product (GDP) from the second quarter of 2018. This resulted in a changed economic environment characterized by important constraints and challenges, as well as a lack of foreign financing. Thus the following questions arose: Would poverty increase – therefore altering its trend in recent years – as a result of these economic developments? What role could and should the agricultural sector play in reactivating the economy? This second question is valid for several reasons. The agricultural sector continues to be an important source of output and employment in Nicaragua. Most of the country's poor live in rural areas, making the agricultural sector a potential avenue for reducing poverty. While other sectors felt the effects of the substantial economic slowdown, the primary sector has managed to maintain more stable levels of productive activity during the economic deceleration. A third question therefore arises: Can public investment in the agricultural sector contribute to economic growth and rural poverty reduction under existing financing constraints, and which particular sectors or value chains would offer the greatest socio-economic returns for said investments?

To respond to these questions, this study presents a prospective analysis of rural poverty under existing economic constraints and challenges and a lack of access to foreign financing – based on scenarios that have been generated using a multisector economy-wide model for Nicaragua. The analysis makes it possible to explore options to finance public investments that target agriculture or its specific sectors, in order to promote growth and reduce rural poverty.

The study identifies those agricultural sectors whereby it is most cost-effective to make public investments in productive infrastructure, in terms of their generation of economic growth and reduction of poverty, given economic constraints including limited external financing and tight public finances.

The particular agricultural sectors or value chains identified could be analysed in greater depth in future studies, in order to determine the respective stages and specific national regions in which it would be more advantageous to make public investments. These studies would serve as a basis for proposing specific investment project road maps.

The study is presented in four sections. Section 2 covers the economic context and the evolution of poverty in Nicaragua since 2010. This section is important for understanding why it is necessary to reactivate the economy by means of public investment and the role that agriculture could play in this. In addition, it contributes substantial elements for the construction of a baseline scenario based on the Nicaraguan economy-wide model, which is subsequently used to create the simulated public investment scenarios. Section 3 describes said model, including the modelling framework and the data used to implement it, and then uses it to fully describe the state of the Nicaraguan economy. In addition, there is an explanation of a complementary microsimulation methodology to calculate poverty in the different scenarios. Section 4 describes the simulated public investment scenarios and presents a detailed analysis of their results. Section 5 then summarizes the main conclusions and provides policy recommendations.

2 Downturn of the Nicaraguan economy: risks and challenges

KEY MESSAGES

- After several years of sustained growth, the Nicaraguan economy contracted by 3.8 percent in 2018.
- Supply-side disruptions caused by roadblocks and damage to infrastructure triggered the economic downturn.
- Weakened confidence on the part of consumers, investors and international financial organizations, as well as international sanctions, intensified the economic crisis.
- These conditions affected public finances, with an increase in the fiscal deficit giving way to more restrictive public policies.
- Investment, employment and social indicators began to register negative trends.
- Despite the crisis, the GDP of the primary agricultural sector increased by 3.3 percent in 2018.

Economic growth and development have become the main objective of Nicaragua's economic policy, given the awareness of how the increased resources generated have manifested an improvement in citizens' well-being and quality of life.

Economic growth and development are currently under further study in the country, given the situation that arose in April 2018, which will be explained as follows.

2.1 Economic growth and employment

Table 1 shows the evolution in terms of economic growth and the main macroeconomic variables for the 2010–2017 period as well as results obtained in 2018. The evolution of GDP shows that the Nicaraguan economy registered an average growth of 5.1 percent in the 2010–2017 period, but with a 3.8 percent reduction in 2018. For 2019, the Central Bank of Nicaragua (BCN) had projected (at the time of this writing) a 3.5 percent to 4.5 percent reduction in growth, which is in stark contrast to the growth observed since 2010.

Given the changes in GDP, the growth rate per capita shifted from 5.5 percent in the 2010–2017 period to -6.2 percent in 2018. However, the level of GDP per capita in 2018 (USD 2 030.5), although lower than the 2017 result (USD 2 165.2), is still higher than the average level of GDP per capita registered in the 2010–2017 period (USD 1 856.6).

The causes of such a substantial economic downturn are well known. Supply-side disruptions resulting from roadblocks and damages to infrastructure weakened the

confidence of national and international consumers and investors, as well as that of international financial bodies, which resulted in the draining of bank deposits, a reduction in private investment and reduced access to external financing. In addition, the aforementioned weakened confidence was accompanied by international sanctions, which imposed an additional financing constraint upon the economy,[1] with adverse repercussions for investment, employment and social indicators. The issue of inflation, which is explained further below, is a noteworthy factor as well. The reduction in GDP began in the second quarter of 2018, in line with the initiation of the disruptions mentioned.

TABLE 1 Main macroeconomic indicators, 2010–2018

Items	2010–2017	2017	2018
Economic activity and employment			
Gross domestic product (GDP) at constant prices (% growth)	5.1	4.7	-3.8
GDP per capita (USD)	1 856.6	2 165.2	2 030.5
GDP per capita (% growth)	5.5	3.1	-6.2
Open unemployment rate* (%)	5.8	3.7	5.5
Prices and exchange rate			
National annual accumulated inflation (%)**	6.0	5.7	3.9
Annual devaluation (%)	5.0	5.0	5.0
Official average exchange rate (NIO x USD)	25.5	30.1	31.6
Monetary sector			
Gross internal reserves/monetary base (ratio)	2.5	2.6	2.4
Total deposits (% growth)	14.2	10.7	-20.7
Gross credit portfolio (% growth)	18.4	13.9	-8.9
Net international reserves balance (USD millions)	2 069.8	2 716.2	2 038.9
Gross international reserves balance (USD millions)	2 193.2	2 757.8	2 261.1
Non-financial public sector (% of GDP)			
Balance before donations	-2.4	-3.1	-4.7
Balance after donations	-1.1	-2.0	-4.1
External financing	2.4	3.2	1.9
Internal financing	-1.3	-1.2	2.2

[1] The financial sanctions are related to the Nicaraguan Human Rights and Anticorruption Act S. 3233, known as the Nica Act, approved in the Senate and Congress of the United States of America and signed by its President Donald Trump. The Nica Act establishes political and economic sanctions against the Government of Nicaragua and applies conditions for loans to the government from international financial institutions such as the World Bank, the International Monetary Fund and the Inter-American Development Bank. In addition, the European Union also reduced bilateral financial aid for the government and has kept possible sanctions in force in the short- and medium term.

TABLE 1 (cont.) Main macroeconomic indicators, 2010–2018

Items	2010–2017	2017	2018
External sector (USD millions)			
Exports of free on board (FOB) goods	2 381.1	2 548.3	2 516.9
Exports of goods from free trade zone	2 306.2	2 638.1	2 870.3
Imports of FOB goods	5 151.7	5 597.8	4 829.4
Imports of goods from free trade zone	1 466.2	1 643.9	1 799.2
Public debt			
Total public balance (USD millions)	5 765.7	6 486.7	6 885.2
Public debt/GDP	51.0	46.9	52.5

Note: * Data from 2018, corresponding to the average of the first three quarters; ** consumer price index (2006 = 100).

Source: Central Bank of Nicaragua.

As shown in Table 2, tourism (hotels and restaurants), construction and retail trade were particularly affected. These are sectors that most contributed to the 2018 GDP contraction because of their relative importance in the economy. Together, they contributed to around 76 percent of the 3.8 percent decrease in GDP, which is consistent with their marginal contribution to this downturn: trade (-1.2 percentage points), hotels and restaurants (-0.8 percentage points) and construction (-0.8 percentage points) (Table 2).

TABLE 2 Gross domestic product per sector, 2010–2018

Items	2010–2017	2017	2018	2010–2017	2017	2018
	Growth rate (%)			Marginal contributions (%)		
Gross domestic product (GDP)	5.1	4.7	-3.8	5.1	4.7	-3.8
(+) Net taxes on products	5.7	4.7	-8.9	0.5	0.5	-0.9
Agriculture (crops)	3.1	6.3	3.3	0.3	0.5	0.2
Livestock	1.7	12.6	-5.4	0.1	0.7	-0.3
Forestry and timber extraction	1.1	1.3	-4.2	0.0	0.0	-0.0
Fisheries and aquaculture	4.7	11.1	14.7	0.0	0.1	0.2
Mining	13.7	-9.1	1.7	0.4	-0.2	0.0
Manufacturing industries	6.8	5.1	1.1	0.9	0.7	0.1
Construction	7.3	1.2	-15.7	0.4	0.1	-0.8

TABLE 2 (cont.) Gross domestic product per sector, 2010–2018

Items	2010–2017	2017	2018	2010–2017	2017	2018
	Growth rate (%)			Marginal contributions (%)		
Electricity	7.3	-2.9	4.3	0.2	-0.1	0.1
Water	6.8	1.7	3.6	0.0	0.0	0.0
Trade	5.9	4.1	-11.4	0.6	0.4	-1.2
Hotels and restaurants	6.8	17.8	-20.2	0.2	0.6	-0.8
Transport and communications	7.8	1.8	-3.5	0.4	0.1	-0.2
Financial intermediation and related services	4.4	6.8	-5.4	0.2	0.3	-0.3
Home ownership	2.1	2.9	-1.2	0.1	0.2	-0.1
Public administration and defence	4.9	5.7	-0.1	0.2	0.2	-0.0
Education	2.6	3.7	2.9	0.1	0.2	0.1
Health	4.4	3.4	2.7	0.1	0.1	0.1
Other services	5.3	4.2	-2.1	0.4	0.3	-0.2

Source: Central Bank of Nicaragua.

One very important aspect that must be pointed out is that there was also a contraction of output in the livestock (-5.4 percent) and forestry and timber extraction (-4.2 percent) sectors, but rather than being structural, this was temporary and mainly due to the aforementioned crisis. It is noteworthy that the GDP of the primary agricultural sector increased by 3.3 percent in the same period (Table 3). Only sugar cane production experienced a reduction due to harmful effects of weather events in planted areas. The other sectors, and mainly that of green coffee farming, showed higher economic activity. In the case of coffee farming, this was the result of the continued entry into coffee production of land that had previously been invaded by leaf rust, as well as greater investments in new coffee plantation areas. For its part, production of basic grains, particularly that of rice, was expanded through increased irrigation of planted areas. Growth was also seen in other parts of agriculture given the increased production of crops such as banana, soya, vegetables, roots, tubers and fruits, among others.

Another sector that showed strong activity in 2018, despite the adverse conditions, was that of fisheries and aquaculture. This was because of the increased production of farmed shrimp and the greater capture of shrimp, fish, and other fishery products such as sea cucumber, octopus and crabs, associated mainly with increased external demand.

TABLE 3 Value added of agriculture, forestry, fisheries and mining, 2010–2018

Items	2010–2017	2017	2018
	Growth rate (constant NIO millions)		
Primary sector	3.6	5.8	0.6
Agricultural activities	3.1	6.3	3.3
Green coffee	6.0	17.1	10.1
Sugar cane	4.3	21.3	-5.9
Basic grains	2.3	0.6	1.0
Other crops	2.2	0.4	1.2
Livestock activities	1.7	12.6	-5.4
Forestry activities	1.1	1.3	-4.2
Fisheries and aquaculture activities	4.7	11.1	14.7
Mining activities	13.7	-9.1	1.7

Source: Central Bank of Nicaragua.

2.2 Prices, monetary sector, foreign trade and public finances

A key aspect in macroeconomic management is price stability. According to Table 1, the rate of inflation in 2018 slowed down by 1.8 percentage points compared to 2017, and 2.1 percentage points compared to the 2010–2017 period. The exchange rate continues to be kept in line with the monetary policy established, with a crawling-peg rate of 5.0 percent. However, beginning in November 2019, and with the objective of facilitating the stability of prices, the BCN revised the crawling-peg rate down to 3.0 percent.[2]

The projected inflation rate at the end of 2019 was 6.4 percent (compared to 3.9 percent in 2018), which reflects the transitory effect of tax measures adopted earlier that year. Although inflation did not escalate and the exchange rate remained stable in 2018, the monetary sector was among the most affected, as a result of a reduction in deposits and credit that hindered economic performance. A change in risk perception may have influenced this result. However, previous performance, adequate management of economic policies, and good results with regard to the external accounts made it possible to maintain adequate levels of international reserves in 2018.

Precisely with regard to the external accounts, and in terms of foreign trade to be more specific, exports of goods and services fell slightly in 2018 (-2.6 percent compared to 2017). Still, exports maintained a higher level than the average levels registered in the 2010–2017 period, while the imports of goods and services suffered a much greater decrease (-14.0 percent compared to 2017), in line with the contraction in domestic demand (Table 4). For the whole period under analysis, the growth in the exports of free trade zone products is worth highlighting: taking as a proxy the variations shown in the activities of textiles manufacturers (11.4 percent), tobacco (10.3 percent) and machinery and equipment

[2] According to independent records, 2004 was the last time that the crawling-peg rate was modified after going from 6 percent to 5 percent.

(-5.3 percent) – the main products associated with the free trade zone – together these registered growth of 5.6 percent compared to 2017. In 2018, however, there was a substantial reduction in the importation of machinery and equipment included in capital goods, among other products.

In addition, and according to data from the BCN, workers' remittances from abroad increased by 7.9 percent in 2018 (while in the 2010–2017 period they had increased by 7.7 percent on average), which contributed to maintaining the levels of international reserves. At the same time, this kept household consumption from falling as much as it could have, particularly given the significant restrictions in credit for consumption and the downgrading of the credit rating by the main international risk rating agencies (Fitch Ratings, Moody's, Standard & Poor's) from B to B–.

TABLE 4 Gross domestic product per expenditure component

Items	2010–2017	2017	2018	2010–2017	2017	2018
	Growth rate (%)			Marginal contributions (%)		
Gross domestic product (GDP)	5.1	4.7	-3.8	5.1	4.7	-3.8
Final consumption*	4.4	5.5	-4.5	3.7	4.6	-3.8
Government consumption	4.9	3.9	-2.8			
Of which:						
Collective consumption	4.9	2.3	-8.5			
Individual consumption	4.8	5.5	2.9			
Consumption of individual households and NPISH*	4.3	5.8	-4.8			
Gross investment	8.9	-5.1	-23.6	2.7	-1.6	-6.6
Public investment	9.7	-0.5	-15.4			
Private investment	8.9	-6.5	-26.4			
Exports of goods and services	7.6	9.7	-2.6	3.1	3.8	-1.1
Imports of goods and services	7.0	3.9	-14.0	4.3	2.2	-7.7

Note: * From 2006, consumption is disaggregated by individual and collective government consumption and individual consumption by households and Non-Profit Institutions Serving Households (NPISH).

Source: Central Bank of Nicaragua.

The adverse economic context has had an impact on public finances, which is seen in the increase in the fiscal deficit. As detailed in the 2018 BCN Annual Report, the fiscal policy followed involves, with regard to income, guaranteeing internal resources. The tax reform implemented in early 2019 is part of this policy. The expenditure policy focuses on responsible management and the quality of public spending. The financing policy focuses on the management and maximizing of concessional funds from multilateral organizations.

Taking this into account, the increase in the fiscal deficit has arisen mainly as a result of revenue reductions. From 2010 to 2017, tax revenues increased by 15.2 percent but subsequently decreased by 6.1 percent in 2018. A reduction in other income, associated mainly with the lower income from public companies, was also observed (Table 5). Government investment and consumption also fell in 2018 (Table 4), although it should be noted that, within government consumption, the expenditure primarily geared towards education and health still grew by 2.9 percent.

At the time of this writing, it was expected that government revenue in 2019 would have increased by nearly 10 percent compared to 2018, as a result of the aforementioned tax reform. This reform sought changes in tax revenue arising from direct taxes, which are levied on revenue and capital gains,[3] as well as from indirect taxes linked to the acquisition of goods and services.[4]

With regard to expenditure, the government applied a contractionary policy. In the 2010–2017 period, the average rate of variation in expenditure was 13.8 percent, but in 2018 growth slowed by 10.4 percentage points. Reduced expenditure in 2018 was mainly associated with fewer purchases of goods and services as well as other expenditures. At the same time, a strong reduction in capital expenditure was observed: after growing by 17.0 percent between 2010 and 2017, it fell to 8.1 percent in 2018 (Table 5).

◆ TABLE 5 Consolidated transactions of the non-financial public sector, 2010–2018

Items	2010–2017	2017	2018
	Growth rate (%)		
1. Income	15.0	11.6	-4.3
Taxes	15.2	11.5	-6.1
Social contributions	17.0	12.1	3.2
Other income*	12.7	11.0	-6.6
2. Expenditures	13.8	11.5	3.4
Employee remunerations	12.1	8.7	5.9
Purchase of goods and services	16.4	11.5	-4.2
Interest	13.3	19.7	1.1
Current and capital transfers	12.7	11.4	0.9
Social benefits	15.7	14.5	16.1
Other expenditures**	14.0	11.5	-1.9

[3] Among the tax reform's modifications of direct taxes, the increase in the collection of income tax is noteworthy; this has been accomplished through an increase in the Definitive Minimum Payment, which went from 1 percent to 2 percent for Main Contributors and from 1 percent to 3 percent for Major Contributors; and through adjustments in the rates of withholding on income from economic activities and withholding on revenue and capital gains. This group of taxes could contribute close to 50 percent of the total collected.

[4] This includes Value Added Tax (VAT) and Selective Consumption Tax (SCT). The VAT would represent almost 30 percent of the total amount collected in indirect taxes, due to the high component of consumer and intermediate goods of imported origin being modified from exempt to levied. The contribution of the SCT would represent a little over 50 percent of this group, due to the reform measures geared towards products that are harmful to health and the environment, including cigarettes and alcoholic drinks, among others.

TABLE 5 (cont.) **Consolidated transactions of the non-financial public sector, 2010–2018**

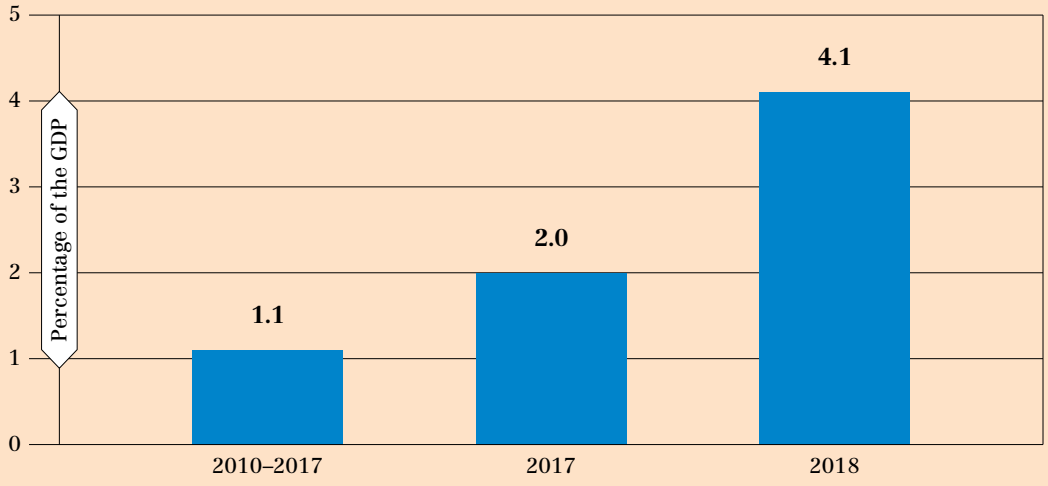
Items	2010–2017	2017	2018
	Growth rate (%)		
3. Net operating income	1 393.8	12.5	-91.2
4. Net acquisition of non-financial assets	17.0	9.7	-8.1
5. Cash surplus or cash deficit before donations (3–4)	11.9	7.8	52.6
6. Total donations	1.9	1.1	-41.6
7. Cash surplus or cash deficit after donations (5+6)	5.5	11.5	100.4

Notes: Methodology in accordance with the Government Finance Statistics Manual (GFSM, 2001 analytic framework); includes the Central Government, the Nicaraguan Social Security Institute (INSS), Managua Mayor's Office (ALMA), Electric Power Transmission Company (ENATREL), Nicaraguan State Water and Sewage Utility (ENACAL), Nicaraguan State Electricity Company (ENEL), National Port Company (EPN), Nicaraguan Institute of Telecommunications and Postal Services (TELCOR), Administrative Company of International Airports (EAAI), Nicaraguan Staple Food Company (ENABAS) and Nicaraguan State Oil Company (PETRONIC); * includes income for services of ENATREL, ENACAL, ENEL, EPN TELCOR, EAAI, ENABAS and PETRONIC; ** includes subsidy for carriers and electrical power; *** includes the net credit of the central bank and of the rest of the financial system.

Source: Ministry of Finance and Public Credit, Central Bank of Nicaragua, INSS, ALMA, ENATREL, ENACAL, ENEL, EPN, TELCOR, EAAI, ENABAS and PETRONIC.

The public sector has managed to maintain a relatively low fiscal deficit, even if this has lately increased. The balance of the non-financial public sector before grants seen as a percentage of GDP was -2.4 percent in the 2010–2017 period, -3.1 percent in 2017 and -4.7 percent in 2018. These percentages are lower once grants are subtracted (Figure 1). Still, an increase in the deficit can nonetheless be observed, which is partly explained by the reduction in GDP itself.

FIGURE 1 **Overall balance of the public sector after grants, 2010–2018**



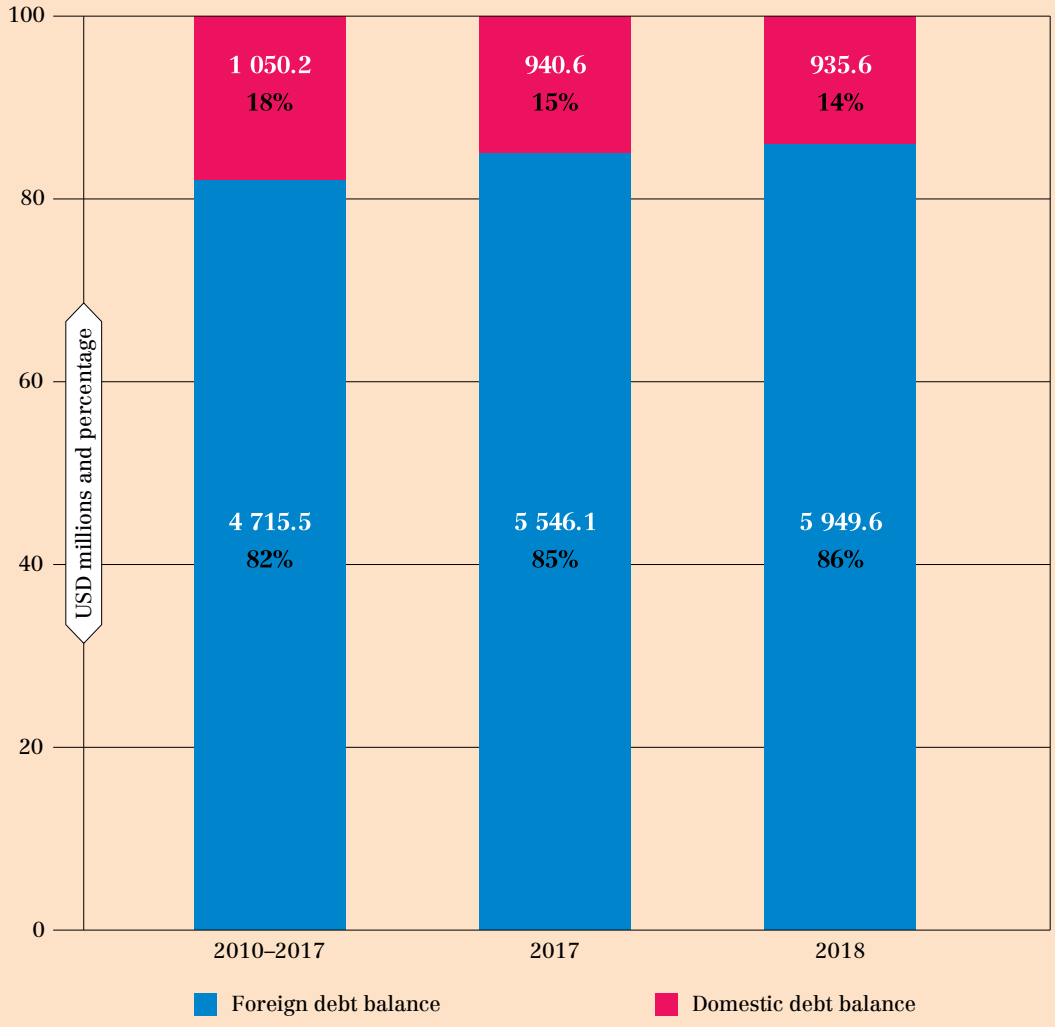
Source: Central Bank of Nicaragua.

For its part, the information related to public debt shows signs that it is still sustainable. The debt-to-GDP ratio was 52.5 percent in 2018. Although slightly above that registered in 2017 (46.9 percent), the ratio in 2018 nearly resembles the result of the 2010–2017 period (51.0 percent). The increase in public debt in 2018 was mainly due to new external concessional loans (or soft loans) to finance development projects, and to the lower level of GDP in the year.

Despite the increased public debt balance and the adverse economic context, a responsible public borrowing policy was maintained in 2018. Figure 2 shows the composition of external and internal public debt held over time. In 2018, foreign debt constituted 4 percentage points more than in 2010–2017, and 1 percentage point more compared to 2017.

The main indicators of public debt detailed in Table 6 appear stable. However, in 2018 said debt was greater than that of the 2010–2017 period. Within this context, the implementation of the tax reform and the austerity policy contained in the bill to amend Law No. 984, the 2019 Annual Law of the General Budget of the Republic, aimed to contain the deterioration of public finances and continue to honour the contractual obligations upon expiry of both the foreign and domestic debt service.

FIGURE 2 Public debt balance: external and internal, 2010–2018



Source: Central Bank of Nicaragua.

TABLE 6 Public debt indicators

Items	2010–2017	2017	2018
Public debt indicators (%)			
Debt balance relative to GDP	51.0	46.9	52.5
Foreign debt balance relative to GDP	41.5	40.1	45.4
Domestic debt balance relative to GDP	9.5	6.8	7.1
Debt balance relative to exports	105.7	101.5	108.6
Debt service relative to exports	17.5	31.2	296.9
Debt service relative to exports excluding short-term instalments to the BCN*	15.0	16.8	29.4
Debt service relative to exports excluding short-term instalments of the BCN*	11.9	13.3	25.5
Public debt (USD millions)			
Debt balance	5 765.7	6 486.7	6 885.2
Debt service	978.7	1 997.4	18 817.4
Debt service excluding short-term instalments to the BCN*	907.5	1 075.6	1 863.8
Foreign public debt (USD millions)			
Foreign debt balance	4 715.5	5 546.1	5 949.6
Foreign debt service	138.9	224.4	248.5
Foreign debt disbursements	341.6	540.5	560.8
Domestic public debt (USD millions)			
Domestic debt balance	1 050.2	940.6	935.6
Domestic debt service	839.9	1 773.0	18 568.8
Domestic debt service excluding short-term instalments to the BCN*	717.6	851.2	1 615.3
Domestic debt issues	733.2	1 767.4	18 514.5

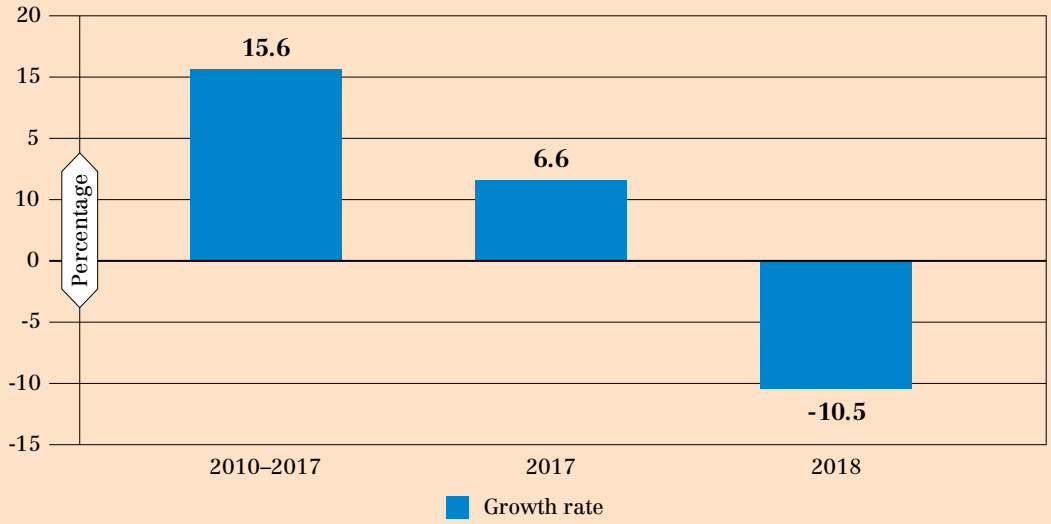
Note: * Refers to instalments requested by the BCN at deadlines of 1, 7 and 14 days.

Source: Ministry of Finance and Public Credit and Central Bank of Nicaragua.

2.3 Employment, household income and poverty

With the economic downturn in 2018, an increase in unemployment was to be expected. In fact, in 2018 open unemployment went up by 5.5 percent, an increase of 1.8 percentage points compared to 2017 (Table 1). In addition, a reduction in formal employment was recorded, using Nicaraguan Social Security Institute (INSS) affiliation as a proxy, which resulted in a drop of around 10.5 percent, as shown in Figure 3.

FIGURE 3 Nicaraguan Social Security Institute (INSS) affiliates, 2010–2018



Source: Central Bank of Nicaragua.

According to INSS data, there was a reduction of 95 800 social security affiliations compared to 2017, with the most affected being the affiliations in the trade sector, which includes commerce, hotels and restaurants (49.5 percent); community, social and personal services (25.7 percent); construction (8.5 percent); and financial establishments (7.5 percent) (Table 7). All of the other sectors also registered a reduction in formal employment, including the agricultural, forestry, hunting and fisheries sectors, where it was reduced by 6 570 formal workers. In addition to a reduction in employment, these results could be a reflection of a shift from formal employment to informal activity.

TABLE 7 INSS affiliates according to economic activity, 2010–2018

Items	2010–2017	2017	2018
Total (number of people)	708 130	914 196	818 396
Agriculture, forestry, hunting and fisheries	63 983	78 512	71 942
Mining	4 482	5 436	4 876
Manufacturing industry	150 052	165 981	168 158
Electricity, gas and water	8 083	10 423	10 371
Construction	23 430	34 842	26 692
Trade*	122 320	186 229	138 825
Transport and communications	26 961	37 439	34 049
Financial establishments*	66 106	87 236	80 046
Community, social and personal services	242 712	308 098	283 437

Notes: * Includes wholesale trade, retail trade, restaurants and hotels; ** includes financial intermediation, real estate, and business and rental activities; the data correspond to the annual average.

Source: Nicaraguan Social Security Institute.

With both economic activity and employment on the decline, household income was also affected. The drop in private consumption referred to above is, therefore, unsurprising (Table 4).

Economic growth and increased employment from 2010 to 2017 were driven by the performance of the majority of productive activities, including agriculture, manufacturing, mining, construction, tourism and services, with part of the tax revenues used to finance social transfers and programmes. All of this, in addition to workers' remittances from abroad, had a favourable impact on poverty, particularly in rural areas where the rate of extreme poverty decreased.

The social and political revolts the country has experienced since April 2018 have led to job losses and a slump in sectors such as trade, tourism and construction. This has had a high social and economic cost, therefore threatening the results of the poverty reduction efforts made by the government in recent years.

To demonstrate Nicaragua's evolution in terms of poverty, Table 8 shows a summary of the percentage of the population living under conditions of general poverty, extreme poverty and non-extreme poverty at a national level and by urban and rural areas, for the different years in which the National Survey of Living Standards (EMNV) was conducted.

Nicaragua has made substantial progress in reducing poverty, showing a positive trend in line with the National Human Development Plan promoted by the government, the main leading elements of which are peace, safety, stability, the eradication of poverty and the reduction of inequality.

At the national level, in 1998, the level of poverty was 47.9 percent and the level of extreme poverty was 17.9 percent. From 2009, as a result of the social programmes implemented by the government and other important elements, such as workers' remittances from abroad,[5] general poverty fell to 42.5 percent and extreme poverty fell to 14.6 percent.

It is worth pointing out that the 2009–2014 period was when general poverty at a national level decreased the most, as the proportion of the population living below the poverty line fell by 12.9 percentage points, going from 42.5 percent to 29.6 percent, and extreme poverty decreased by 6.3 percentage points, mostly due to the 10.5 percentage point reduction in extreme rural poverty.

According to the results of the latest EMNV from 2016, the poverty decrease was maintained in the 2014–2016 period, achieving a reduction in total poverty from 29.6 percent to 24.9 percent; while in the same period extreme poverty fell by 1.4 percentage points, going from 8.3 percent to 6.9 percent.

Although Nicaragua has achieved substantial progress in the reduction of poverty, it still continues to be high and, given the lack of data for 2018 – at the time of this writing, the question arises as to whether poverty did increase as a result of the reduction in growth, employment, household income and consumption.

[5] The impact of remittances on poverty (or how a reduction in them affects poverty in Nicaragua) has been duly documented. See Sánchez (2015), for example.

TABLE 8 Poverty rate, 2001–2016

Items	2001	2005	2009	2014	2016
National poverty (% of the population)	45.8	48.3	42.5	29.6	24.9
Non-extreme	30.7	31.1	27.9	21.3	18.0
Extreme	15.1	17.2	14.6	8.3	6.9
Urban poverty (% of the population)	30.1	30.9	26.6	14.8	
Non-extreme	23.9	24.2	21.0	12.4	
Extreme	6.2	6.7	5.6	2.4	
Rural poverty (% of the population)	67.8	70.3	63.3	50.0	
Non-extreme	40.4	39.8	36.5	33.7	
Extreme	27.4	30.5	26.8	16.3	

Source: Authors' elaboration based on the reports from the Nicaraguan National Institute of Development Information.

2.4 Final considerations

The strength of the Nicaraguan economy in the 2010–2017 period, and the prudent management of the economy and public finances in 2018, have made it possible to maintain macroeconomic stability in the face of the effects generated by the social and political events that have occurred in the country. However, the functioning of the economy has still exhibited some structural changes.

The increase in open unemployment as well as the reduction of 95 800 INSS affiliates in 1995 not only shows that there was a decrease in employment but also rising informality in the labour market. Given the lack of data for 2018 – at the time of this writing – the question arises as to whether poverty will increase as a result of the reduction in growth, employment, household income and consumption.

At the sectoral level, the primary sector has maintained stable growth. This is a positive aspect for food security and suggests that this sector is relatively more resilient to economic shocks (at least those of a domestic nature) and has productive potential to spur economic growth, despite its decrease in size with regard to GDP. However, there are risks associated with the financing constraints for funding new public investments in the sector, as well as its vulnerability to climate phenomena.

At the time of this writing, the outlook for 2019 was positive – there was no hint yet of the upcoming COVID-19 pandemic – as could be gathered from the 2019–2020 National Production, Consumption and Trade Plan. However, there was the risk of diminished economic performance due to the lack of financing for the acquisition of fertilizers and insecticides, as well as the climate effects that could have a negative impact.

Although data for 2019 was still limited at the time of this writing, it was predicted that sectors such as construction, financial intermediation, home ownership, trade, transport and communications, and other services would continue to show subpar economic growth. In addition, with the tax reform that the government implemented in early 2019, it was estimated that the contribution from taxes on products to revenues would be higher than in 2018.

Nevertheless, the downturn in economic activity had an impact on fiscal performance, and the deficit after grants widened as a percent of GDP in 2018, mainly as a result of reduced incomes. This poses a major challenge for a country that has successfully resorted to public investment during a long economic bonanza but that at present faces very substantial constraints for continuing with that policy.

Given all the questions that arise, the following sections present a prospective analysis of rural poverty under existing economic constraints and challenges, including a lack of external financing as described. Alternative scenarios are examined to determine in which Nicaraguan agricultural sectors it is more cost-effective to make public investments in order to promote economic growth and enable the continued reduction of rural poverty.

3 Methodology and data for analysis

KEY MESSAGES

- An economy-wide model that represents the Nicaraguan economy as a whole was built in order to analyse different scenarios of productive public investment in agriculture.
- The model makes it possible to evaluate macroeconomic, sectoral and distributive effects in the short- and long term.
- The model-based assessment is performed within a framework of accounting consistency: macroeconomic balances, supply and demand balances in each productive sector, and equality between income and expenditures in each institutional sector (households, enterprises, government and the rest of the world) are all considered simultaneously. In this way, it is possible to identify and quantify the relative importance of the different transmission channels.
- A Social Accounting Matrix developed for Nicaragua with data from 2016, consisting of 104 productive activities and 107 products, provided key information to calibrate the economy-wide model.
- In 2016, the primary agriculture sector was responsible for 16.6 percent of value added and 55.3 percent of employment. The agricultural and agroindustrial sectors considered together contributed 41.4 percent of total exports.
- The results regarding consumption per capita of the economy-wide model for different groups of households are distributed among each of the households of the 2014 EMNV in order to determine poverty results.

3.1 Computable general equilibrium model (CGE): a brief description

This study uses an economy-wide model to represent the Nicaraguan economy as a whole. More specifically, a recursive-dynamic computable general equilibrium (CGE) model that is "calibrated" with Nicaraguan data is used to analyse different public investment scenarios. The model was developed based on the structure of the multipurpose CGE model detailed in Cicowiez and Lofgren (2017). The latter, in turn, is based on the neoclassical–structuralist tradition that has been followed in the construction of CGE models applied to developing countries for the analysis of policies and external shocks. In addition, the model used for Nicaragua is similar to the MAMS (Maquette for MDG simulations) model (Lofgren, Cicowiez and Diaz-Bonilla, 2013) and the IFPRI standard model (Lofgren, Lee Harris and Robinson, 2002). In both cases, these are extensively used and widely tested models; in addition, both have been applied for Nicaragua in previous studies (see, for example, Sánchez and Vos, 2006, 2010; Gámez, 2008).

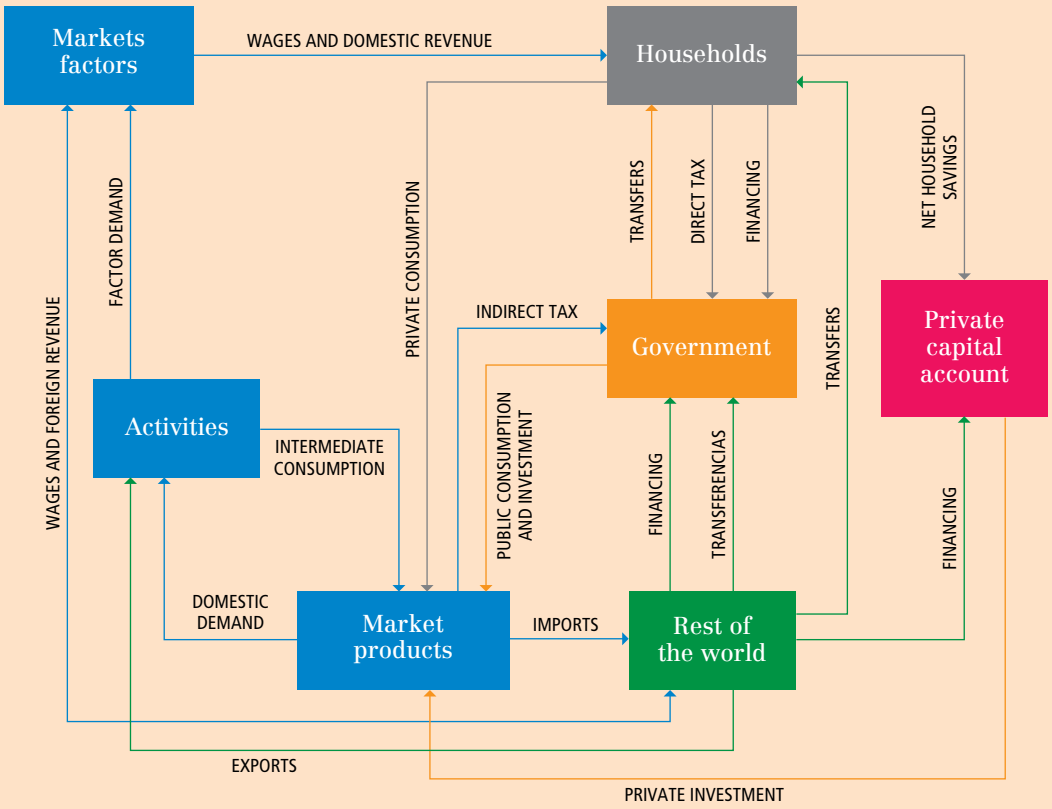
The CGE model developed for Nicaragua by FAO makes it possible to evaluate the macroeconomic (for example, regarding the GDP), sectoral (for example, regarding the sectoral structure of production) and distributive (for example, regarding the income of different groups of households) effects, in the short- and long term, resulting from stepping up investment in productive infrastructure, whether by the public and/or private sector. The model-based analysis (further presented in the next section) is conducted within a framework of analytical and accounting consistency, which would not be the case if an alternative partial equilibrium approach were to be taken. The accounting consistency is ensured by simultaneously considering the macroeconomic balances (for example, equalization between saving and investment), the balance of supply and demand in each productive sector, and the balance between income and expenditures of each of the institutional sectors or institutions represented in the model (households, enterprises, government, and the rest of the world, among the most important).

The remaining part of this section provides a discursive presentation of the model. A detailed description of the variables and equations of such, as applied to the Nicaraguan case, is available upon request to the authors.

INTRA-PERIOD SOLUTION. The system presented in Figure 4 summarizes the main flows that the Nicaraguan CGE model captures, for each period or year of simulation. The arrows represent the direction of the flow of funds between markets and institutions and between institutions themselves. The institutions represented in Figure 4 are households, the government and the rest of the world. For example, the government gathers income from direct taxes that the households pay. In turn, the activities (in other words, the producers of goods and services) use production factors such as labour and capital. Households that are owners of said factors receive remunerations for their employment. In general, the CGE models such as these take into account the real economy, excluding monetary aspects. Consequently, they do not consider phenomena such as inflation. This means that they focus their attention on capturing changes in the way in which the resources of the economy modelled are allocated, in response to a change in relative prices resulting from an external or political shock. In this regard they are particularly useful for analysing the impact of a policy that consists of stepping up public investment in productive infrastructure.

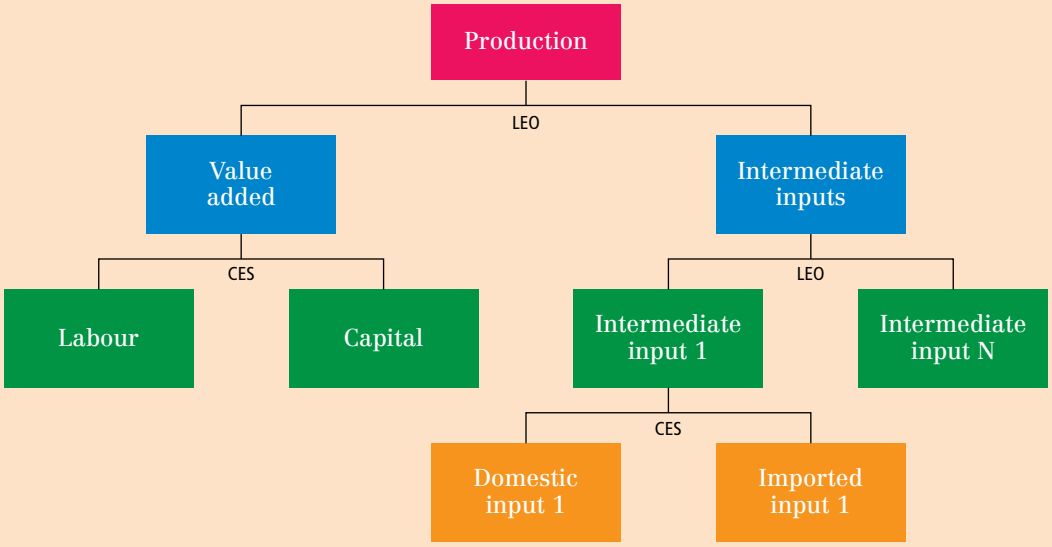
The production sectors are represented by activities (i.e. producers) that maximize their profits in markets that are assumed to be competitive. In particular, a nested production technology is used; this is summarized, in a simplified manner, in Figure 5. To begin with, the production takes place by combining – in accordance with fixed proportions – the value added and the intermediate inputs. The value added in turn is generated by means of the combined use of primary production factors (labour, capital and, depending on the sector, land and natural resources). The activities can produce one or more products in fixed proportions. In turn, each product can be produced by more than one activity; in other words, the model permits the presence of primary and secondary production within a single sector. The total production of each good or service can be geared towards the domestic market or exported to the rest of the world.

FIGURE 4 The circular flow of "inter-period" income in the Nicaraguan computable general equilibrium model



Source: Authors' own elaboration.

FIGURE 5 Nested production function



Note: LEO is Leontief or fixed proportions and CES is constant elasticity of substitution.
Source: Authors' own elaboration.

Typically, households, enterprises, the government and the rest of the world are identified as institutional sectors – or simply institutions. Households and enterprises are also typically bundled together, so hereafter the term "households" represents both institutions. Households obtain their income from the production factors they own as well as the transfers they receive from other institutions included in the model. They use this income to buy the goods and services they consume, pay direct taxes, and make transfers to the other institutions; eventually, they also save part of this income.[6] This savings can be used to finance investment and/or, as further explained below, to cover the public deficit. The government receives income from collecting taxes and from the transfers it receives from the other institutions. It uses its income to consume (or provide) goods and services, make transfers to other institutions, and to invest. The difference between public income and expenditure is covered with net financing from national institutions (households and/or companies) or from the rest of the world. The rest of the world provides the demand for the goods and services that Nicaragua exports and supplies the goods and services that Nicaragua imports. The model assumes that Nicaragua, being a small country, takes as a given the world price of the products it sells to the rest of the world.

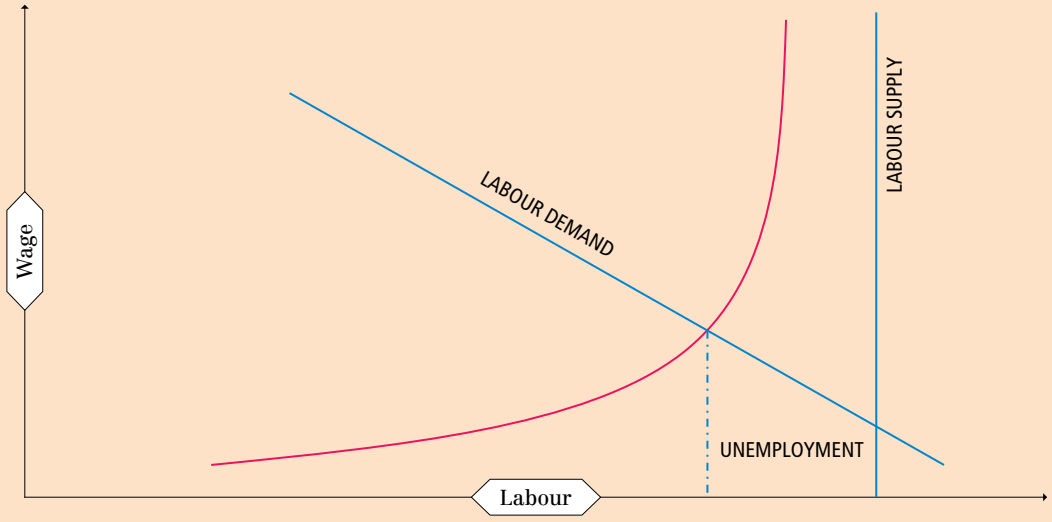
In addition, the model makes it possible to identify eight types of taxes: on household income, on activities, on sales, on value added, on exports, on imports, on the income that owners of production factors receive (labour, capital, land and other natural resources) and on the use of said production factors in productive activities. In any case, the taxes appear represented by their effective rates calculated as the ratio between the amount collected and the tax base. In addition, the trade and transport margins are modelled explicitly, assuming that the corresponding services are required in fixed proportions to transport a good from the producer to the consumer.

In terms of foreign trade, the model assumes that goods and services differ depending on their country of origin (Armington, 1969). Trade can therefore be modelled in two directions – the same good can be imported and exported simultaneously. The combination of domestic and imported products consumed is the same regardless of the destination of the products (for example, intermediate consumption versus final consumption). The assumption of imperfect substitution between domestic purchases and imports is implemented with a constant elasticity of substitution (CES) function. On the production side, a symmetrical assumption is made in that exports are imperfect substitutes for sales to the domestic market – to this end, a constant elasticity of transformation (CET) function is used. In other words, the producers determine how much to sell to the domestic and foreign markets based on the relative prices obtained in these two markets. For example, ceteris paribus, an increase in the export price of meat compared to the local price will increase meat exports at the expense of domestic meat sales. In the medium run, however, it is to be expected that meat production will increase and that this will make it possible to compensate for the drop in sales to the domestic market.

The model also assumes the existence of unemployment in the labour market resulting from a wage curve (Figure 6), with a negative relationship seen between the level of wages and rate of unemployment (see Blanchflower and Oswald, 1994). In all cases, labour is perfectly mobile between sectors – workers can move from one sector to another without any kind of friction. For example, sectors promoted by a given public policy could fulfil their labour demand by taking on workers previously employed in other activities; this could also affect the unemployment rate. For its part, the capital factor, once installed, is immobile between sectors.

[6] In Figure 4, the transfers between institutions are expressed in net terms. In other words, the arrows that indicate transfers capture the differences between paid and received transfers.

FIGURE 6 Labour market with unemployment



Source: Authors' own elaboration.

INTER-PERIOD SOLUTION. The Nicaraguan CGE model is dynamic and recursive. It is a model where the economic agents are short-sighted when it comes to what will happen in the future, and thus these agents expect future conditions to be similar to the present ones. Likewise, they expect that future prices will be identical to the prices of the present period. In addition, there are four sources of dynamics that link each inter-period solution: capital accumulation, growth of the labour force, growth of the supply of natural resources, and increases in the productivity of production factors. At the outset of each period, the sectoral capital stocks are modified on the basis of the investment realized in the previous period. The sectors that will attract the most investment will be those that register a relatively high rate of return on capital, compared to the average for the economy. For its part, the allocations of all the other production factors grow exogenously. The capital stocks and investment for each period are differentiated into public and private. In summary, the dynamic model solution involves solving a succession of static (intra-period) models connected by changes in the accumulation of factors.

PUBLIC INVESTMENT AND TOTAL FACTOR PRODUCTIVITY. In addition, the Nicaraguan CGE model assumes, on the basis of the empirical evidence available (and as explained further below) that increases in the public capital stock can have positive effects on total factor productivity (TFP). For example, in the case of the transport sector, road improvements would reduce, ceteris paribus, the cost of transporting goods from the producer to the consumer.

3.2 Calibration of the computable general equilibrium model (CGE) with Nicaraguan data

The above-described modelling framework must be calibrated with Nicaraguan data so that it represents the country's economy as best as possible. In other words, all of the components of the model – including, for example, sectoral production, production technologies, and incomes and expenditures of households and the government, among others – must reflect the Nicaraguan economy in a recent year of relatively normal conditions that we call the

base year in the remainder of this study. The calibration process uses a Social Accounting Matrix (SAM) combined with estimates for the model's elasticities. Briefly, a SAM is a table that displays the information that the national accounts of a country typically provide. For their part, the elasticities define behaviour; that is, the degree in which producers can substitute labour with capital, consumers can substitute domestic goods and services with imported ones, or consumers increase consumption of each good and service when their income increases (to name the most important behaviours). Last, it should be stressed that, in the absence of shocks, the model solution for the base year (the first intra-period solution) must replicate the transactions recorded in the SAM used for the model's calibration.

3.3 Social Accounting Matrix and the state of the economy in 2016

The SAM is a square matrix (that is, the number of rows is equal to the number of columns) that shows all of the transactions made in an economy (subnational, national or global) in a specific year. For this study, a SAM was constructed for Nicaragua using data from 2016, as documented in Ramírez (2019). In general, this SAM for Nicaragua is similar to those used by other CGE models. However, it includes some specific characteristics linked to external financing of the government and of the private sector and to the internal financing of the government. In addition, in order to better capture government activity, and to be consistent with the study objectives, public investments are disaggregated by sector of destination.

The main information sources for building the 2016 Nicaraguan SAM were the national accounts that the BCN prepares. In particular, the Supply and Use Tables (SUT) and Integrated Economic Accounts (IEA) were used. Data from the 2014 EMNV were also used in order to identify different categories of workers and households. The SAM developed therefore identifies 104 activities and 107 products. For this study, and for practical reasons, a slightly more aggregated version of the original SAM was used.

On the basis of the Nicaraguan SAM it is possible to describe the state of the economy in 2016, which is then used as the base year to provide the dynamic and recursive solution for the Nicaraguan CGE model. Table 9 shows the accounts contained in the 2016 SAM used to calibrate the model (for more details, see Ramírez, 2019). The 104 activities and 107 products that the 2016 national accounts (specifically the SUT) identify were aggregated into two groups of 36 activities and 36 products each. (As the names are the same for both groups, in the table these have been simplified into one list of 36 activities/products.) The agricultural activities are disaggregated into coffee, sugar cane, basic grains (maize, beans, sorghum and rice), other crops and livestock farming.[7] Forestry and fisheries appear separately. Notably, the households are disaggregated into 12 categories of "representative households", in accordance with their location (i.e. urban/rural) and their main source of income (i.e. labour by qualifications, capital, government transfers and remittances).[8]

[7] Other agricultural products include banana, soya, peanuts, sesame, unmanufactured tobacco, grassland pastures, vegetables, roots and tubers, fruit and citrus fruit, as well as other agricultural products.

[8] Typically, a CGE model – and the SAM used to calibrate it – identifies one or more representative households. In our case, each of them represents a portion of the income and expenditure of Nicaraguan families.

TABLE 9 2016 Nicaraguan Social Accounting Matrix statements

Activities/products (36)	Distribution margins (3)	Taxes (7)
Coffee	Distribution margin, national products	Activities tax
Sugar cane	Distribution margin, imported products	Value added tax
Basic grains	Distribution margin, exported products	Import tax
Other agricultural products		Products tax
Livestock farming	**Factors (6)**	Products subsidy
Forestry	Low-skilled labour (<secondary)	Activities subsidy
Fisheries	Medium-skilled labour (<tertiary)	Income tax
Mining	High-skilled labour (tertiary)	
Electricity	Capital	
Water and sanitation	Land	
Meat	Other natural resources	
Sugar		
Dairy	**Institutions (16)**	**Saving and investment (13)**
Oils and fats	Rural household dependent on low-skilled labour	Capital account, non-government national institutions
Milled goods	Rural household dependent on medium-skilled labour	Capital account, government
Baked goods	Rural household dependent on high-skilled labour	Capital account, rest of the world
Other food	Rural household dependent on capital	Public investment – water and sanitation
Drinks and tobacco	Rural household dependent on remittances	Public investment – education; health; housing
Textiles	Rural household dependent on government transfers	Public investment – agroecological and organic production
Paper	Urban household dependent on low-skilled labour	Public investment – technological under-development
Refined petroleum products	Urban household dependent on medium-skilled labour	Public investment – social projects to support production
Chemicals; rubber and plastic	Urban household dependent on high-skilled labour	Public investment – irrigation
Other non-metallic mineral products	Urban household dependent on capital	Public investment – other infrastructure
Metals	Urban household dependent on remittances	Public investment – public administration
Machinery and equipment	Urban household dependent on government transfers	Private investment
Other manufactured products	NPISH	Changes in inventories
Construction	Companies	
Trade	Government	
Hotels and restaurants	Rest of the world	
Transport		
Communications		
Finance		
Company services		
Public administration		
Other services		
Domestic services		

Source: Authors' own elaboration.

The information contained in the SAM facilitates the interpretation of the results of the series of simulated scenarios described in Section 4. In general terms, it shows the characteristics of the Nicaraguan economy structure that are of value in determining the results that the CGE model delivers. For example, the shocks originating from the rest of the world are transmitted to the local economy by means of the current account of the balance of payments. It is therefore important to understand in advance: (a) the sources of inflows and outflows of foreign exchange, and (b) the sectoral structure of Nicaraguan international trade as captured in the SAM and, consequently, also in the CGE model.

Table 10 shows an aggregated or simplified version of the 2016 Nicaraguan SAM (called "macro SAM"). In particular, for the purposes of the presentation, only two activities and two products are distinguished (agriculture and non-agricultural), the production factors are aggregated into labour and non-labour (capital, land and natural resources), the 12 households into just one, and public investment accounts into just one as well. In the table, the flow that comes out of each column represents an expenditure, while the flow that each row receives represents an income. For example, cell [c-nagr, a-agr], which contains 6.7 percent of the GDP, represents payments that agriculture makes for the purchase of intermediate goods/services from non-agricultural activities. As another example, cell [hou, govt], which contains 6.2 percent of the GDP, represents government transfers to households.

TABLE 10 2016 Nicaraguan macro SAM

A. DATA EXPRESSED AS A PERCENTAGE OF GDP

	a-agr	a-nagr	c-agr	c-nagr	marg	f-lab	f-cap	hhd	ent	gov	row	tax-indir	tax-dir	cap-insdng	cap-gov	cap-row	inv-gov	inv-priv	dstk	Total
a-agr			23,9	0,0																23,9
a-nagr			0,2	152,5																152,7
c-agr	2,3	13,2						6,0		0,1	5,4						0,0	0,8	1,0	28,7
c-nagr	6,7	64,2			17,3			64,2		14,7	33,4						7,4	19,3	2,6	229,7
marg			2,8	14,5																17,3
f-lab	12,0	38,2																		50,2
f-cap	2,6	35,6																		38,2
hhd						50,2	10,4		6,1	6,2	12,1									85,1
ent							27,2	0,7		0,7	0,0									28,7
gov							0,6	6,2	0,8		0,7	11,6	6,7							26,6
row			1,8	52,9					2,4	0,5										57,6
tax-indir	0,3	1,5	0,1	9,7																11,6
tax-dir								0,0	6,7											6,7
cap-insdng								8,0	12,6							–2,9				17,7
cap-gov										4,5				–0,7		2,2				6,0
cap-row											6,0									6,0
inv-gov														1,8	5,6					7,4
inv-priv														13,4		6,7				20,1
dstk														3,2	0,4					3,5
Total	23,9	152,7	28,7	229,7	17,3	50,2	38,2	85,1	28,7	26,6	57,6	11,6	6,7	17,7	6,0	6,0	7,4	20,1	3,5	

B. NOTATION USED FOR THE DEFINITION OF EACH ACCOUNT

Account	Description
a-agr	Activity – agriculture
a-nagr	Activity – other
c-agr	Product – agriculture
c-nagr	Product – other
marg	Distribution margins
f-lab	Factor – labour
f-cap	Factor – capital
hhd	Households
ent	Enterprises
gov	Government
row	Rest of world
tax-indir	Taxes – indirect
tax-dir	Taxes – direct
cap-insdng	Capital account – households and enterprises
cap-gov	Capital account – Government
cap-row	Capital account – rest of world
inv-gov	Investment – GFCF* – Government
inv-priv	Investment – GFCF* – private
dstk	Investment – changes in inventories

Note: * Gross fixed capital formation.

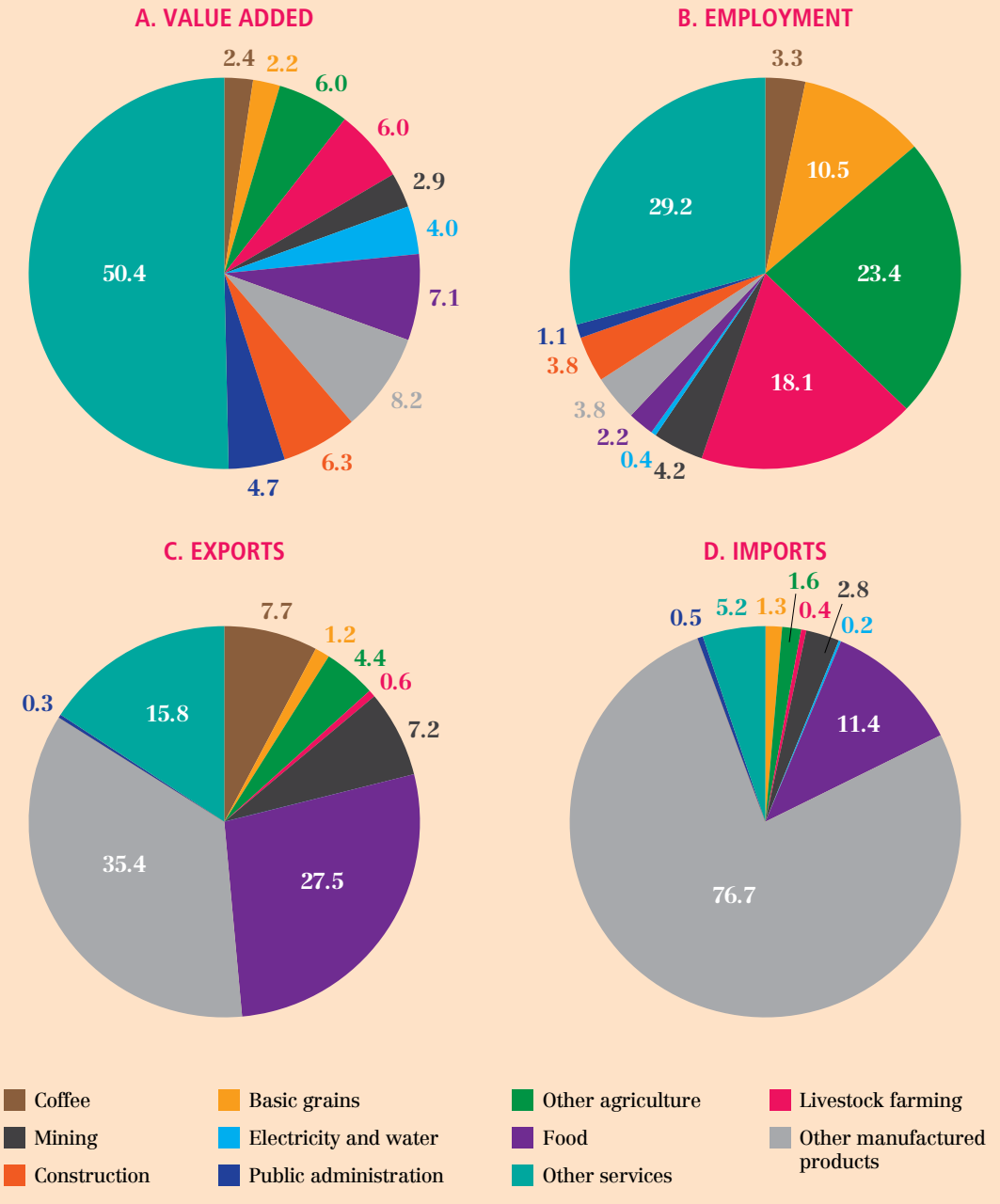
Source: Authors' own elaboration.

By design, the SAM reproduces the macroeconomic aggregates as recorded in the national accounts that the BCN prepares. For example, in 2016 the public deficit (calculated thusly: [cap-govt, govt] - [inv-govt, cap-govt] - [dstk, cap-govt]) was equal to 1.5 percent of GDP and was covered with foreign borrowing. In turn, the net domestic borrowing was negative. In terms of taxation, in 2016, the Government of Nicaragua collected taxes and social security contributions amounting to 18.3 percent of GDP (calculated thusly: [govt, tax-indir] + [govt, tax-dir]). Of this total, 11.6 percent corresponds to indirect taxes and the rest to direct taxes. The balance of payments shows that, after exports (calculated thusly: [c-agr, row] + [c-nagr, row]), the main source of foreign exchange was remittances – equal to 12.1 percent of GDP. For its part, direct foreign investment amounted to 6.7 percent of GDP. The distribution of the income from the factors between labour and capital was 50.2 percent and 38.2 percent, respectively.

Panels (a) through (d) of Figure 7 summarize the sectoral structure of the Nicaraguan economy; to save space, the 36 sectors that appear in Table 9 were aggregated into 11. Panels (a) and (b) show the sectoral participation in value added and employment, respectively. In 2016, the primary agriculture sector was responsible for 16.6 percent of value added and 55.3 percent of employment. In turn, the agricultural – including forestry and fisheries – and agroindustrial sectors considered as a whole represented 41.4 percent

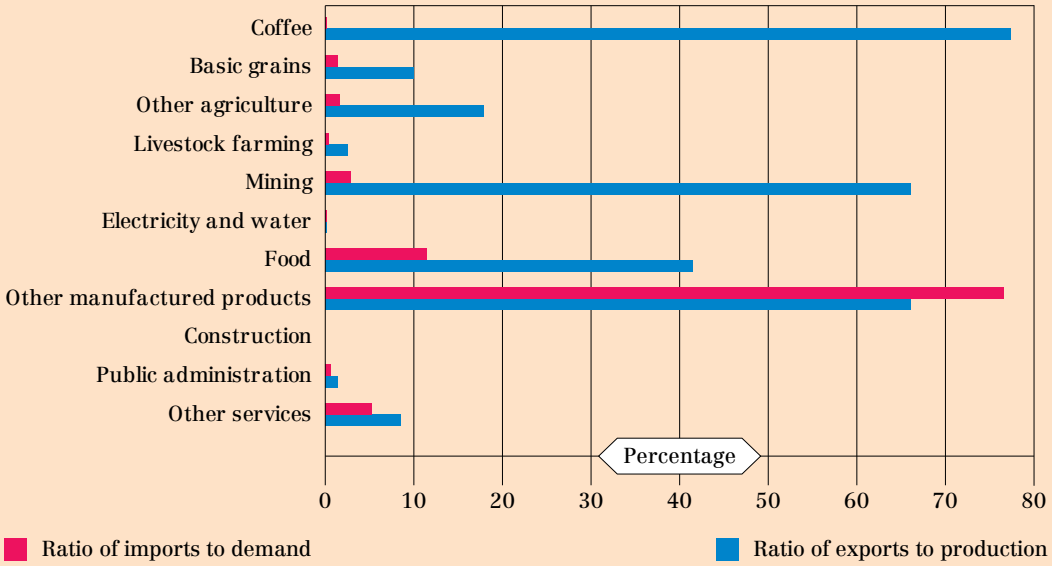
of total exports (see panel [c]), with exports representing 30.6 percent of their production (see Figure 8). In practice, a sector very much geared towards exports, such as coffee in the case of Nicaragua, is not limited by an exclusive dependence on domestic demand to sell its output. Among the other manufactured products, the products that are most export-oriented are food and textiles. The sectors that are most import-oriented are other manufactured products, with 76.7 percent of their consumption covered by imports (see Figure 8). In particular, machinery and equipment stand out with 98 percent of their demand covered by imports.

FIGURE 7 Sectoral structure of the economy (by percentage)



Source: Authors' own elaboration.

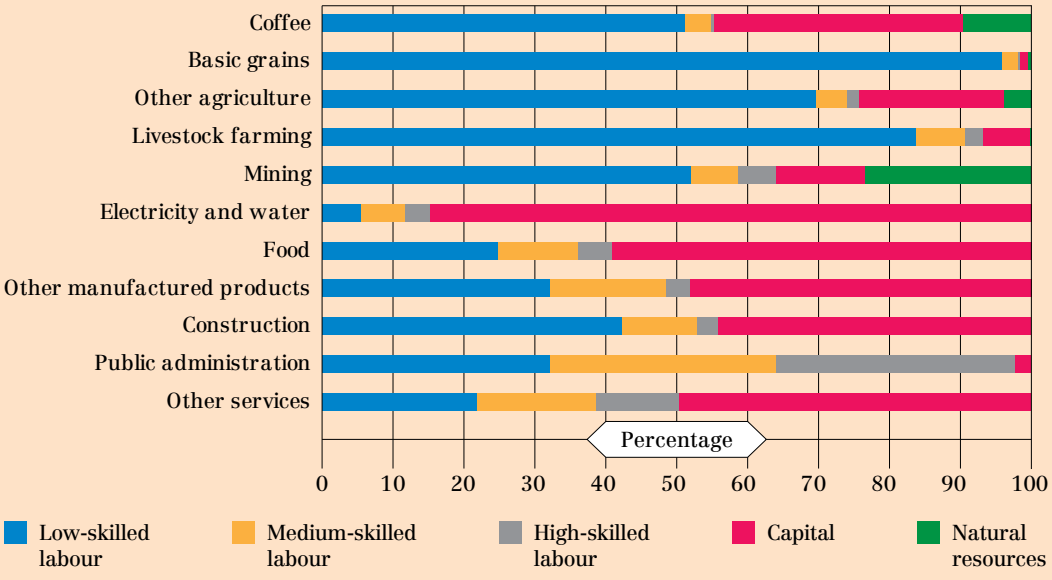
FIGURE 8 Export and import intensity by sector



Source: Authors' own elaboration.

Factor intensity in each production sector represented by means of the capital/labour ratio of each is shown in Figure 9. The intensity with which each production sector uses a given factor makes it possible to anticipate which of these factors would win or lose as a result of a shock or policy that benefits some sectors more than others. In terms of value, the agricultural and mining sectors are relatively intensive in the use of land and extractive resources, respectively. For their part, the activities that provide business services and public administration are relatively intensive in the employment of skilled labour.

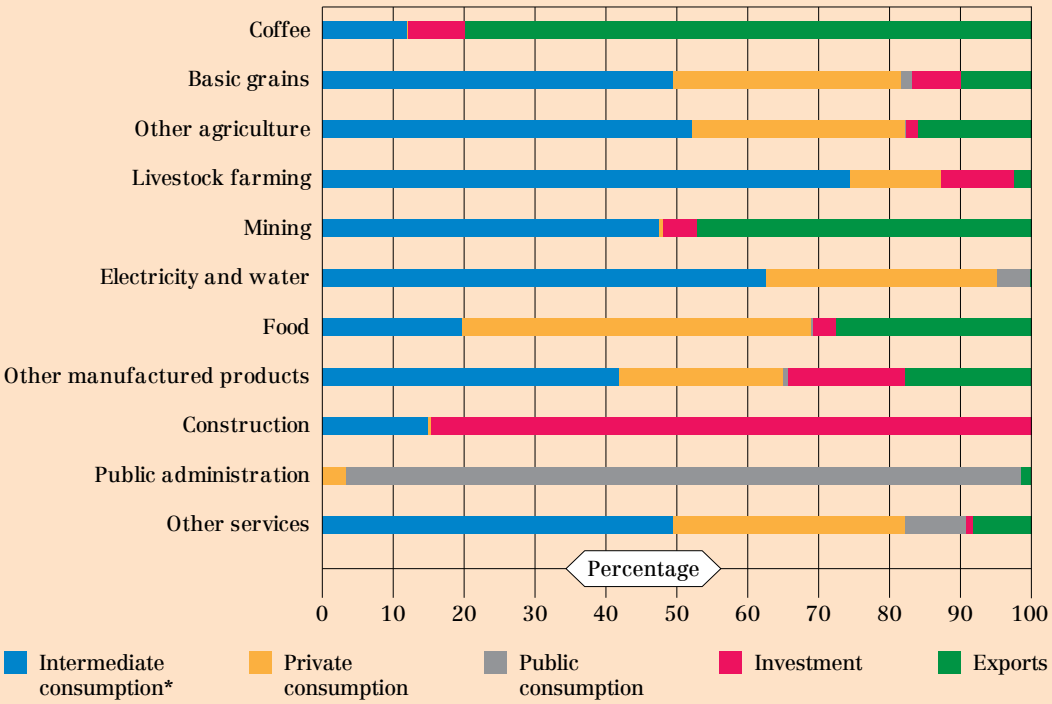
FIGURE 9 Composition of value added by sector



Source: Authors' own elaboration.

Figure 10 summarizes the structure of the demand for each of the products in the SAM (and in the model too, once calibrated). Sectors such as that of coffee are geared towards fulfilling the demand from the rest of the world; in particular, 80 percent of coffee production is geared towards export. In contrast, a sector such as construction assigns more than 80 percent of its production to fulfilling investment requirements.

FIGURE 10 Composition of demand by good and service

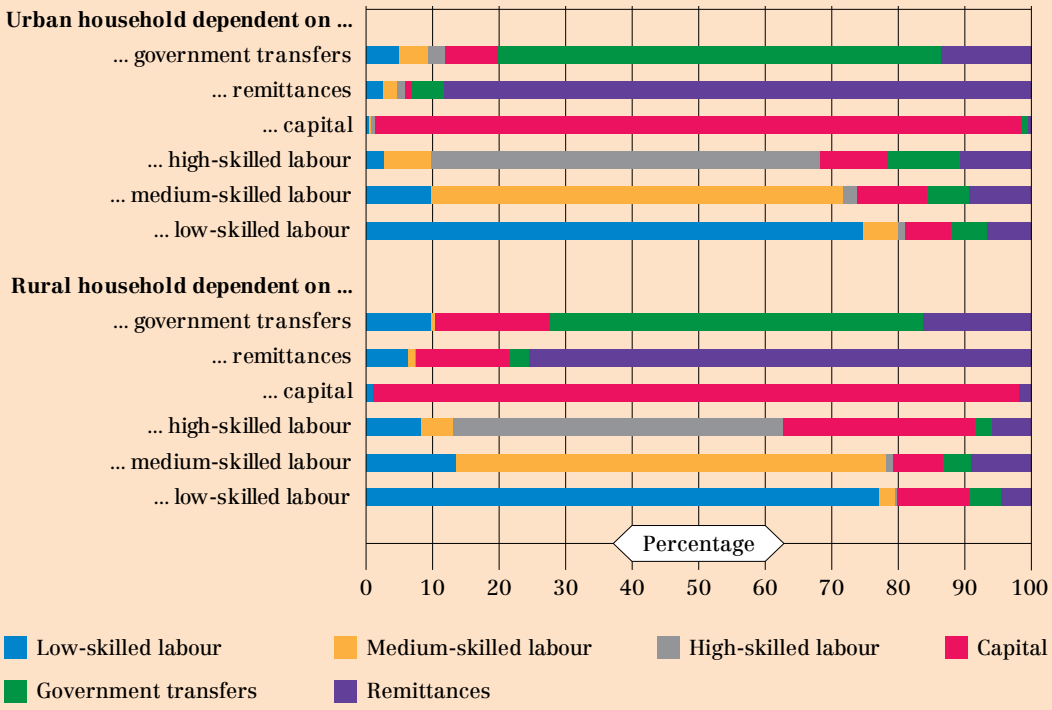


Note: * Includes distribution margins.

Source: Authors' own elaboration.

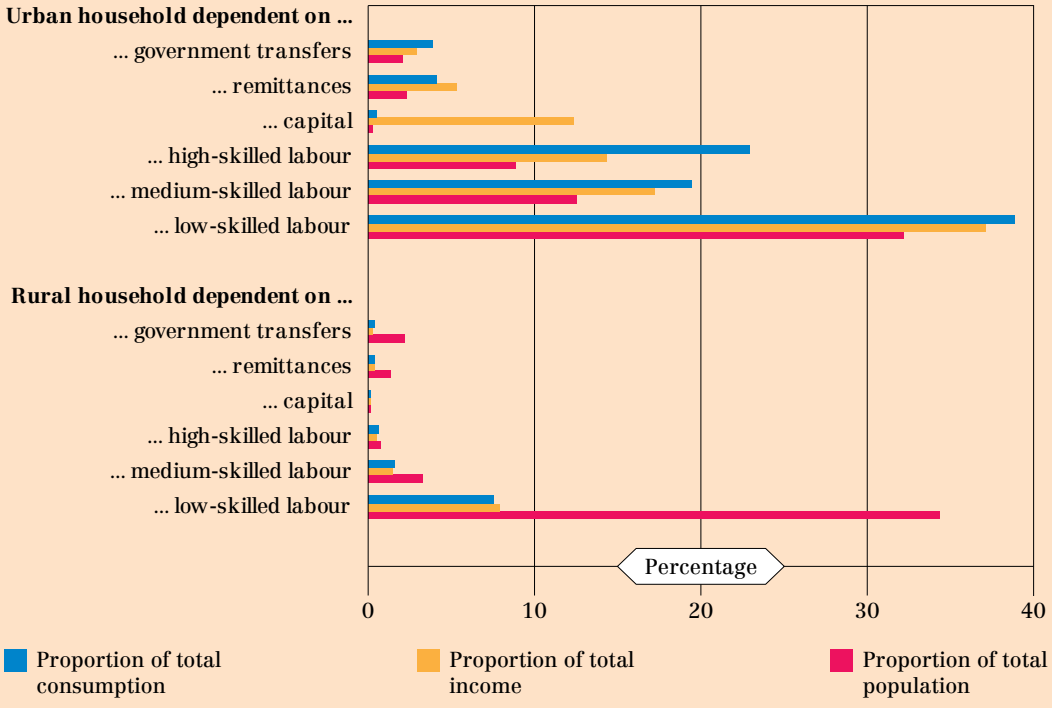
Figure 11 details the structure of household incomes identified in the SAM. For example, the main source of income for each of the 12 representative households is consistent with the name they have been assigned (see Table 9). In general, the main source of household income is labour. However, for rural households dependent on workers' remittances, the income they receive for the use of land is also important (in Figure 11, this is aggregated together with the capital factor). In terms of distribution (see Figure 12), the households that represent a larger proportion of the population are rural and urban ones whose main source of income is the work performed by members with primary education. In total, these two groups of households represent 66.4 percent of the Nicaraguan population. As a result, a shock or policy that affects the income of unskilled workers will, a priori, have substantial distributive effects. For its part, the households dependent on the income generated by the use of the capital factor only represent 0.24 percent of the total. Interestingly, the households dependent on remittances represent as much as 3.7 percent of the total. In addition, the income and consumption per capita increase in line with the level of education.

FIGURE 11 Composition of household income by source



Source: Authors' own elaboration.

FIGURE 12 Proportion of each representative household in total population, total income and total consumption



Source: Authors' own elaboration.

3.4 Elasticities

In the calibration of all CGE models, supply and demand elasticities are used in addition to the SAM. These, in the particular case of the Nicaragua model, were mostly obtained on the basis of a literature review. The substitution elasticities among primary production factors measure the degree to which the different production sectors can substitute one production factor for another; for example, labour for capital. For Nicaragua, the elasticity of substitution among primary production factors ranges from 0.2 for extractive sectors, up to 0.95 for services such as construction, trade and transport (see Aguiar *et al.*, 2019). In the agricultural sectors, a substitution elasticity of 0.25 is used that also captures the difficulty of substituting natural resources. Consequently, given these values the agricultural and extractive sectors (i.e. the activities intensive in natural resources) cannot easily increase their production without additional land and natural resource allocations, respectively.

Furthermore, one needs to specify the values of the elasticity that defines the substitution between: (a) imports and domestic purchases, and (b) exports and domestic sales; in both cases as a response to changes in the corresponding relative prices. Based on the literature available for developing countries (see Sadoulet and de Janvry, 1995), this kind of elasticity tends to take the following values: 2 for primary products, 1.5 for manufactured products and 0.9 for other sectors and services. In the latter case, a value below the unit implies that there is a certain complementarity between domestic and imported products. The elasticities that define the substitution of the destination of Nicaraguan production between exports and domestic sales, also known as transformation elasticities, are assumed to be equal to the elasticities of substitution between imports and domestic purchases.

With regard to consumption, the model assumes that the preferences of consumers are of the "Stone-Geary" type, which results in a linear expenditure system. In this system, the expenditure elasticity defines how much the consumption of each good or service will shift as a result of changes in the total expenditure on goods and services. In the case of Nicaragua, the expenditure elasticities were obtained from the econometric study by Muhammad *et al.* (2011), with relatively low estimates for food and textile products. Calibration of the linear expenditure system also required the Frisch parameter (Dervis, de Melo and Robinson, 1982), defined as the ratio between discretionary spending and total spending; this discretionary spending refers to that performed after the minimum consumption of each good and service has been fulfilled. In our case, the Frisch parameter ranges from -4.1 to -1.1, depending on the level of income per capita of the representative household.

The elasticity wages with regard to the unemployment rate, which defines the aforementioned wage curve (see discussion regarding Figure 6), was established at -0.1 for the labour categories considered in accordance with the three educational levels (primary, secondary, higher), consistent with the estimates reported in Blanchflower and Oswald (2005) for a wide range of countries. In other words, with a variation of 1 percent in the unemployment rate, there will be a 0.1 percent variation in the wage level. In any case, given the uncertainty there may be regarding the value that supply and demand elasticities are taking, Annex B analyses the sensitivity of the results to changes in these values.

As previously mentioned, the model developed assumes, on the basis of the empirical evidence available, that public investment has positive effects on TFP at the sectoral level. Consequently, a key parameter in the scenarios simulated is related to the elasticity of the TFP concerning the levels of the different types of public infrastructure. The value of this elasticity is defined as part of the definition of the scenarios described and analysed in Section 4.

3.5 Other data

It is necessary to complement the SAM and the elasticities previously described with information regarding population and factor stocks; for example, the number of workers employed in each production sector and the unemployment rate in 2016. In 2014 (the most recent year available at the time of this writing), and according to EMNV data, the following average unemployment rates were recorded: 2.9 percent, 5.9 percent and 6.6 percent for workers with primary, secondary and higher education, respectively. In addition, according to estimates by the International Labour Organization (ILO), labour underutilization reached 35.6 percent that year.[9] This information was therefore used in the CGE model of Nicaragua to simulate the actual functioning of the labour market.

For their part, the initial capital stocks are calibrated by means of the following assumptions. In the case of private sectors, it is assumed that the capital profitability rate is 7.5 percent, consistent with the generation of a reference scenario assuming balanced growth in the economy (see Section 4) – in other words, consistent with a situation in which the macroeconomic aggregates grow at similar rates. In the case of land, both the amount available and its yield in agricultural production grow at the rate observed in recent years, in accordance with information from the World Bank's World Development Indicators.

The size of the Nicaraguan population must also be specified in the base year of the model (2016) as well as its growth rate in subsequent years of the baseline scenario. This information and the population projections were taken from the World Population Prospects of the United Nations. The growth rate of the labour supply was obtained by applying the participation rate to the population that was also calculated based on the EMNV.

3.6 Microsimulation model for poverty/inequality data

Results in terms of poverty and inequality are not directly derived from Nicaragua's CGE model, which is built to represent the economy as a whole and contains representative groups of households. To obtain these results, the model is complemented with a microsimulation model.[10] The results regarding per capita consumption that the CGE model generates for each representative household are therefore distributed among each of the households that the 2014 EMNV identifies using the microsimulation model. For example, if the CGE model indicates, for a specific scenario, that the per capita consumption of a representative household will increase, the same will happen with all of the households of the 2014 EMNV linked to that representative household. In addition, changes in the prices of goods and services are taken into account to determine the change in the actual per capita consumption expenditure of each representative household group.

In general, any type of shock simulated with the CGE model is transmitted to household income/consumption mainly by means of the factors' market. Thus, the effect on the income/consumption of representative households identified in the SAM and in the CGE model

[9] According to the ILO (2018), labour underutilization refers to the proportion of the *wider labour force* that is in a situation of unemployment, time-related underemployment, or that forms part of the potential labour force. The latter corresponds to the people of working age who are inactive (in other words, who are not employed), having either a) looked for work although they were not available to work, but would be in the near future; or b) not looked for work although they were available to work.

[10] As specified, the CGE model makes it possible to calculate the changes in the distribution of average income/consumption among the 12 groups of representative households specified (see Table 9). However, it is not possible to calculate the distribution of income/consumption changes within these 12 groups of representative households. The poverty calculation must be based on the estimate of the whole income distribution; in other words, taking into account what happens in the distribution within the different groups of households. This methodological limitation is remedied by the microsimulation model.

is a function of the factor allocations of these households (see Figure 11). Consequently, the microsimulation model is particularly useful when the SAM used to calibrate the CGE model disaggregates households according to their main source of income, as is the case in this study.

In addition, a reduction in the costs of agricultural products will have a positive effect on the consumption expenditure throughout the whole distribution of income, but the effect will be more significant for the households with lower income levels. We must remember that the poorest households use a larger proportion of their income to buy foodstuffs.

As we shall see in the next section, the results are based on widely used poverty and inequality measures: moderate poverty rate and extreme poverty rate, for both urban and rural households and for all households together at the national level; and the Gini coefficient for per capita household consumption as a measure of inequality. The poverty rates are calculated in accordance with the official methodology for measuring poverty of the Nicaraguan National Institute of Development Information (INIDE).

4 Simulated scenarios: results and analysis

KEY MESSAGES

- Using the economy-wide model for Nicaragua, a baseline scenario was generated to serve as a point of comparison for scenarios of productive public investment in agriculture.
- The baseline scenario begins in 2016. From 2017 to 2019 it reproduces the trajectories observed in the main macroeconomic aggregates, and from 2020 to 2030 the economy evolves in accordance with the medium- and long-term trends observed in recent years.
- In the other scenarios, public investment in infrastructure which makes agriculture more productive increases from 2020–2028. The scenarios are different in that both the sectors receiving the public investment and the source of the financing change.
- Productive public investment then gradually increases in agricultural sectors, up to 0.5 percent of GDP from 2023–2025. This increases the economic growth rate by around 0.09 and 0.1 percentage points per year until 2030 – or by more than three percentage points when comparing the GDP levels at the end of the period.
- In comparative terms, livestock is the sector that shows the most socio-economic gains when it is the beneficiary of investment, because of its linkages with other processing sectors (meat and dairy).
- The promotion of productivity in agricultural activities that are intensive in the use of unskilled labour substantially reduces poverty, mainly in rural areas.

4.1 Baseline scenario

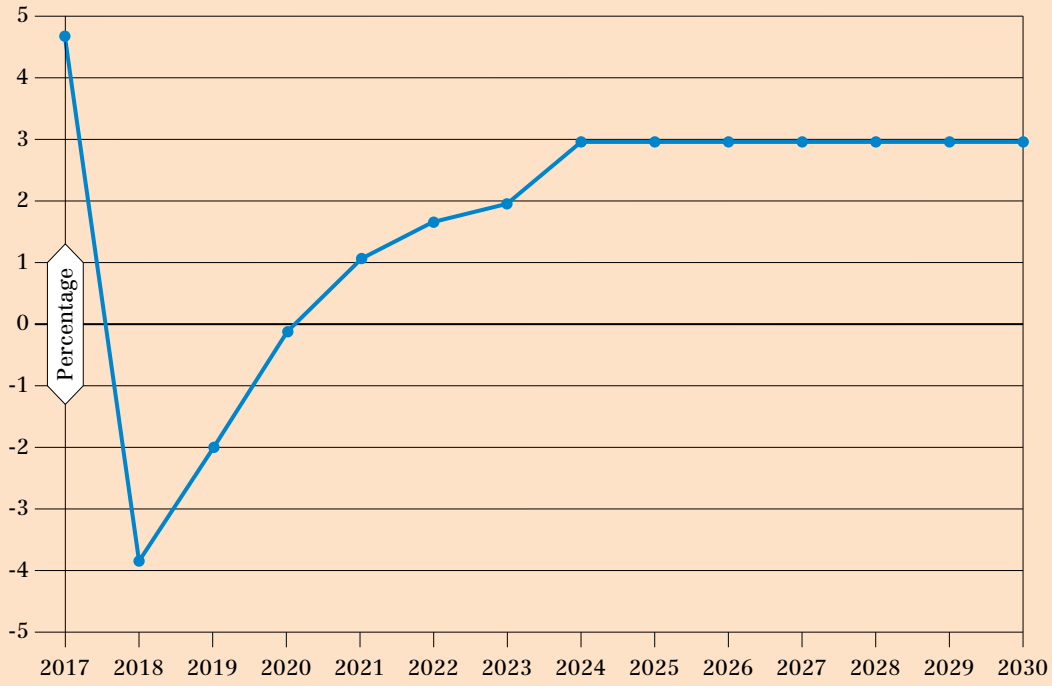
After calibrating the economy-wide model with the data described above, we proceeded to generate the baseline scenario. As will be seen, this baseline scenario is key because it served as a point of comparison for the public investment scenarios upon which we base the conclusions of this study. The starting point for the baseline scenario is 2016, the baseline year of the model as defined by the data in the SAM. Then, for the 2017–2019 period, the trajectories observed for the main macroeconomic aggregates prevail – and these are well informed by the description presented in Section 2. In addition, this baseline scenario assumes that the Nicaraguan economy evolves from 2020 to 2030 in accordance with the medium- and long-term trends observed in recent years (recall that at the time of writing, we had no indication of the upcoming COVID-19 crisis). In other words, it is a "business as

usual" scenario. It is important to highlight that the baseline scenario does not try to predict the future evolution of the Nicaraguan economy. Instead, it is a projection based on the assumptions detailed as follows.

To generate the baseline scenario, the growth rate shown in Figure 13 was used. The projected GDP growth for 2019 was obtained from the BCN. For the 2020–2030 period the BCN projection was then combined with the latest World Economic Outlook projections from the International Monetary Fund (IMF) – at the time of writing. In particular, the IMF estimates for 2024 were also applied to the 2025–2030 period. The population projections are from the World Population Prospects 2019 issued by the United Nations. It is assumed that the economically active population grows at the same rate as the working age population. The supply of agricultural land remains constant. The use of mining and fisheries natural resources grows at the same rate as that of GDP. Public income and expenditure as a proportion of GDP evolve according to the ratios observed and projected by the BCN for the 2016–2019 period. Subsequently, for the 2020–2030 period, it is assumed that these ratios are kept constant with the 2019 ratio. For the other exogenous elements of the model (for example the remittances that households receive from abroad) we keep constant their percentage with respect to GDP registered in 2016. As we will see, the analysis of the public investment scenarios focuses on the 2020–2030 period; in other words, for the 2016–2019 period all of these scenarios are identical to one another and with regard to the baseline scenario.

The baseline scenario is simulated under the following additional assumptions. For the government, tax rates remain unchanged (tax policy as such does not change). For its part, both the other public income – for example, grants from abroad – and all of the public expenditures are expressed as a fixed share of GDP, which is defined on the basis of official figures for the 2017–2019 period. The GDP share for 2019 remains unchanged during the 2020–2030 period. Consequently, total public income and expenditure are equalled by means of changes – increases or decreases as required – in public borrowing. In particular, public domestic borrowing is determined in an endogenous manner (in other words, by means of the model itself) to balance the public accounts. For example, assuming that everything else remains constant, an increase in tax collection would transform into a reduction in domestic public borrowing. The current account balance of the balance of payments in foreign currency is assumed to be constant; as such, foreign exchange inflows and outflows are balanced out by means of variations in the real exchange rate. Meanwhile, the other components of the balance of payments evolve in such a manner that, seen as a share of GDP, they replicate the data observed in the 2016–2019 period, and the share for 2019 remains unchanged for the 2020–2030 period. In this way, the scenarios considered avoid situations in which Nicaragua can obtain unlimited foreign borrowing to finance its imports. In other words, the real exchange rate is flexible such that the simulations are consistent with a medium- and long-term horizon where there is no possibility of unlimited borrowing to balance out inflows and outflows of foreign exchange. Last, it is assumed that private investment is also a constant share of GDP. In turn, the savings rates of households are determined in an endogenous manner such that savings can be identical to private investment. However, it is worth pointing out that said savings rates hardly change between 2020 and 2030 in the scenarios that are analysed in the remainder of this study. Thus, we can state that there is no substantial change in the savings behaviour of households. Overall, the assumptions described in this paragraph are known as the "macroeconomic closure rules" of the model. As we will see, in the non-baseline scenarios, there are changes in: (a) the mechanism to balance the public budget, and (b) the mechanism in which savings and private investment are equalized – in addition, of course, to the simulated increase in public investment.

FIGURE 13 GDP growth rate in the baseline scenario, 2017–2030



Source: Authors' own elaboration.

4.2 Macroeconomic and sectoral results

The economic results generated by the Nicaraguan CGE model for the baseline scenario at both the macro- and sectoral levels are shown in Figures 14–18. Figure 14, for example, shows the evolution of the main macroeconomic aggregates expressed in 2016 córdobas. Figure 15 shows the same information, but in terms of the average annual growth rate for the 2020–2030 period. As we can see, and as a result of the assumptions made previously, the macroeconomic aggregates grow in a balanced manner, with average annual growth rates between 2.3 percent and 2.4 percent.

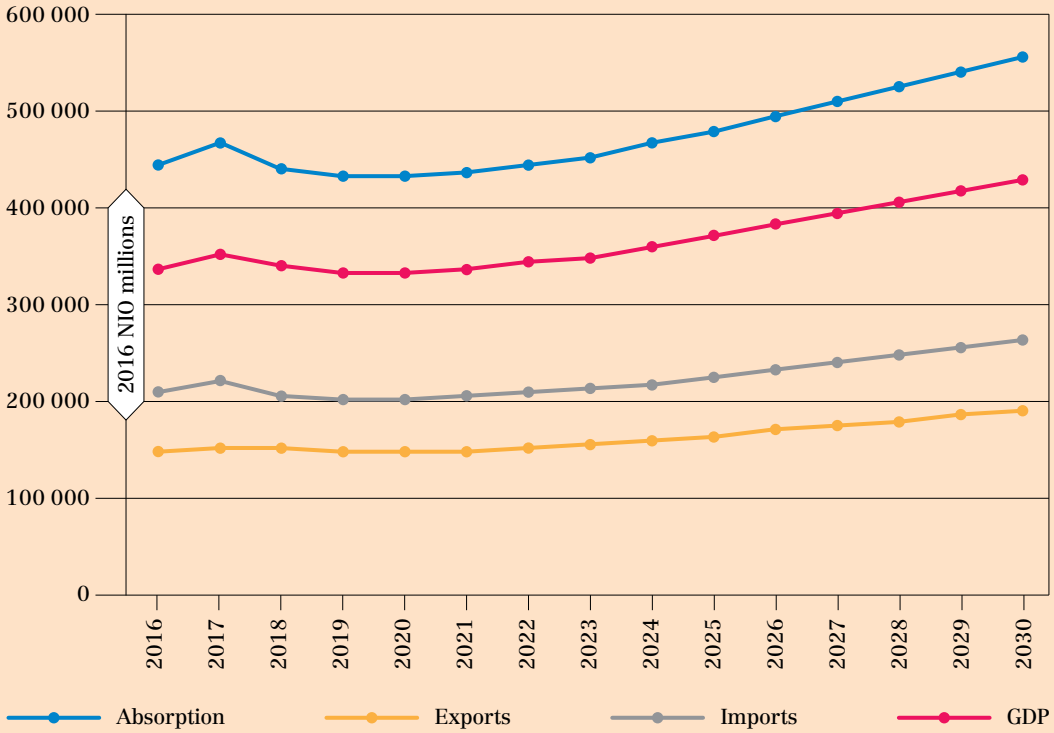
In sectoral terms, since agricultural sectors use land whose supply is assumed to be virtually constant, agricultural production growth is lower compared to other sectors (see Figure 16).[11] For their part, the other sectors grow at rates that, by annual average, vary from 2.3 percent to 2.6 percent. An exception is the mining sector, which has a relatively high growth rate as a result of its high export orientation; specifically, a little over 66 percent of the mining production of Nicaragua is exported to the rest of the world.[12]

[11] In the other sectors, the growth rate is determined by the amounts of capital and labour they use. In other words, they do not face the type of barrier imposed by the use of natural resources such as land or extractive resources.

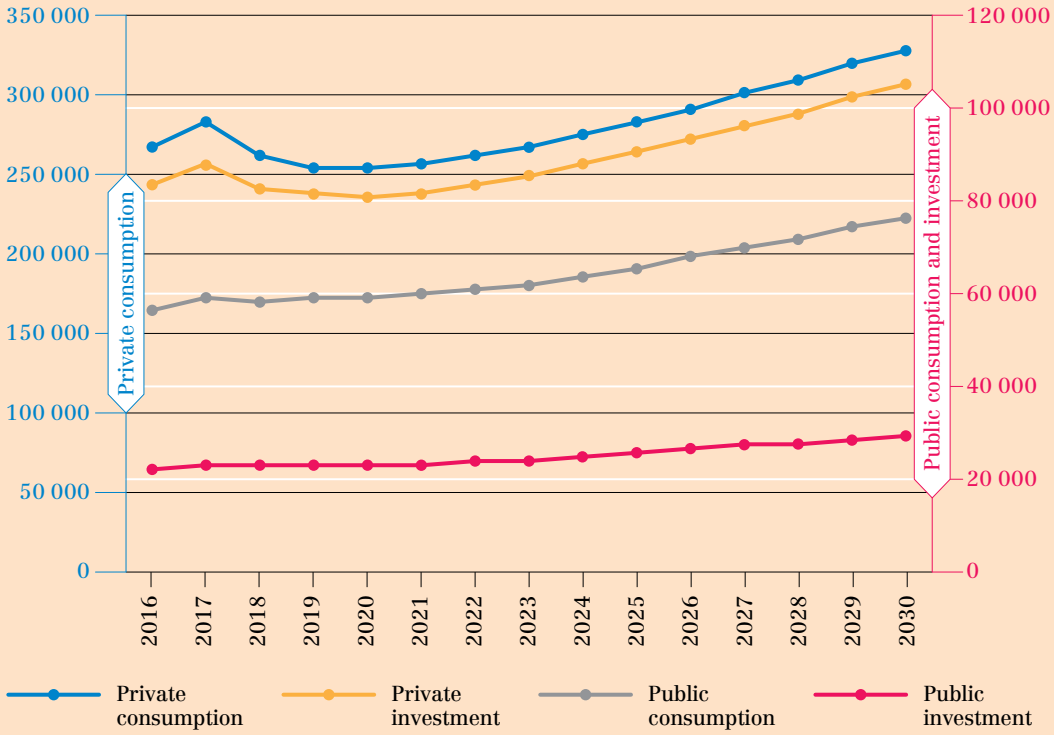
[12] The results with the most sectoral disaggregation possible from the Nicaraguan CGE model can be made available by sending a request to the authors.

FIGURE 14 Selected macroeconomic aggregates in the baseline scenario, 2016–2030

A. ABSORPTION, FOREIGN TRADE AND GDP

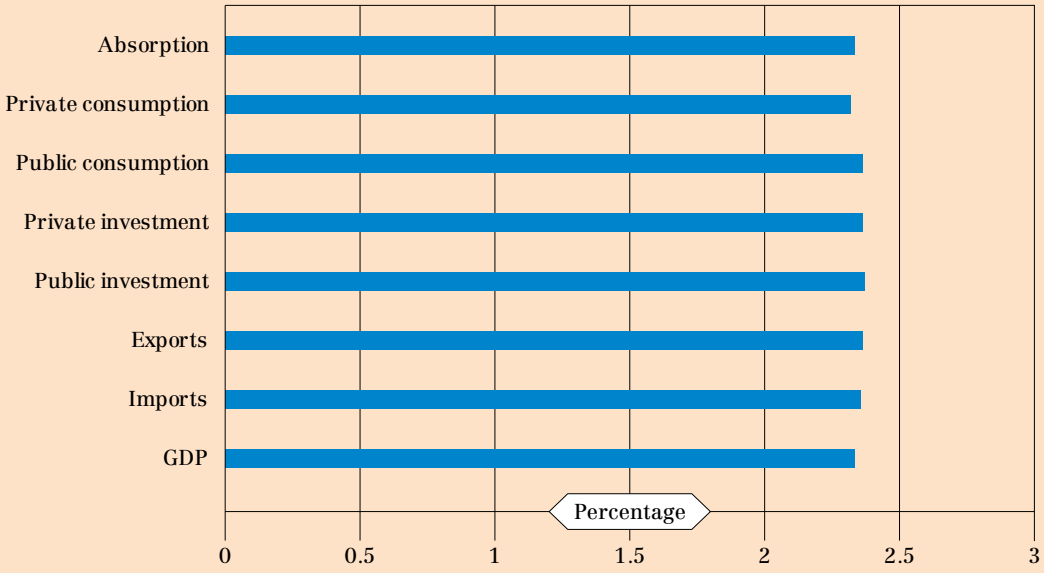


B. CONSUMPTION AND INVESTMENT



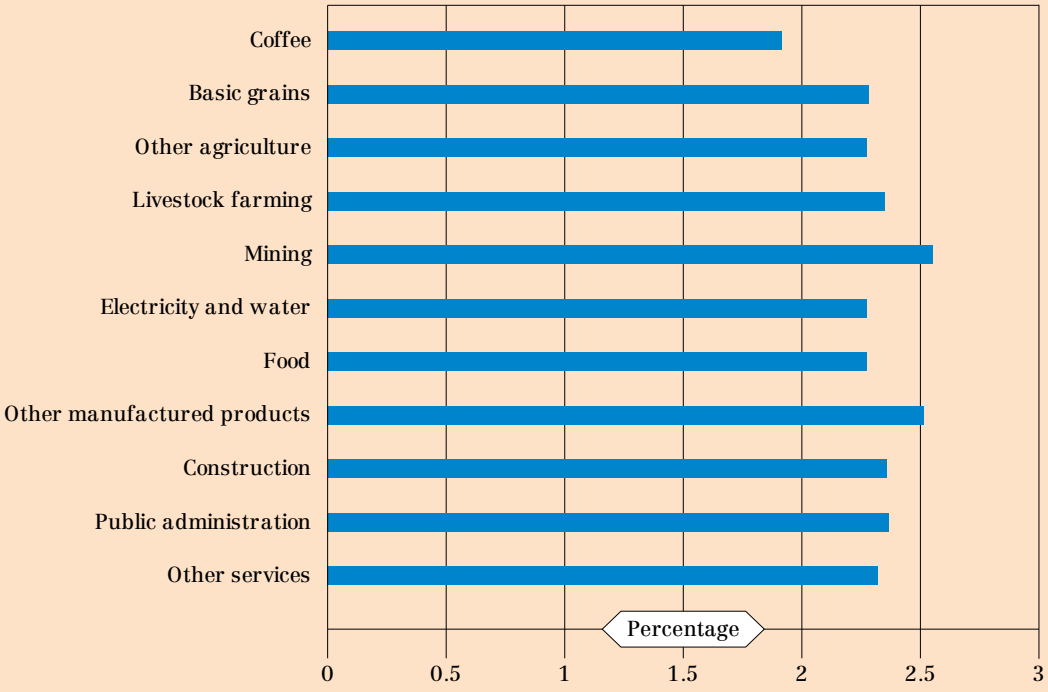
Source: Authors' own elaboration.

FIGURE 15 Average annual growth rate of the macroeconomic aggregates in the baseline scenario, 2020–2030



Source: Authors' own elaboration.

FIGURE 16 Average annual growth rate of sectoral production in the baseline scenario, 2020–2030



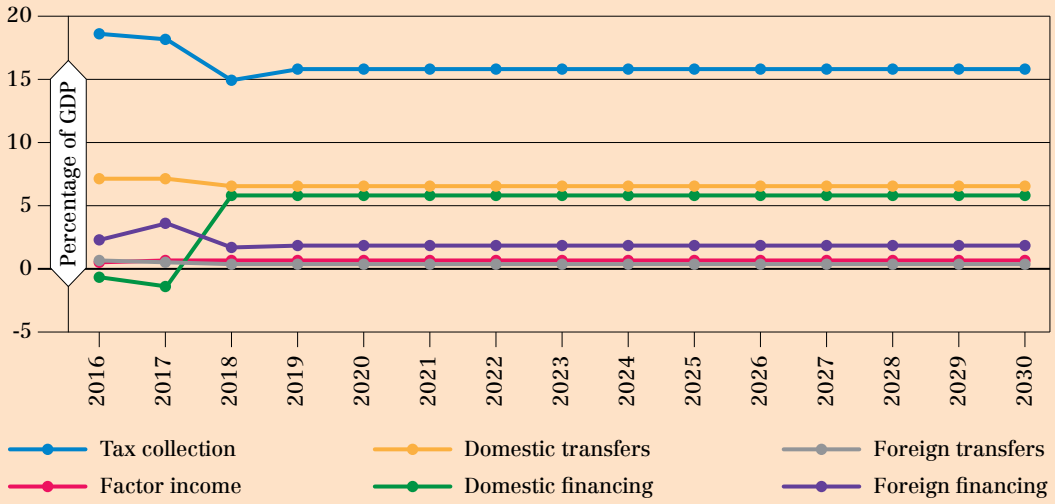
Source: Authors' own elaboration.

4.3 Public income and expenditures

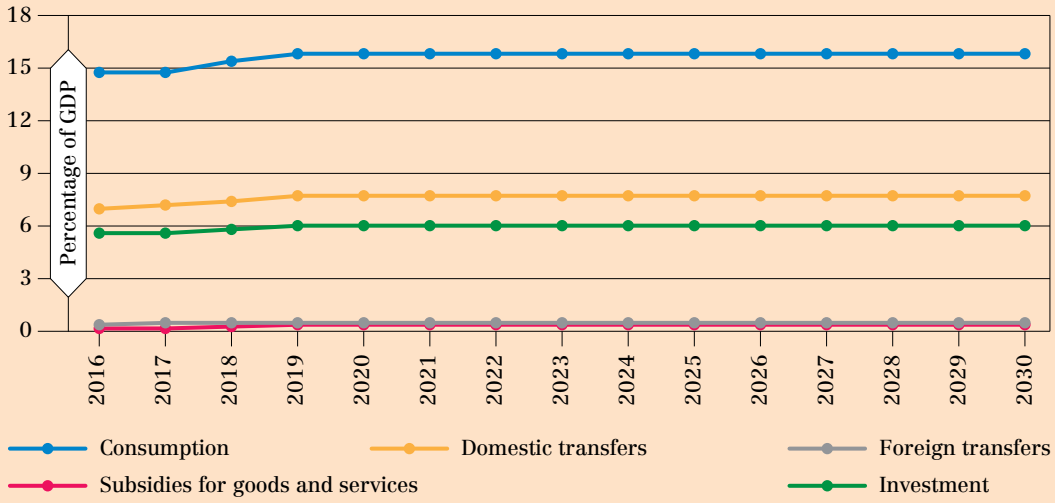
The evolution of public income (panel a) and expenditures (panel b) is shown in Figure 17. It replicates the actual figures observed in the 2016–2019 period. The percentages with respect to GDP recorded in 2019 are used for the 2020–2030 period. In the 2019–2030 period, the government records a deficit representing 7.5 percent of GDP and uses domestic borrowing (5.7 percent of GDP) and foreign borrowing (1.8 percent of GDP) to cover it. Consequently, the baseline scenario assumes that the government has access to foreign financing during the whole simulation period, but in an amount considerably lower than that registered from 2016–2018; in fact, foreign credit was already falling from 3.6 percent in 2017 to 1.8 percent in 2019. Hence, we can clearly see how domestic borrowing increases to compensate for the drop in foreign borrowing. In terms of expenditure, it is mainly dominated by public consumption, although transfers to households are also significant relative to the other items.

FIGURE 17 Public income and expenditure in the baseline scenario, 2016–2030

A. INCOME



B. EXPENDITURE

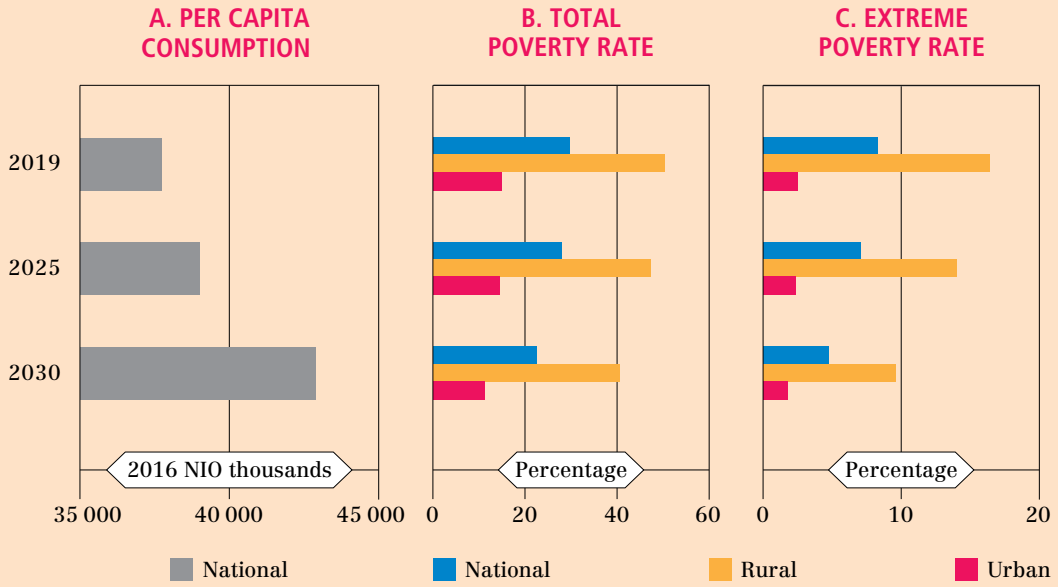


Source: Authors' own elaboration.

4.4 Per capita consumption and poverty

Last but not least, the description of the baseline scenario ends with the projection of per capita consumption of households and total and extreme poverty rates (see Figure 18). As can be observed, the total poverty rate falls from 29.6 percent in 2019 to 22.4 percent in 2030. The total poverty rate is higher in rural areas, but here it also decreases from 50.1 percent in 2019 to 40.2 percent in 2030. Naturally, this decrease in poverty in the baseline scenario can be explained by the projection of growth (see Figure 13). In addition, the baseline scenario registers a reduction in inequality, measured by the Gini coefficient that decreases from 0.381 in 2019 to 0.376 in 2030 (not shown graphically here), which is mainly the result of a relatively faster increase in the per capita consumption of rural households. Part of this result can be explained by migration from rural to urban areas, which is implicitly included in the projections of the employed population used to generate the baseline scenario.

FIGURE 18 Per capita consumption and poverty rates in the baseline scenario, 2019–2030



Source: Authors' own elaboration.

4.5 Public investment scenarios

Having constructed the baseline scenario, we now consider economy-wide effects of stepping up public investment in agricultural sectors. In general terms, we assume that the government manages to modestly increase its access to foreign financing in order to finance an increase in public investment in productive infrastructure. This increase is in most scenarios (unless otherwise indicated) equal to half a percentage point of GDP above what is registered in the baseline scenario. It involves public investment projects that help increase the productivity of selected agricultural sectors by means of enabling new productive infrastructure. Due to the type of information used in the model, which comes mostly from the national accounts as noted earlier, the type of infrastructure or projects in question cannot be specifically identified in our analysis. In general, public investment in productive infrastructure encompasses roads, irrigation systems, storage systems, and even research and technology,

among others. Reaching this level of detail requires empirical evidence for Nicaragua as to how each investment or project of this kind would boost productivity. Unfortunately, there is not a lot of this type of evidence and, as such, it should be the subject of a separate study (better still a study conducted at the level of specific value chains). Notwithstanding this lack of empirical evidence, the increased public investment in productive infrastructure in the Nicaraguan CGE model still has the potential to affect the productivity of the sectors selected as part of the simulation. At the same time, the amount of land or natural resources registered in the baseline scenario does not increase, which means that in the simulations any expansion of production is not the result of extending areas of production.

The analysis is carried out by carefully comparing the different scenarios of increased productive public investment against the baseline scenario. The specifics of the nine productive investment scenarios that we take into account are summarized in Table 11.[13] In all cases, the scenarios aim to promote agricultural activities that have a direct impact on the well-being of Nicaraguans mostly living in rural areas. The specific equations of the model that enable the evaluation of the direct impact of the increased public investment on productive infrastructure are explained in Annex A.

TABLE 11 Definition of the nine public investment scenarios, 2020–2030

#	Name	Sectoral focus	Marginal product of new public capital	Financing source	Additional investment amount (% GDP)
1	agr-20-fbor +05	Crops and livestock	0.2	Foreign debt	0.5
2	cof-20-fbor+05	***Coffee***	0.2	Foreign debt	0.5
3	liv-20-fbor+05	***Livestock***	0.2	Foreign debt	0.5
4	cofliv-20-fbor+05	***Coffee and livestock***	0.2	Foreign debt	0.5
5	bgrains-20-fbor+05	***Basic grains***	0.2	Foreign debt	0.5
6	agr-0-fbor+05	Crops and livestock	***0.0***	Foreign debt	0.5
7	agr-40-fbor+05	Crops and livestock	***0.4***	Foreign debt	0.5
8	agr-20-dbor +05	Crops and livestock	0.2	***Domestic debt***	0.5
9	agr-20-fbor+1	Crops and livestock	0.2	Foreign debt	***1.0***

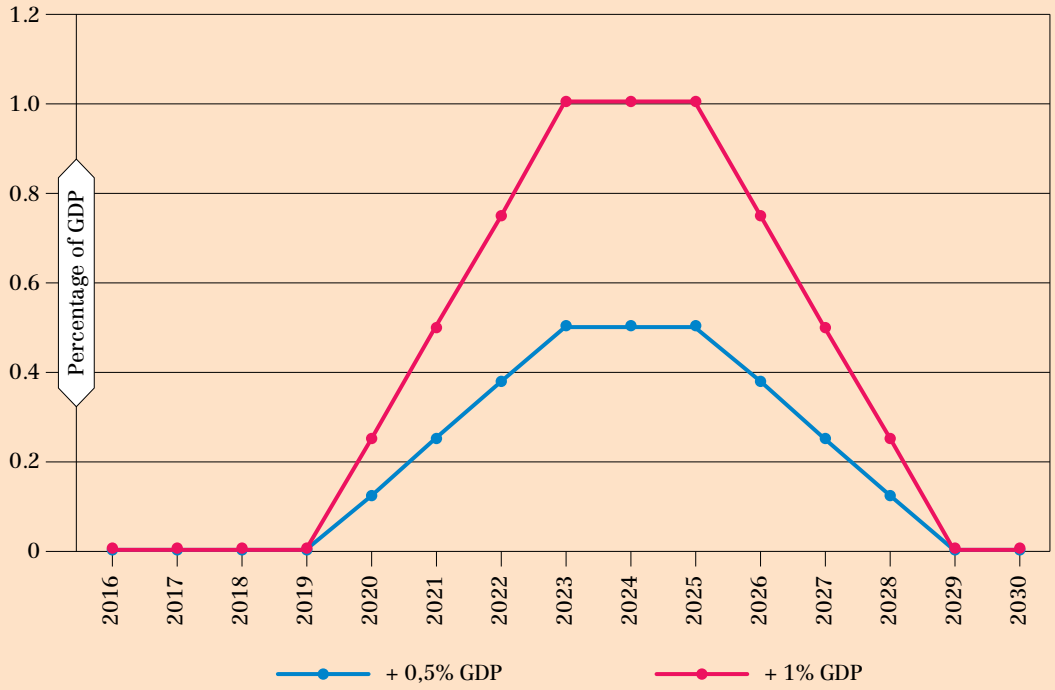
Notes: The use of bold and italic text indicates changes in scenarios 2–9 with respect to the first scenario. The additional public investment amount is expressed as a proportion of GDP compared to the baseline scenario; for example, 0.5 means that the government increases public investment by half a percentage point of GDP as compared to the baseline scenario. The increases in public investment are exactly the same in scenarios 1–8.

Source: Authors' own elaboration.

[13] The scenarios are named according to the following "sect-mpk-financ+inv" scheme, where: sect = sector promoted by means of increased public investment; mpk = marginal product of new public capital; financ = source of financing (e.g. foreign or domestic borrowing); inv = additional investment amount (with regard to the baseline scenario) expressed as a percentage of GDP.

In all cases, productive public investment increases in the 2020–2028 period, returning to the baseline scenario amounts for the 2029–2030 period (see Figure 19). As we can see, public investment in infrastructure, which makes agriculture more productive, rises gradually in the 2020–2022 period until it reaches the amounts of the last column of Table 11 in the 2023–2025 period. Then, during the 2026–2028 period, public investment in agriculture returns – also gradually – to the amounts registered in the baseline scenario. During this latest subperiod the scenarios capture the long-term effects of the new public investments. The timing of additional public investment is ad hoc but consistent with a scenario whereby, due to the amounts considered, there are no absorption capacity constraints.[14] When public investment is stepped up, a selected source of financing is simultaneously increased.

FIGURE 19 Increased public investment in the public investment scenarios, 2016–2030



Source: Authors' own elaboration.

The first public investment scenario is taken as a sort of point of reference; the other scenarios (2–9 in Table 11) vary in comparison to it in certain specific aspects. In this first scenario, we assume an increase in public investment of half a percentage point of GDP geared towards promoting agricultural activities as a whole, financed with foreign borrowing. In particular, agriculture includes the following products: coffee, sugar cane, basic grains, other agricultural products and livestock. In other words, no subsectors in this first scenario are prioritized over others. In addition, it is assumed that the public investment generates benefits in terms of factor productivity equal to 0.2 córdobas for each córdoba that is invested in increasing the public capital stock.[15] Technically, this parameter is known

[14] It is worth noting that the amount of the simulated additional investment, the timing of the increase and the choice of sectors were agreed upon with policymakers and the technical officials of Nicaragua's Government during a mission in October 2019.

[15] The public capital stock in the period t (K_t) evolves in accordance with the equation $K_t = (1 - \delta)\, K_{t-1} + I_{t-1}$, where δ is the rate of depreciation of public capital and I_{t-1} is the public investment in the period t–1.

as the marginal product of public capital. Naturally, the results of the simulated scenarios presented below depend on the value used for the marginal product of public capital. We use plausible values obtained from the literature. For example, in several scenarios it is assumed that, *ceteris paribus*, investing one million córdobas more in productive public capital increases GDP by 200 000 córdobas; that is, the marginal product of public capital is 0.2. In the literature, the estimates for the marginal product of public capital vary enormously, but are situated in the 0.15–0.60 range for a high number of countries (see Gupta *et al.*, 2014; Dessus and Herrera, 2000). In any case, the range considered in this study (0.4, 0.2 and 0; see Table 11) is quite conservative. Last, in the first scenario of initial public investment, foreign borrowing increases (endogenously) in the exact amount necessary to finance increased public investment (see Figure 19).

The estimates of Acosta and De los Santos-Montero (2019), calculated by means of a stochastic distance function approach, show that there is potential to increase factor productivity in the production of crops and livestock in Nicaragua.[16]

The other scenarios (2–9 in Table 11) vary from the first in one of the following parameters: (a) the sectors that directly benefit from the new investment (scenarios 2–5); (b) the value of the marginal product of (new) public capital (scenarios 6–7); (c) the sources of financing (scenario 8); and (d) the investment amount (scenario 9). For example, the last scenario (agr-20-fbor+1) is the only one that considers an increase in public investment, compared to the baseline scenario, equal to one percentage point of GDP. In contrast, the other scenarios simulate increased public investment amounting to half a percentage point of the GDP compared to the baseline scenario. In sectoral terms, scenarios 2–5 promote different agricultural sectors. For example, in scenario 5 (bgrains-20-fbor+05), the additional public investment is geared towards promoting the production of basic grains (i.e. maize, beans, sorghum and rice). Scenarios 2, 3 and 4 respectively gear public investment towards the coffee sector, livestock sector, and coffee and livestock sectors jointly. The selection of agricultural subsectors took place on the basis of recommendations received from different Nicaraguan authorities and taking into account the importance of these sectors in terms of the generation of value added, employment, output and exports, among others.

For their part, scenarios 6–7 aim to evaluate the sensitivity of the results of the first scenario to changes in the marginal product of public capital. Scenario 6 therefore assumes that the additional investment in public capital has no effect on agricultural productivity. Consequently, only the Keynesian effects are considered (i.e. only the increase in the final demand) of the additional public investment. In contrast, scenario 7 assumes that the government finances additional investment that has positive effects on agricultural productivity that double the effects of scenarios 1–5. Scenario 8 evaluates the consequences of financing additional public investment through domestic borrowing, in order to show an example of how the results change with regard to the scenarios with foreign borrowing that the government is more likely to opt for. In the case of domestic borrowing, and at least in the short term, it is expected that there will be a crowding-out effect on private investment as a result of an increase in the additional public investment financed with domestic savings.[17]

16 It is worth highlighting that during the two FAO missions to Nicaragua (March and October 2019), both the decision makers and technical officials stressed that low productivity is a serious problem in Nicaraguan agriculture.

17 Although the model captures the evolution of domestic and foreign debt stocks, the effect that the accumulation of these debts could have on the perception of the risk of non-payment has not been captured. This, in turn could lead to differences in the rate of interest enforceable and as such in the convenience of using one or another financing route. In any event, the analysis focuses above all on foreign borrowing, which the government is more likely to opt for to finance new productive investments in the context of Nicaragua.

In addition, in the simulations in Table 11 some of the assumptions made to generate the baseline scenario have been modified. In particular, all of the components of the public budget and of the balance of payments, which were assumed to be a constant share of GDP, are now assumed to be constant in real terms (in other words, they can vary as a percentage of GDP). For example, in all of the scenarios, the government provides the same amount of goods and services as in the reference scenario, regardless of the evolution of GDP. As a result, private investment is adjusted endogenously to match savings available, both private and of the rest of the world.[18] The macroeconomic closure rule detailed in this paragraph means that, *ceteris paribus*, an increased public investment financed with domestic borrowing translates into a reduction in the savings available to finance the private investment. Consequently (and once again, *ceteris paribus*), in the medium to long term, the private capital stock will fall (as well as GDP) compared to the baseline scenario. In general, the assumptions described here make it possible for the scenarios we present in this section to only differ from the baseline scenario as a result of the additional public investment shocks that are the subject of the study.

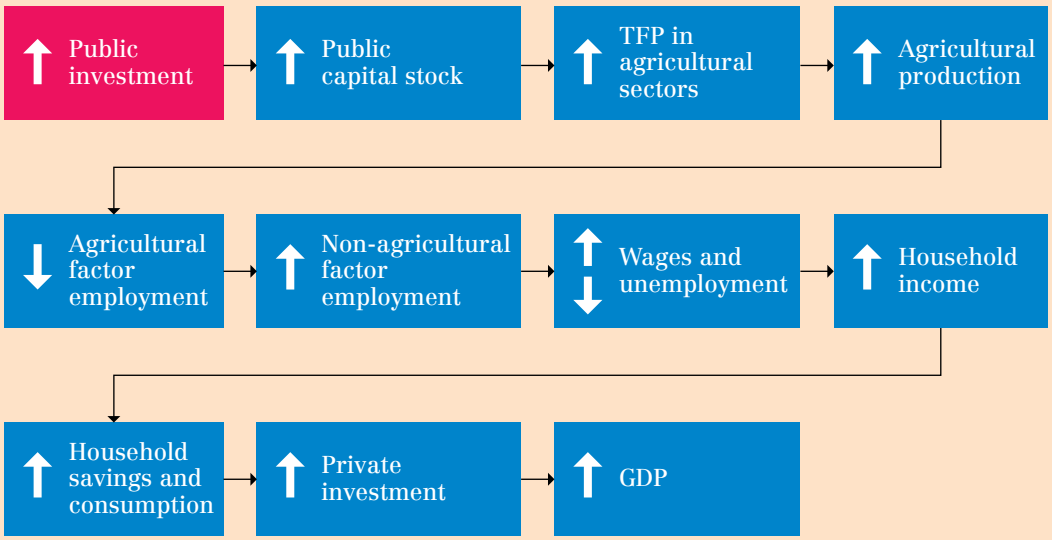
Panels a–c of Figure 20 summarize the main transmission channels that make it possible to explain the results generated by the increased public investment simulations. First, panel a illustrates the effects directly linked to the increased public investment. In all scenarios, the increased investment builds up public capital stock, which in turn has a positive impact on TFP in agriculture, in accordance with the value assumed for the marginal product of public capital (as previously explained). Subsequently, the increase in TFP in agriculture will have a positive effect on GDP, depending on several factors: the export orientation of agricultural sectors being promoted, the backward productive linkages (i.e. the purchases of goods and services for their use in production), and the forward productive linkages (the sales of goods and services to other sectors). In principle, an increase in the sectoral TFP will have more positive effects the greater the export orientation of the sector and the more important its productive linkages. In any case, it is to be expected that the increase in agricultural productivity will have a positive impact on household income; which, in turn, would trigger positive responses in consumption and savings (as well as private investment).

Second, panels b and c of Figure 20 refer to the effects directly linked to the source of financing that the government uses. In particular, foreign financing makes it possible to finance the increased public investment without directly affecting domestic demand (panel b). In addition, foreign financing brings about inflows of foreign exchange, thus exerting pressure on the real exchange rate to appreciate, which has a negative impact on the tradable goods sectors of the economy (i.e. the sectors that trade goods and services with the rest of the world). In contrast, financing with domestic debt has a direct negative effect on private investment – it reduces the savings of households and companies that would otherwise be available to finance private investment (panel b). Consequently, in this case in particular, from a theoretical point of view, the net effect expected from public investment is, a priori, undefined; and it is the application of the model itself with the Nicaraguan data that, as will be seen, makes it possible to define it in a measurable manner. Naturally the public debt stock increases in scenarios of financing with both foreign and domestic borrowing.

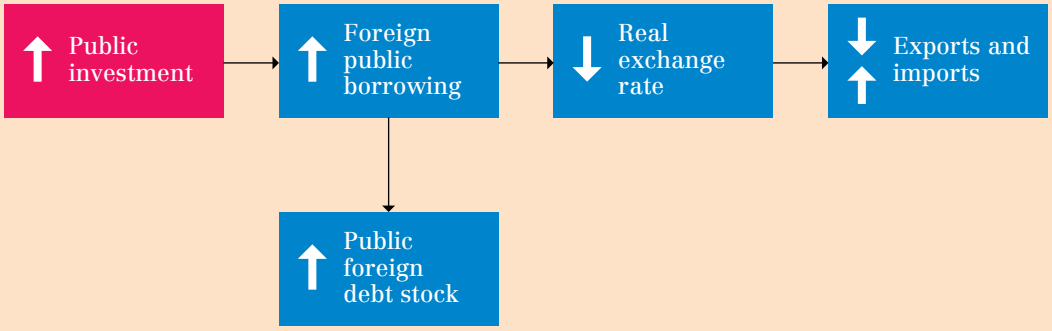
[18] In contrast, the baseline scenario assumes that private investment is a constant proportion of GDP, defined exogenously from the model, while the household marginal propensities to save are adjusted endogenously.

FIGURE 20 Transmission channels of increased public investment in productive infrastructure

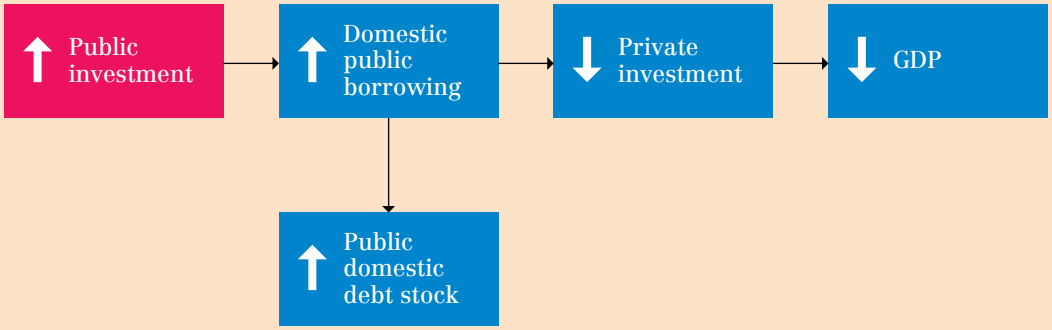
A. MAIN EFFECTS



B. SITUATION IF FINANCING IS WITH FOREIGN DEBT



C. SITUATION IF FINANCING IS WITH DOMESTIC DEBT



Source: Authors' own elaboration.

Figures 21–25 detail the results of the scenarios presented above. Figures 21 and 22 show the evolution of private consumption and private investment in the different scenarios, respectively. Last, in order to perform a cost-benefit analysis, we calculate the net present value of the public investments taken into account in this section.[19]

4.6 Macroeconomic results

In all cases, positive macroeconomic effects are observed in the medium to long term. In other words, indicators such as GDP, employment and private consumption grow, on average, at higher rates than those recorded in the baseline scenario. For example, the growth rate of private consumption is up to 0.2 percentage points higher than in the baseline scenario (see scenario agr-20-fbor+1 in Figure 23) – that is, when the additional investment is equivalent to one percentage point of GDP and is financed with foreign debt. Alternatively, in this same scenario, private consumption in 2030 is 2.1 percent higher than in the baseline scenario. In addition, other indicators such as GDP, level of employment and private investment also show positive effects in the medium to long term. Naturally, an increase in private investment is reflected in an increase in private capital stock which, in turn, has a secondary positive effect on the macroeconomic indicators.

It is interesting to note that, in line with the main transmission channels previously discussed (Figure 20), the short-, medium- and long-term effects are different. In the short term, only the domestic borrowing scenario delivers negative results, as a consequence of the crowding-out effect on private investment (see scenario agr-20-dbor+05 and Figure 20c). Naturally, the effects are more positive the greater the marginal product of public capital, as the additional public investments tend to boost TFP in agriculture much more. In this sense, it is worth remembering that increases in TFP (for example, an increase in agricultural yields) drives production with the same level of factor employment. In turn, the marginal product of public capital determines how much TFP rises for a given increase in public investment. In addition, the public investment financed using external resources has positive effects in the short or medium term, even when the marginal product of public capital is zero (scenario agr-0-fbor+05). In this case, the positive effects appear by means of the increased final demand that results from increasing public investment (in other words, the Keynesian effect prevails).

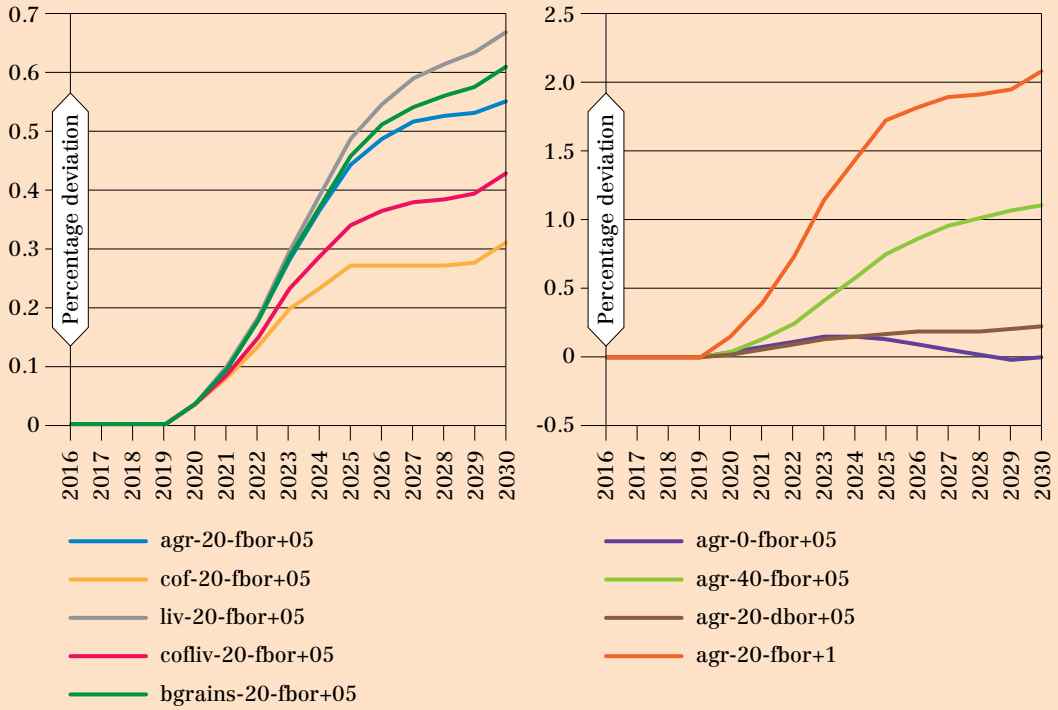
Notably, the positive effects persist once public investment begins to decline in order to return to the baseline scenario levels. Obviously, this effect is not observed when the marginal product of public capital is zero. Therefore, obtaining positive results from productive public investments in the medium or long term will highly depend on financing projects that generate increases in TFP in agriculture.

[19] To this end, the following formula is used:

$$VPN = \sum_{t=2019}^{t=2030} \frac{\sum_{h \in H} EV_{h,t}}{(1 + intrat)^{2019-t}}$$

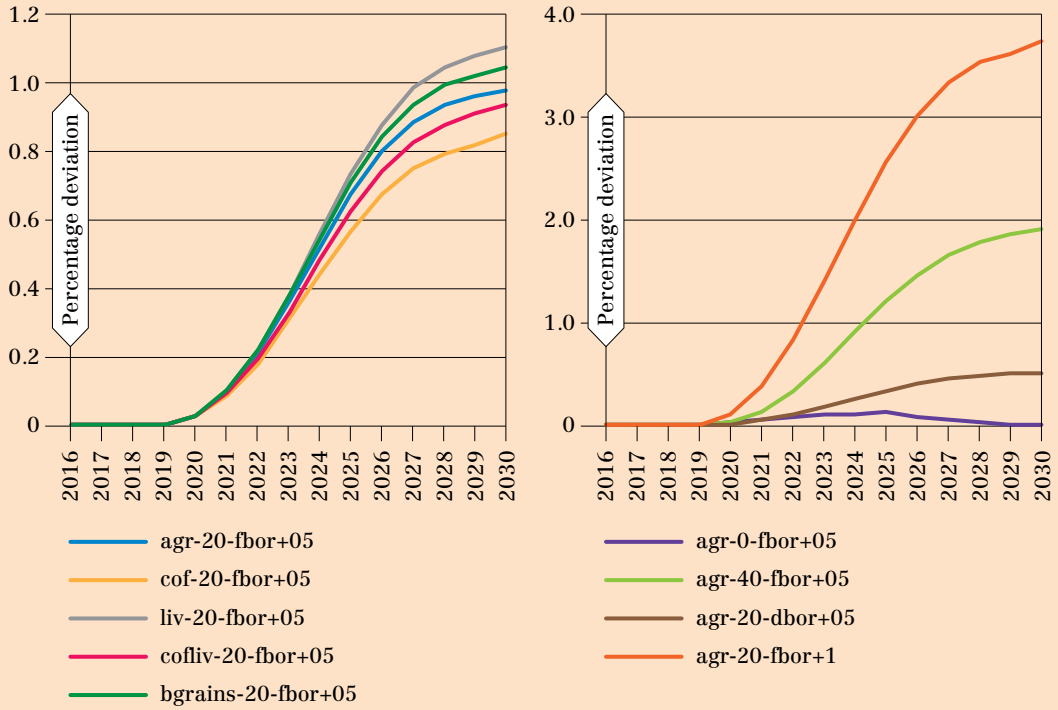
where $EV_{h,t}$ is the equivalent variation or measurement of well-being of Nicaraguan households, and *intrat* is the interest rate that, following the official practice in Nicaragua, is equal to 8 percent. The equivalent variation measures the change in well-being that Nicaraguan households experience. To this end, it answers the following question: How much income should be transferred to Nicaraguan households to achieve the same change in well-being that the increased public investment generates? In the previous equation, the well-being of each of the 12 households identified in the model is calculated in the same way. In other words, and in an implicit manner, a utilitarian social welfare function is used. The results of the scenarios considered indicate that the increased aggregate well-being would be higher if a well-being function were used that gives a higher weighting to households with lower per capita consumption.

FIGURE 21 Percentage deviation of private consumption compared to the baseline scenario



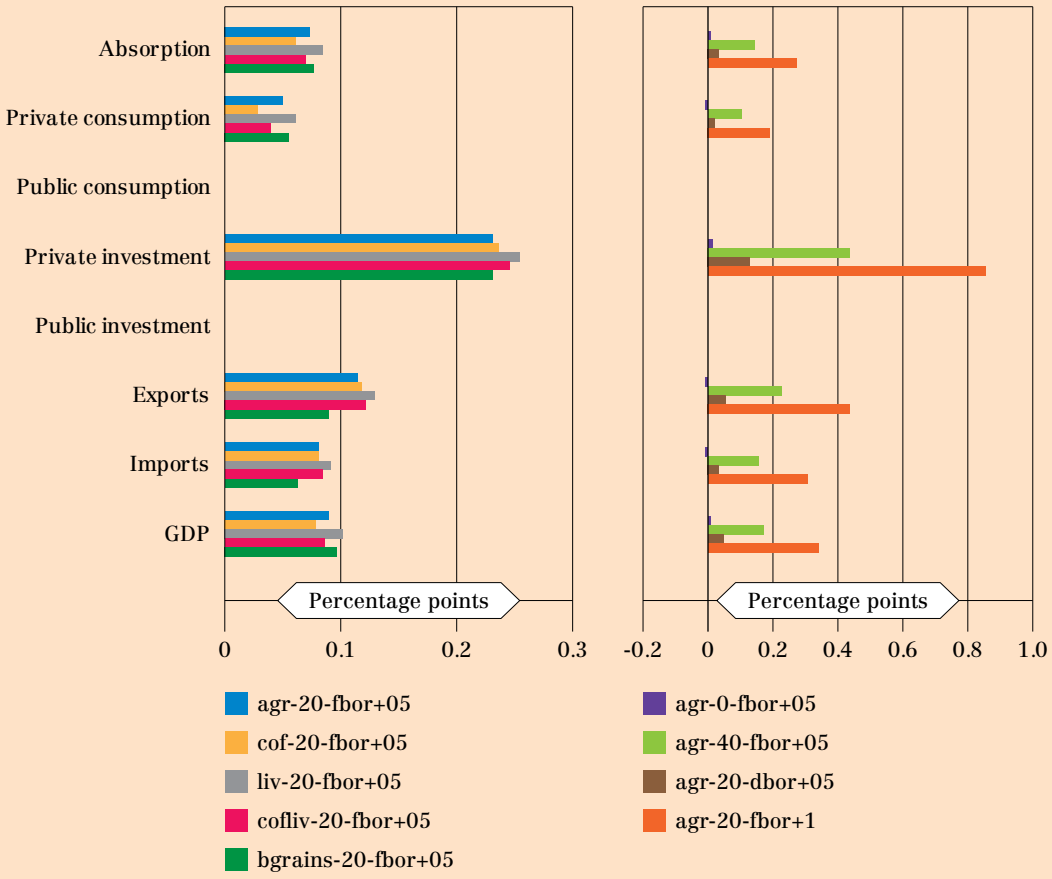
Source: Authors' own elaboration.

FIGURE 22 Percentage deviation of GDP compared to the baseline scenario



Source: Authors' own elaboration.

FIGURE 23 Average annual growth rate of different macroeconomic aggregates in 2020–2030 (difference with respect to the baseline scenario in percentage points)



Notes: Public investment does not exhibit any changes because in 2030 its level is identical to that recorded in the baseline scenario (see Figure 19). In addition, it should be noted that public investment is exogenous, and equal in all scenarios that appear in the figure on the left.

Source: Authors' own elaboration.

In terms of private consumption (welfare) and GDP, in simulations where the increased public investment is focused on one of the agriculture sectors, it is livestock farming that presents the most favourable results. This can be explained by the quite substantial export-oriented nature of the meat sector – i.e. the forward productive linkages are also key to this result. More specifically, almost half of the Nicaraguan production of meat is exported to the rest of the world. Consequently, when the primary and secondary activities are considered jointly (that is, livestock farming and meat production), the sector is not limited by domestic demand to sell its output.

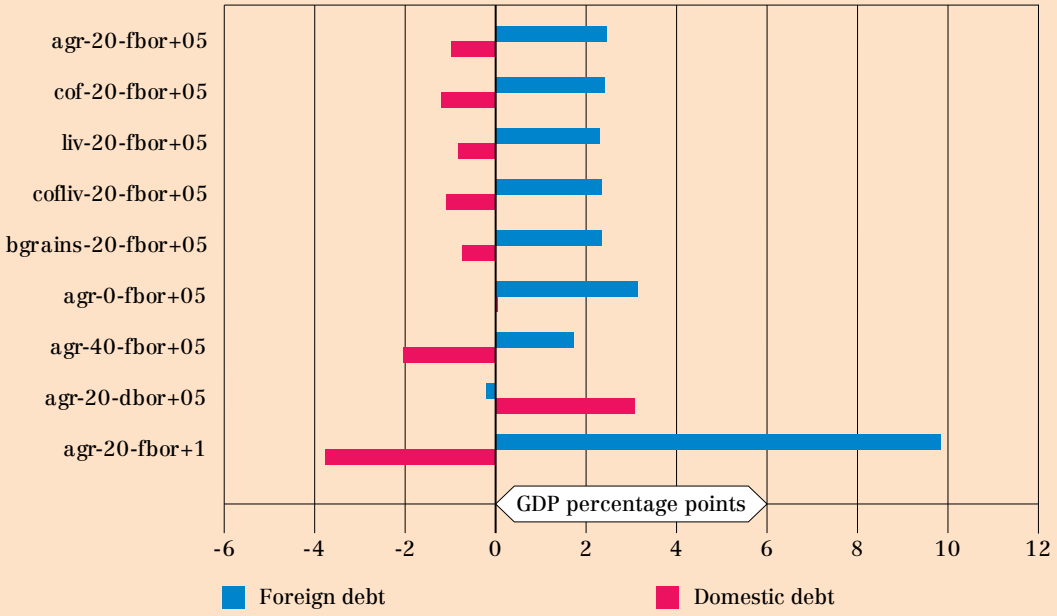
For its part, the promotion of the basic grains sector also has a positive effect on private consumption. However, in this case this is explained by the direct effect of increasing production on domestic prices. In addition, the sector is geared towards the domestic market – specifically, 90.1 percent of its production is sold domestically. In the baseline scenario, imports cover 17.3 percent of the demand for basic grains. In contrast, in the scenario that promotes the production of basic grains (bgrains-20-fbor+05), the percentage of the demand that imports cover decreases to 15.2 percent.

On the other hand, coffee farming is the sector showing the least positive impact on private consumption. In this case the productive linkages are relatively weaker, as this is a sector whose output is geared substantially towards exports (as previously explained). Consequently, the promotion of the coffee sector by means of productive public investments would have more substantial positive effects if accompanied by a policy geared towards developing the whole value chain, including processing, and not just primary production.

Looking now at financing, financing with domestic borrowing generates positive effects but considerably fewer than those produced by foreign financing. The explanation of this result is linked to the crowding out of private investment that results from increased public investment in agricultural sectors. In other words, when internal financing is used, the Keynesian effect that the increased public investment triggers is compensated by the reduction of other components of the final demand: private investment and consumption. However, the positive effect of the increased TFP in agriculture predominates.

It is worth noting that none of the scenarios analysed here consider that public debt (foreign or domestic) incurred must be repaid in the future. Hence it must be taken into account that all of the scenarios involve increasing the public debt stock (remember the transmission channels in Figures 20b and 20c, and also the results shown in Figure 24).[20] Consequently, in the evaluation of the different scenarios, other aspects linked to the intertemporal preferences of policymakers also come into play. Therefore, the highest debt stock must be considered taking into account the fact that the public capital stock is also growing (with all of its favourable effects).

FIGURE 24 Changes in public debt stocks compared to the baseline scenario, 2030



Source: Authors' own elaboration.

[20] The evolution of the debt stocks assumes that the interest rates are 6.3 percent and 2.37 percent for domestic and foreign public debt, respectively, in accordance with the information provided by the General Directorate of Public Credit of the Ministry of Finance and Public Credit.

Financing with foreign debt generates, as expected given its positive impact on GDP, a decrease in domestic debt expressed as a proportion of GDP. In fact, only when the investments are financed with domestic debt is it possible to note an increase in the domestic debt as a proportion of GDP (see scenario agr-20-dbor+05). For its part, the foreign debt as a proportion of GDP grows from 1.7 (scenario agr-40-fbor+05) to 9.8 (scenario agr-20-fbor+1) percent; keep in mind that the scenario agr-40-fbor+05 assumes that the government finances investments that have the highest effects on TFP in agricultural sectors. Consequently, the most productive investments also generate a relatively low increase in public debt (expressed as a proportion of GDP).

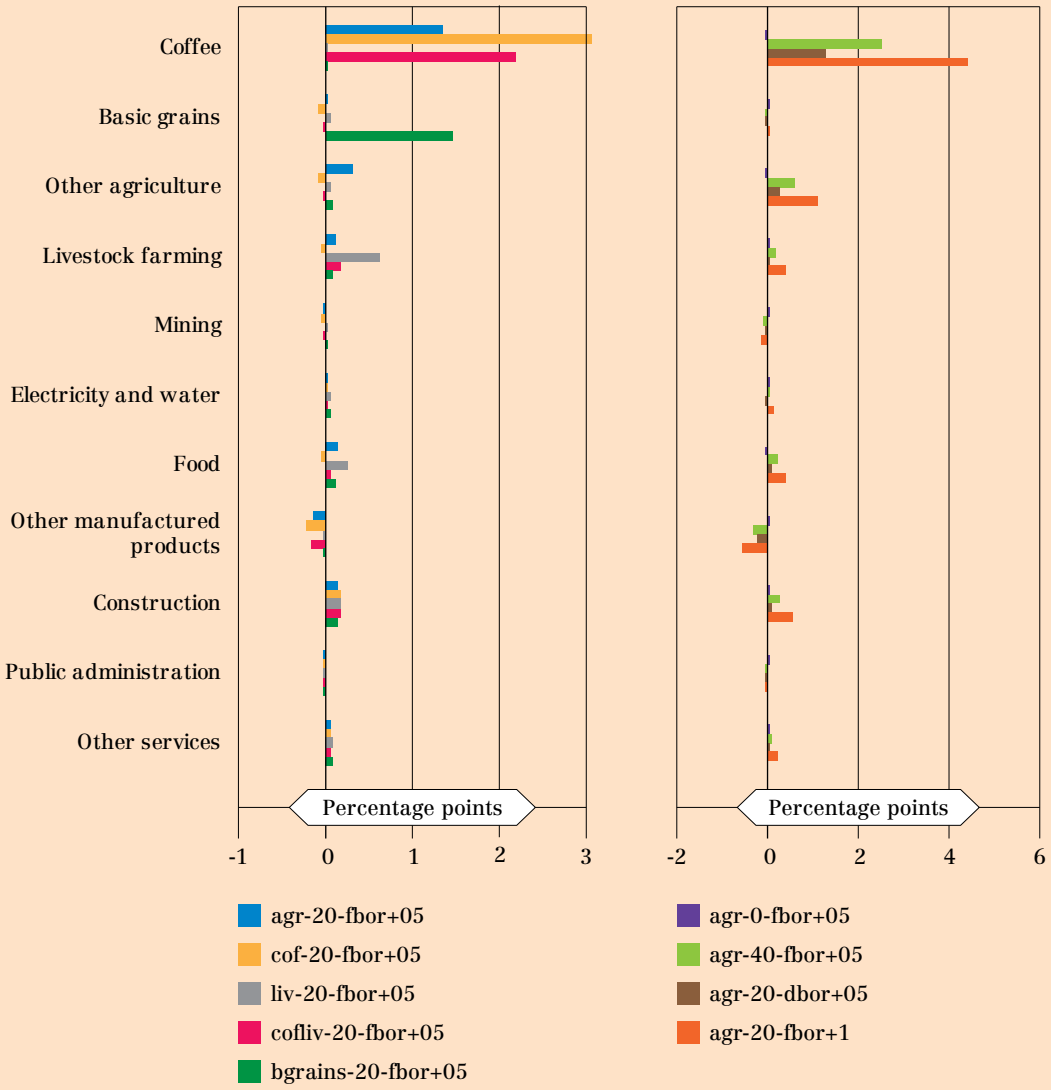
4.7 Sectoral results

Moving on now to the sectoral level, the directly promoted sectors, as expected, register substantially rising outputs (see Figure 25). In addition, when livestock farming is promoted, increases are also observed in the production of meat and dairy. In the basic grains scenario, we also observe increases in the production of milled and baked goods.

The employment levels increase in all cases, except when it is assumed that the marginal product of new public capital is zero. At the same time, and in line with the assumption of the wage curve (i.e. the negative relation between wage level and unemployment rate), the wage level increases. Moreover, the employment levels increase for the three labour categories considered. However, given the factor intensity of the agricultural sectors more significant positive effects are observed for workers with lower skill levels. We can then see that the households that receive a relatively high proportion of their income from unskilled labour show the most substantial gains in per capita consumption. Consequently, and due to the previously mentioned link between per capita consumption levels and income from labour by skill level, we can see that the promotion of the agricultural sectors has pro-poor effects. In addition, and due to the way in which the scenarios in Table 11 were designed, the households showing the lowest increases in income are those that depend mostly on transfers from the government or on remittances.

As a complementary exercise, scenarios (whose results are not addressed or reported in detail here) were also considered in which each of the four basic grains (maize, beans, sorghum and rice) were promoted separately, by means of the same simulation of additional public investment and with foreign borrowing. The results showed that it is more convenient to promote the four basic grains jointly. In addition, given that individually they are relatively small in size (for example, the production of beans represents only 0.3 percent of the national value added), these are sectors that find it difficult to individually absorb investments that are equal to half a percentage point of GDP, like those simulated for other sectors.

FIGURE 25 Average annual growth rate of sectoral production in 2020–2030 (difference with respect to the baseline scenario in percentage points)



Source: Authors' own elaboration.

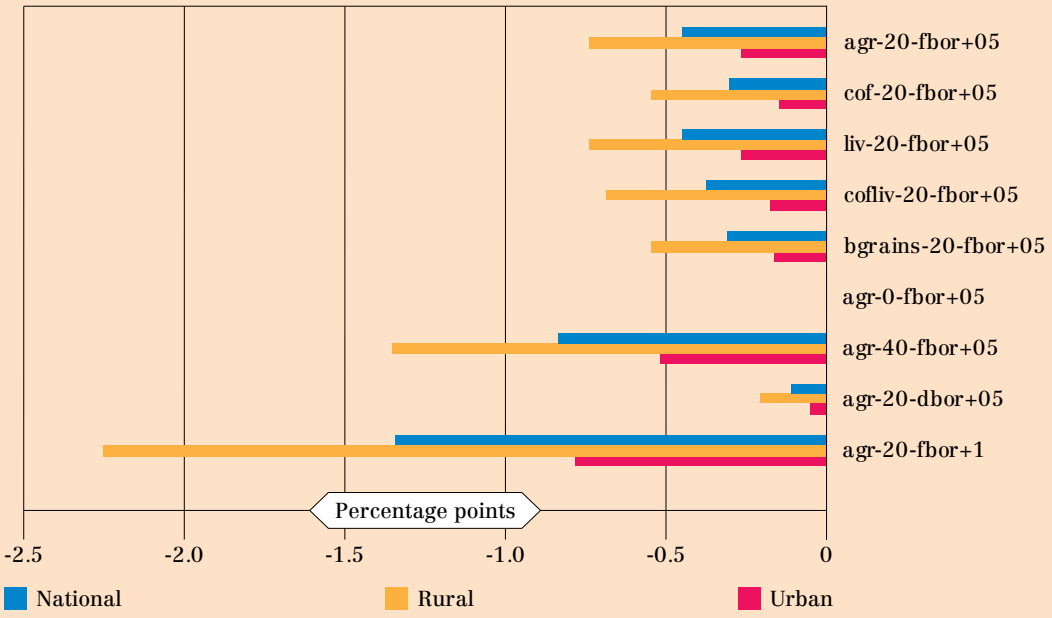
4.8 Results regarding poverty and inequality

In terms of total poverty (see Figure 26), the most significant effect can be observed in rural areas. The ranking of scenarios in terms of the reduction of poverty is in line with that described regarding the evolution of private consumption. However, it is worth noting the rather high impact on total poverty under the scenario that focuses on the agricultural sector as a whole. In this case, the reduction of prices that the increase in TFP generates is observed for a high number of components from the food baskets of Nicaraguan households. In addition, extreme poverty is also reduced. From 2019 to 2030, depending on the scenario, total poverty in rural areas is reduced by 0.5 to 2.25 percentage points, while extreme poverty is only reduced by 0.16 to 0.31 percentage points. The greatest impact is seen when public investments are made across all agricultural sectors, as noted; when investments are

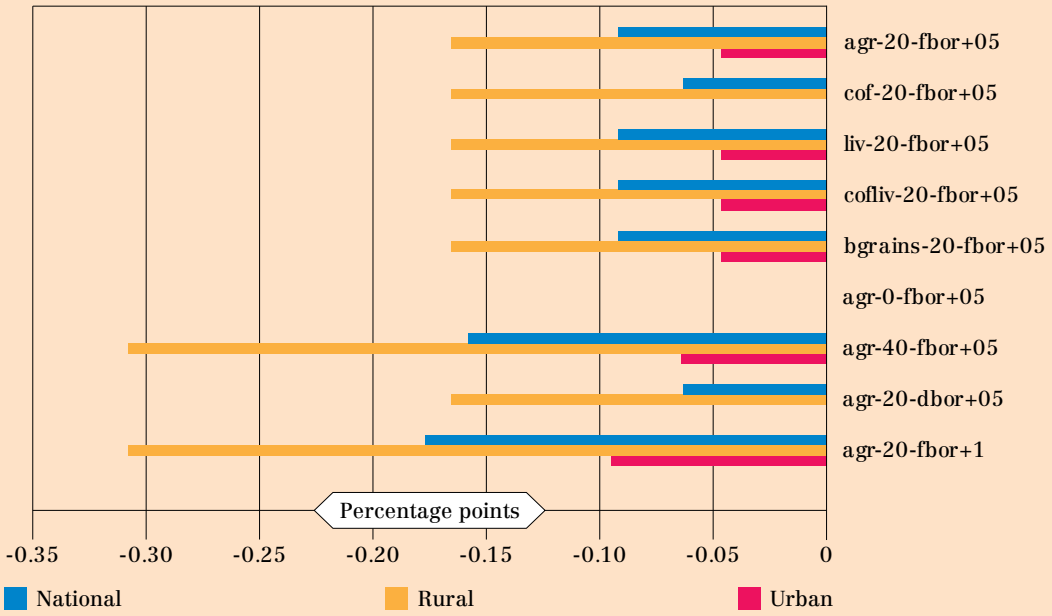
made by subsector, the investment in livestock farming has the greatest impact, followed by that in coffee farming and basic grains sectors, although the differences between them are not great. Likewise, the Gini coefficient is reduced in all of the scenarios promoting agricultural sectors, although by a small proportion. Once again, this result can be explained by the relative improvement experienced by those households that depend on low-skilled employment to generate their income.

FIGURE 26 Total and extreme poverty rates in 2030 (difference in percentage points compared to the baseline scenario)

A. TOTAL POVERTY



B. EXTREME POVERTY

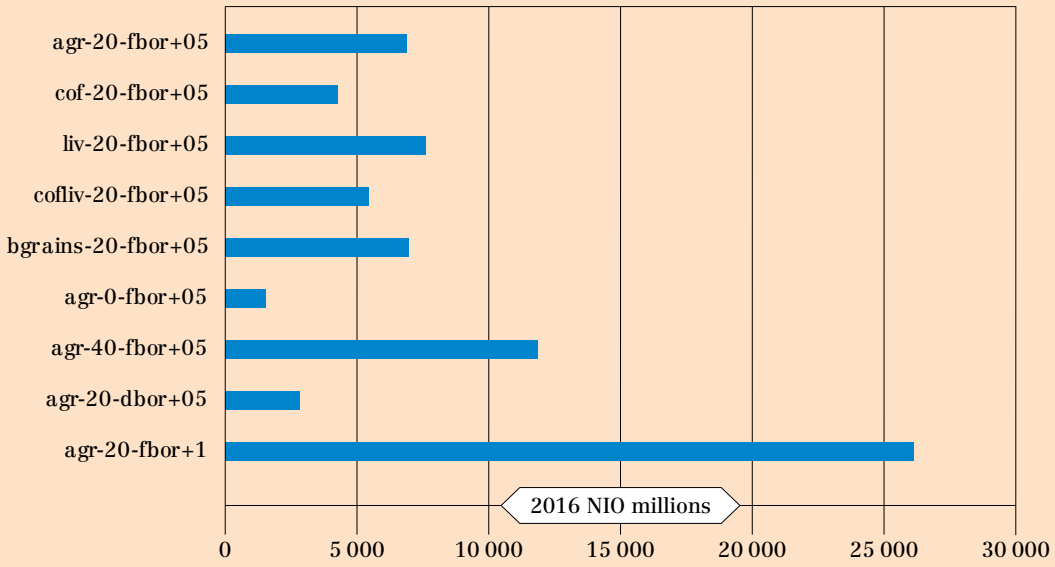


Source: Authors' own elaboration.

4.9 Net present value of investments

In order to present a global evaluation resulting from the macro and sectoral effects described above, we estimated the net present value of the public investments for the 2020–2030 period. As shown in Figure 27, the net present value varies between 0.4 percent of GDP in 2019 (scenario agr-0-fbor+05) and 6.9 percent of GDP in 2019 (scenario agr-20-fbor+1). In other words, the investments considered in this study appear profitable from the perspective of their social net present value. The order of the scenarios taken into account in the figure is the same as that described above: due to its export orientation, the livestock sector is the one with the highest net present value of public investment.

FIGURE 27 Net present value of the simulated public investments, using equivalent variation



Source: Authors' own elaboration.

5 Conclusions and recommendations

Even before the onset of the COVID-19 crisis, Nicaragua had recently experienced a significant economic downturn. Supply-side disruptions, caused by roadblocks and damages to infrastructure, had reduced the confidence of consumers, investors and international financial organizations. This resulted in the draining of bank deposits, a reduction in private investment and less access to external financing. In addition, international sanctions aggravated these financing constraints. The reduction in GDP began in the second quarter of 2018, in line with the initiation of the disruptions mentioned.

The impacts of these events could have been greater if it weren't for the strength of the Nicaraguan economy in the 2010–2017 period and its prudent management in 2018. Nevertheless, there were still adverse effects. Open unemployment and informality increased and income and household consumption decreased. For 2019 (at the time of this writing), the activities relating to construction, financial intermediation, home ownership, trade, transport and communications as well as other services were expected to continue contracting. Given the lack of data, the question arose as to whether poverty would increase, therefore altering its trend in recent years, as a consequence of these socio-economic manifestations – not even accounting, of course, for the effects of the COVID-19 pandemic.

This question led us to reflect on the role that the agricultural sector could and should play in economic reactivation, for two reasons. The first is that the agricultural sector continues to be an important generator of value added and employment in Nicaragua. At the same time, most of the nation's poor live in rural areas, which makes the agricultural sector a potential pathway for reducing poverty. The second reason is that while other sectors can explain the substantial economic downturn, the primary sector has managed to maintain more stable levels of economic activity; in other words, it has been resilient to the economic shocks experienced. Insofar as the primary sector is not burdened by (or manages to adapt to) adverse weather conditions, or hit by considerable external shocks, it has great potential to have an impact on economic growth and poverty reduction in the Nicaraguan context.

This study has taken on the task of analysing options for public investment in productive infrastructure in the agricultural sector, taking into account the existing financing constraints. With the aim of generating quantitative evidence by means of a rigorous methodological approach, alternative scenarios have been explored. These have helped determine in which Nicaraguan agricultural sectors it would be more cost-effective to make public investments in productive infrastructure, in order to promote economic growth and avoid reversing the trend of reducing poverty of recent years.

To evaluate the impact of public investment on productive infrastructure, a multisector economy-wide model was used which, within a framework of accounting and analytical consistency, considers Nicaragua's financing and macroeconomic constraints, its different markets, and the performance of its economic actors, among other aspects. This model was used to evaluate alternatives to public investment in productive infrastructure that increase agricultural returns at the sectoral level. The findings show that public investment, as a whole, could increase productivity by improving or building roads, irrigation systems, storage systems, and even research and technology, among others. We say as a whole, because assessing investment in each of these types of infrastructure would require empirical evidence for Nicaragua as to how each of them has an impact on productivity – evidence which, unfortunately, does not exist.

Different scenarios were created to estimate the impact of an increase in this type of public investment in the 2020–2028 period. This investment gradually intensifies until it is equal to half a percentage point of the GDP in 2023–2025, and then gradually lowers as well. The new investment is financed with additional external resources. It was found that this change could increase the rate of economic growth by around 0.09 and 0.1 percentage points per year until 2030, on average, if the receiver of that investment was the agricultural sector as a whole, or only subsectors such as livestock, basic grains or coffee farming. In comparative terms, livestock is the subsector that registers the most impact. Although said change would be for the average growth rate of the whole 2020–2030 period, output growth tends to be much higher towards the end of the period. For example, it can be observed that in 2030, compared to the scenario without additional investment for the same year, GDP would increase between 0.8 percent and 1.1 percent when particular sectors (livestock farming in this case) are targeted with new investment, and 3.7 percent when the new investment takes place in the agricultural sector as a whole – and, in addition, when it is also increased to 1 percent of GDP rather than 0.5 percent. These scenarios clearly assume that there are no other policy changes or external shocks during the period: in other words, the impact of the simulated public investment is isolated.[21]

The promotion of activities intensive in the use of unskilled labour, such as the aforementioned agricultural activities, reduces poverty substantially. The majority of households living in poverty obtain their income from unskilled labour and thus experience an increase in their consumption. It is not surprising, then, that poverty would fall much more in rural than in urban areas, as a result of public investment in productive infrastructure for the agricultural sector. From 2019 to 2030, depending on the scenario, total poverty in rural areas decreases by 0.5 to 2.25 percentage points, while extreme poverty does so by 0.16 to 0.31 percentage points. The reduction in poverty at the national level as well as in urban areas is relatively low, yet by no means insignificant.

In general terms, and taking into account financial constraints, it is worth focusing investments in selected sectors instead of distributing them among all agricultural activities. The recommendation as to which sector should receive the most investment, based on these results, will not only depend on its impact on economic growth and poverty, but also on any given policy's primary objective(s), which could include increasing exports, or first guaranteeing food security objectives, or both – so long as the objectives are not contradictory, and take into account the historic Nicaraguan economic, productive and social development process. In general terms, the sectors where production is – directly and indirectly – geared more towards exports have more potential to absorb the increases in productivity caused by new public investment. That is, their production could increase without reductions in their prices as they do not depend exclusively on the domestic market. Indeed, policymakers in Nicaragua are convinced of the advantages that exports offer, even for products that have been geared more towards the domestic market (such as beans, for example).

Against this backdrop, the analysis suggests that **livestock and meat production** have the potential to expand with positive effects for the rest of the economy. In particular, the forward linkages of livestock production with the production of meat and dairy, as well as the export-oriented nature of meat production, make the value chain particularly attractive as a destination for public investment. The **coffee sector** also shows potential, provided that the focus is on developing a local processing industry. At present, over 75 percent of coffee bean production is exported without any kind of domestic processing. The development of agroindustry focusing on coffee, and in general terms regarding the rest of the primary

[21] It is important to note that the analysis performed did not include a comparison of the effects of public investments in agricultural sectors with the effects that equal levels of additional public investments in non-agricultural sectors would have on the economy.

sector, will be vital for the agricultural and food sectors to be a source of economic growth and of rural poverty reduction. **Basic grains**, on the other hand, should be promoted as a whole and not simply product by product; that way it will be possible to increase the supply of several of the components of the basic food basket of Nicaraguan households and promote food security. However, in some cases, such as beans for example, there would be a need to deepen the possibilities for export in order to expand the market. In all cases, as explained, poverty would be notably reduced. It is possible that other dynamic agricultural sectors (which proved resilient in the 2018 crisis), such as fisheries and aquaculture for example, may have productive potential given the possibility of new investments that promote them. However, whether they manage to have a large impact at the national level (for example, on the economic growth rate and the national poverty rate) will depend more on a medium- or long-term process, taking into account the relatively smaller size of these sectors compared to the others analysed in depth.

The feasibility of public investments in the productive infrastructure of the agricultural sector was analysed in terms of the source of financing that would have to be resorted to in order to make them a reality. External financing would seem to be the most feasible option for financing the additional investment amount (which in 2023–2025 represents 0.5 percent of GDP), for two reasons. First, it is a better option than the internal financing, which generates a lower economic growth rate as it crowds out private investment. In addition, a recent tax reform makes it unthinkable to consider increasing taxes as a political feasible financing option. Second, under external financing, the country's public debt only increases by around 2 points of GDP by 2030, thus remaining at sustainable levels.

In summary, by means of this study it is now possible to understand the potential economic growth and poverty reduction that can be generated as a result of modest public investments in productive infrastructure for the agricultural sector. If the possibility exists to mobilize foreign borrowing to this end, and depending on the primary government policy objectives, it would be worth studying productive chains more in depth, such as those of livestock farming (among others), to define the phases (both in terms of the stages of the chain and the geographical level) where public investments should be made and which types of specific investments and investment projects would be needed. Putting said investments into practice would give the government a concrete alternative to reactivate the economy and reduce rural poverty in the face of an economic downturn.

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Annexes

Annex A. Direct impact of increasing public investment in productive infrastructure according to the equations of the model

This annex explains the specific equations of the model that make it possible to evaluate the direct impact that an increase in public investment would have on productive infrastructure (Lofgren and Cicowiez, 2018). The value added production function is:

$$QVA_{a,t} = \varphi_a^{va}\left(\sum_{f\in H}\delta_{f,a}^{va} \bullet QF_{f,a,t}^{-\rho_a^{va}}\right)^{\frac{-1}{\rho_a^{va}}} + \sum_{f\in FCAP} mpk_{a,f,t}\left(\sum_{i\in INS} QFINS_{i,f,t} - \sum_{i\in INS} QFINS_{i,f,t}^{0}\right)$$

where

$t \in T$: time

$a \in A$: activities

$f \in F$: factors and $FCAP \subset F$: capital factors

$i \in INS$: institutions (households, enterprises, government, rest of the world)

$QVA_{a,t}$: value added

$QFf_{a,t}$: factor demand

$QFINS_{i,f,t}$: factor allocation

$QFINS_{i,f,t}^{0}$: base factor allocation

$mpk_{a,f,t}$: sectoral marginal product of capital in productive infrastructure

φ_a^{va}, $\delta_{f,a}^{va}$, ρ_a^{va}: constant elasticity of substitution (CES) production function parameters.

As we can see, this formulation allows us to capture how changes (increases) in investment relative to the baseline scenario lead to a change in the capital stock in public infrastructure that affects total factor productivity.[22] In the main text we simulate increases in the public capital allocation for public infrastructure (i.e. $QFINS_{gov,f,t}$).

In turn, and at aggregate level, the marginal product of capital in productive infrastructure is defined as:

$$MPKT_{f,t} = \frac{dGDP_t}{dK_t}$$

where K_t is the capital stock in productive infrastructure and $dGDP_t / dK_t$ is the change in GDP that leads to increasing K_t into one unit. As can be observed, the distribution of $MPKT_{f,t}$ among activities ($mpk_{a,f,t}$) is key to determine the results of increased investment in productive infrastructure. Naturally, the results of the simulations presented in Section 4 depend on the value estimated for the $MPKT_{f,t}$ parameter for each of the public investments taken into consideration.

[22] In practice, this situation substantially facilitates the calibration of the model. In particular, it makes it unnecessary to estimate the initial public capital stocks to capture the effect of public investment in productive infrastructure on TFP.

Annex B. Sensitivity analysis

The results of a CGE model, like that used here, will depend on: (i) the structure of the model (for example, the functional forms used, the selected macroeconomic closure rule, etc.); (ii) the baseline-year data used in its calibration; and (iii) the value assigned to the parameters embedded in the equations, mainly that of those which define behaviour such as elasticities, whose value does not result directly from the Social Accounting Matrix as part of the calibration of the CGE model.

Admittedly, the elasticities used to calibrate the Nicaraguan CGE model implicitly include an error margin, as is the case for any other similar models. Consequently, this annex provides a systematic sensitivity analysis of the results obtained in the different scenarios with regard to the value assigned to the elasticities. Therefore, to the extent that the conclusions of the analysis remain unchanged irrespective of the changes in the set of elasticities used for the calibration, there will be a greater degree of trust in the results that the different scenarios shown in Section 4 provide.

The sensitivity analysis assumes that each of the elasticities of the model are distributed in a uniform manner around the value used to obtain the results provided in this study. The range of variation permitted for each elasticity is +/– 75 percent; in other words, it is considered a substantial range of variation. With this information, an alternative to the method originally proposed by Harrison and Vinod (1992) was implemented, which makes it possible to conduct a systematic sensitivity analysis. In short, the aim is to evaluate the results of the model for different sets of elasticities that can vary substantially. This makes it possible to obtain a distribution of results that enables building confidence intervals for each of the results generated. The method for conducting the sensitivity analysis implemented is explained below.

The first stage determines the distribution followed by each of the parameters of the model that are modified as part of the sensitivity analysis: elasticities of substitution between production factors, elasticities related to trade, expenditure elasticities, and unemployment elasticities of the wage curves.

In the second stage, the model is run repeatedly, each time using a different set of elasticities; it is therefore a "Monte Carlo" type of simulation. First, the value that the elasticity takes is selected randomly. Second, the model is calibrated using the elasticities selected at random. Last, using these elasticities, instead of those initially employed, the same scenarios are simulated. These three steps are repeated several times (500 times in our case) and sampling is performed by replacing the value assigned to the elasticities.

Table B1 shows, for two aggregate macroeconomic aggregates in 2030, the estimated percentage change with the original elasticities used in the model, the average of the 500 observations that the sensitivity analysis generates, and the upper and lower limits calculated under the assumption of normality. All of the runs of the Monte Carlo experiment receive the same weighting.

As can be observed, the changes in the growth rates of real private consumption and real GDP reported in this study are statistically significant. At the same time, the estimates of Figures 21 and 22 of this study show values that fall within the reported confidence interval. This means that, for example, there is virtual certainty that the scenario liv-20-fbor+05 has the most significant positive effects on private consumption and on GDP when compared with other similar scenarios that promote non-livestock sectors. This conclusion can be drawn by performing a means test for the results shown in Table B1.[23]

[23] In other words, it is possible to verify whether the differences between the averages reported in Table B1 are statistically significant.

The same type of evaluation can be performed for the other results reported in the scenarios of this study.

TABLE B1 Results of the sensitivity analysis expressed as percentage deviation of real private consumption and real GDP with respect to the baseline scenario in 2030

Item	agr-20-fbor+05	cof-20-fbor+05	liv-20-fbor+05	cofliv-20-fbor+05	bgrains-20-fbor+05	agr-0-fbor+05	agr-40-fbor+05	agr-20-dbor+05	agr-20-fbor+1
Private consumption									
Central elasticities	0.551	0.309	0.666	0.429	0.609	-0.017	1.098	0.212	2.061
Mean	0.557	0.320	0.667	0.436	0.600	-0.021	1.115	0.196	2.088
Standard deviation	0.055	0.060	0.042	0.050	0.055	0.015	0.102	0.050	0.195
Lower limit	0.450	0.202	0.585	0.339	0.493	-0.050	0.916	0.098	1.707
Upper limit	0.664	0.438	0.749	0.534	0.708	0.009	1.315	0.295	2.470
Gross domestic product (GDP)									
Central elasticities	0.972	0.846	1.099	0.935	1.040	0.019	1.897	0.511	3.720
Mean	0.984	0.866	1.100	0.950	1.019	0.020	1.922	0.501	3.770
Standard deviation	0.070	0.069	0.045	0.057	0.086	0.004	0.133	0.054	0.246
Lower limit	0.848	0.732	1.012	0.838	0.850	0.012	1.661	0.394	3.287
Upper limit	1.121	1.001	1.189	1.062	1.188	0.027	2.183	0.608	4.253

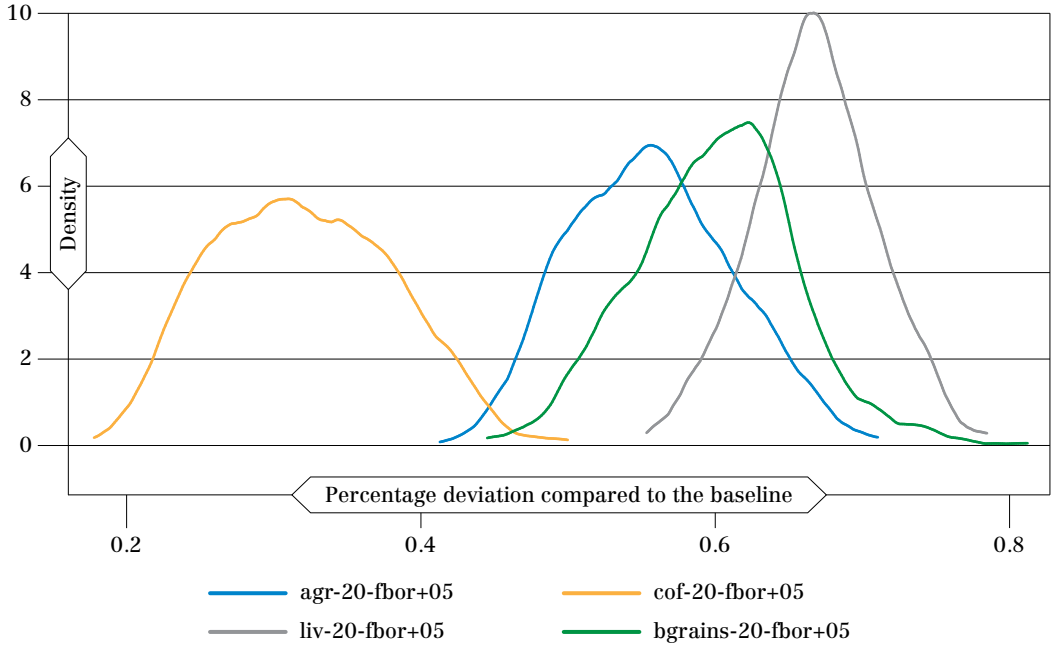
Note: Estimates as per a confidence interval of 95 percent following the assumption of normality.

Source: Authors' own elaboration.

Figures B1 and B2 show non-parametric estimates of the density function for the percentage change in 2030 of real private consumption and real GDP, respectively.[24] Once again, it is observed that both the sign of the results as well as the relative magnitudes between scenarios do not change when the elasticities vary by +/– 75 percent with regard to the estimates reported in this study which are based on the initial elasticities.

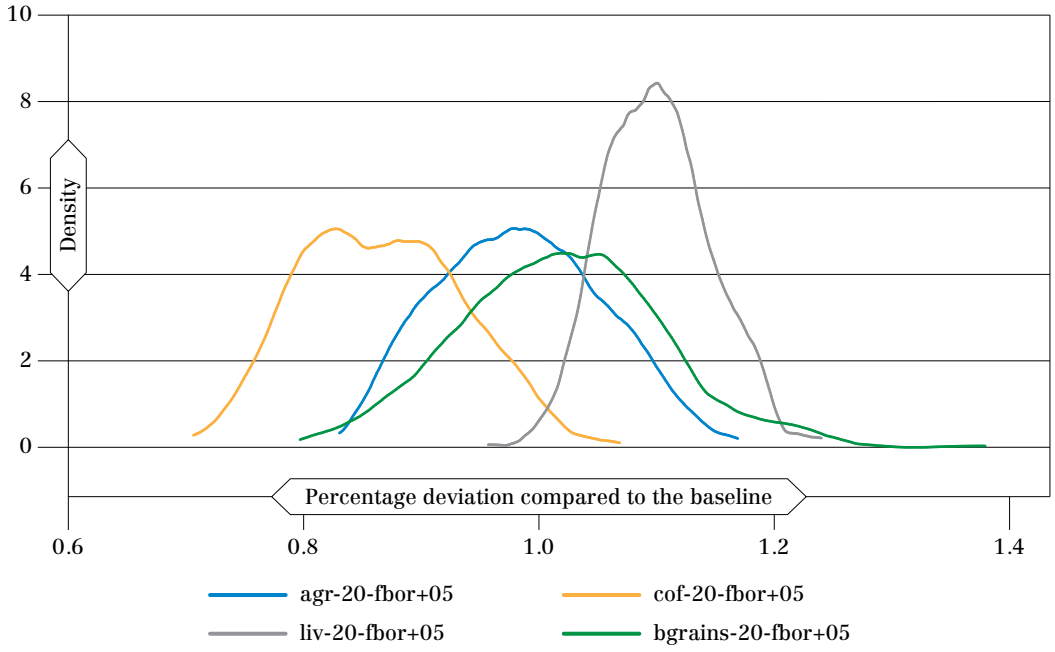
[24] For example, the height of the curve measures how likely it is that the simulations will provide a specific result. That is to say, the values that register a higher density are values that are more likely to be obtained as results of the simulations.

FIGURE B1 Results of the sensitivity analysis by means of the non-parametric estimation of the density function for the percentage change in real private consumption in 2030



Source: Authors' own elaboration.

FIGURE B2 Results of the sensitivity analysis by means of the non-parametric estimation of the density function for the percentage change in real GDP in 2030



Source: Authors' own elaboration.

Nicaragua's economy decelerated significantly from the second quarter of 2018, due mainly to exogenous elements or disruptions. This resulted in a changed economic environment characterized by important constraints and challenges, as well as a lack of foreign financing.

In order to evaluate economic recovery options, this study analyses scenarios on the impact of increasing public investment on the productive infrastructure of the agricultural sector (roads, irrigation systems, storage systems, research and technology, etc.) in Nicaragua for the 2020–2028 period. This investment is scaled up gradually until it represents half a percentage point of the gross domestic product (GDP) in 2023–2025, and then lowered gradually as well.

Increased public investment in productive infrastructure could boost economic growth by around 0.09 to 0.1 percentage points per year until 2030, on average, in those scenarios with the following investment focus: crops and livestock (i.e. the agricultural sector as a whole), livestock only, basic grains, and coffee farming. In comparative terms, for those sectors that receive independent investment, livestock is the sector that reveals the greatest impact due to its linkages with meat and dairy production, as well as the export-oriented nature of meat production. Moreover, from 2019 to 2030, depending on the investment scenario, total poverty in rural areas would decrease by 0.5 to 2.25 percentage points, while extreme poverty would decrease by 0.16 to 0.31 percentage points.

Putting said investments into practice would give the government a concrete alternative to reactivate the economy and reduce rural poverty under existing economic constraints.

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