Public investments in infrastructure and economic growth in Morocco: dynamic EGC modeling.

KHARBOUCHE Ayoub, Ph.D. Candidate, Laboratory of Economic Analysis and Modelling (LEAM), Department of Economics, Faculty of Economics, Law and Social Sciences, Mohammed V University in Rabat (Morocco)

RAOUF Radouane, Professor of Economics, Laboratory of Economic Analysis and Modelling (LEAM), Department of Economics, Faculty of Economics, Law and Social Sciences, Mohammed V University in Rabat (Morocco).

DRAFT 12, May 2024: Not for publication.

DRAFT: Not for publication

Abstract

Investing in public infrastructure is one of the main policies of developing countries to support their economic growth (Barro, 1990). Indeed, these investments, by stimulating an increase in the overall productivity of the economy, have the potential to address most of the structural imbalances and challenges facing these economies. Furthermore, these investments improve the competitiveness of firms and support the favorable integration of these economies into global markets.

Public investment in infrastructure and its productive role is one of the most fruitful subjects in economic science, in this case after World War II. In 1945, within the framework of the massive pulse theory, the concept of the big push emerged that gives industry a major place for economic take-off, and for it to be effective, it should involve several sectors of activity and lead to increasing scale returns. The theory shows that the state must intervene to coordinate investments and make them profitable and effective. In this context, infrastructure plays a major role in promoting market expansion through reduced transport costs and in enhancing synergies between different production sectors. Neoclassical school theorists view public infrastructure as an essential productive factor, as do labor and capital, and contribute to productive efficiency and increase overall productivity [Meade 1995]. The Arrow and Kutz model (1970) extends the perspective of the role of infrastructure in economic growth by integrating public capital into the Solow model. The endogenous growth theory has contributed greatly to this field, developing dynamic models that analyze key determinants of public services. According to this theory, infrastructures play a direct role in the process of long-term growth, and through their externalities, they provide a favorable environment for economic recovery and compensate for the decrease in marginal productivity of capital (depreciation) over time [Barro 1990]. The pioneering work was by Ashauer (1989), who found that much of the decline in American productivity was closely linked to the fall in public capital investment rates over the period 1949–85. Using a Cobb-Douglas production function with public capital, the author estimated that the elasticity of production relative to infrastructure is 0.24.

DRAFT. Not for publication

Since the beginning of the 2000s, Morocco has been engaged in economic and social reforms at the highest level (education and training, health and social protection, etc.), with a view not only to modernizing the structure of its economy but also to increasing the involvement of different categories of the population in the process of economic development and in the fight against poverty and inequalities.

Indeed, the issue of the productivity of physical capital has been the subject of several institutional reports in Morocco. According to a 2016 report[1] from the Office of the High Commissioner for the Plan, the nation has not yet amassed enough physical capital and has not reached its full potential for growth. Furthermore, the conclusions of the Special Commission for the 2021 Development Model emphasize that, for renewed and more efficient Moroccan growth, more productivity gains need to be based on better allocation of investment to productive capacities.

Today, Morocco is seeking to improve its connectivity, logistical efficiency, and overall competitiveness. This includes investments in transport, energy, water, and digital technologies, which are essential to boosting economic growth and promoting sustainable development. It is from this perspective that a new "Investment Charter 2023" has been introduced, which guides investments towards strategic priorities and offers an attractive incentive framework. It represents a key strategic framework for the country's economic development, with particular emphasis on investment in productive infrastructure. In this regard, we are trying to answer the following question: What are the impacts of public investment in infrastructure and, by type, on economic growth in Morocco? Before dealing with this issue, it is necessary to examine some statistics and indicators describing the state of physical capital in Morocco. The average coefficient of capital[2], the marginal coefficient of capital[3], and the capitalist intensity[4] for each sector[5]. The analysis of all these indicators and their interrelationships has enabled us to provide an overview of the effectiveness of investment in Morocco between 1998 and 2019. Morocco has experienced a dynamic investment that has allowed it to accumulate upward capital; in fact, its stock has increased since the early 2000s by 6.2% instead of the 4.6% observed between 1980 and 1990. But

[1] "Rapport Sur Le Rendement De Capital Physique Au Maroc." *HCP*, Jan. 2016.
[2] Capital stock in relation to gross domestic product.
[3] ICOR: incremental capital output ratios.
[4] Capital K per worker L.
[5] Agriculture, Industry, Public Works and Building and Services.

DRAFT. Not for publication

despite this remarkable effort to accumulate capital, economic growth was not at the same pace as investment. The review of capital efficiency through the ICOR shows a low return on investment, even though there was a high capitalist intensity between 2000 and 2019. On the other hand, the sectoral analysis of capital shows that investments are concentrated in low-value sectors. The interpretation of these indicators suggests that one of the causes of the inefficiency of physical capital is the orientation of investments towards sectors that do not generate positive externalities and are not productive. This requires reallocation and reorientation of investment in public infrastructure to sectors with high added value and generating externalities. In fact, the goal of this study is to figure out which areas would benefit the most from public investments in infrastructure by simulating the effects on economic growth. To do this, a dynamic PEP 1-t EGC model (Decaluwé et al., 2013) was used, which was calibrated from SAM 2019 data and includes twenty areas of activity and three types of workers based on their level of education and degrees: unskilled work (USK), qualified We have also made some adjustments to the model, such as the estimation of public capital by the Kamps method (2004), the introduction of externalities in the production function by Luc Savard (2010), and the addition of equations and variables that introduce the funding mechanism. The dynamic MEGC simulation compares the effects of increases in public infrastructure investments for each sector on economic growth, taking into account scenarios in funding modes. Indeed, we are examining the impact of a 10% increase in public capital of each type through financing modes that include: 1) public deficit and 2) additional tax on production.

Key-Words: Public infrastructure, Economic growth, CGE, Productivity, Morocco.

Jel-classification : H54, C68, O4, O47.

DRAFT . Not for publication

Introduction

Investment in infrastructure represents one of the main leverages of economic policy in developing countries to support economic growth (Barro, 1990). Indeed, by stimulating overall productivity growth, these investments hold immense potential to address these economies' structural imbalances and challenges. They enhance firms' competitiveness and pave the way for better integration into global markets, instilling a sense of hope for a brighter economic future.

Since the beginning of the 2000s, Morocco has undertaken many strategic plans and economic and social reforms at the highest level (education and training, health and social protection, etc.), with a view not only to modernizing the structure of its economy but also to increasing the involvement of different categories of the population in the process of economic development and the fight against poverty and inequalities. However, the results of these plans and reforms have yet to result in the expected results, in this case, in terms of development. The country still needs sufficient physical capital, and its growth potential has yet to be fully exploited (HCP, 2016)[6]. As a result, the growth strategy adopted has not significantly reduced unemployment or accelerated the transformation of the industrial sector by allowing for a shift from the high concentration of low-skilled labor to innovation.

It is crucial to underscore the issue of the productivity of physical capital, a topic that has garnered significant attention in Morocco's institutional reports. The Special Commission for the 2021 Development Model's findings reveal a stark reality: a mere 30% of total investment in Morocco originates from the private sector. This figure underscores the urgent need for more productivity gains[7] to fuel renewed and more efficient Moroccan growth. It calls for a more judicious allocation of investments towards productive capacities and a more substantial contribution from the private sector. This growth, in turn, must be more resilient, boast a more diversified productive base, and flourish in job creation.

Today, Morocco seeks to improve its connectivity, logistical efficiency, and competitiveness. This includes investments in transport, energy, water, and digital technologies, essential to boosting economic growth, promoting sustainable development, and improving citizens' quality of life. In

[6] HCP, 2016, “Report on the Physical Capital Return in Morocco”.

[7] Taoufik Abbad (2017) Capital accumulation and productivity gains. Au Maoc.

DRAFT: Not for publication

this perspective, a new "Investment Charter 2023" has been introduced, which guides investments towards strategic priorities and offers an attractive incentive framework. It represents a critical strategic framework for the country's economic development, particularly emphasizing **investment in productive infrastructure.**

This work questions the effectiveness of public investments initiated in Morocco between 1998 and 2019. More specifically, it seeks to assess the impact of public investment in infrastructure by type and sector on economic growth. This will identify the linkages of infrastructure by nature/type and their contribution to development.

To do this, it is necessary to consider specific indicators describing the state of physical capital, such as the increment capital output ratio[8] and capital intensity[9] for each sector[10]. Analyzing all these indicators and their interrelationships has enabled us to shed new light on the effectiveness of public investment in Morocco. The interpretation of these indicators suggests that one of the causes of the inefficiency of physical capital is **the orientation of investment into sectors that do not generate enough positive externalities or are not sufficiently productive.** This situation calls for the reallocation and reorientation of public investment in infrastructure to industries with high-added value and generating externalities.

The most relevant approach to this work is to opt for EGC modeling by simulating the impact of public infrastructure investments by sector on economic growth and identifying the most profitable ones. We have implemented a dynamic PEP 1-t EGC model (Decaluwé et al., 2013), calibrated from the SAM 2019 database, containing twenty-five activity sectors. Three categories of workforce disaggregated according to the level of education and degrees held by each individual in the household (unskilled work (USK), qualified work (SK), and intermediate skilled labor (MSK). We also made some adjustments to the model, such as the estimation of public capital by the Kamps method (2004) and the introduction of externalities in the production function (Luc Savard, 2010), and we also added equations and variables that introduce the funding mechanism. The dynamic MEGC simulation compares the effects of increases in public infrastructure investments for each sector on economic growth, considering scenarios in funding modes.

[8] ICOR.

[9] Capital K per worker L.

[10] Agriculture, Industry, Public Works and Building and Services.

DRAFT : Not for publication

Following this introduction, the continuation of the paper is structured as follows: The first section is devoted to the presentation of investment in Morocco between 1998 and 2019, based on a descriptive analysis of various indicators such as capital intensity, the structure of investment, and the overall productivity of factors. A literature review is then carried out to examine how other researchers have dealt with the problem. The third part presents the model used for the simulation, detailing its assumptions and methodologies. Finally, a discussion of the results is proposed, highlighting the implications and prospects for public policies for investment and economic growth in Morocco.

Investment in Morocco between 1998 and 2019.

Total investment in a given country is the sum of private and public investment. Its objective is to increase a sector's productivity and output by increasing its physical capital, i.e., sustainable means of production such as machines, new information technologies, buildings, and vehicles. Gross fixed capital formation (GFCF) is the critical indicator for measuring investment. This is the value of durable goods acquired by the production units to be used for at least one year in their production process. The joint analysis of this indicator makes it possible to assess the investment activity of a country and its impact on economic growth.

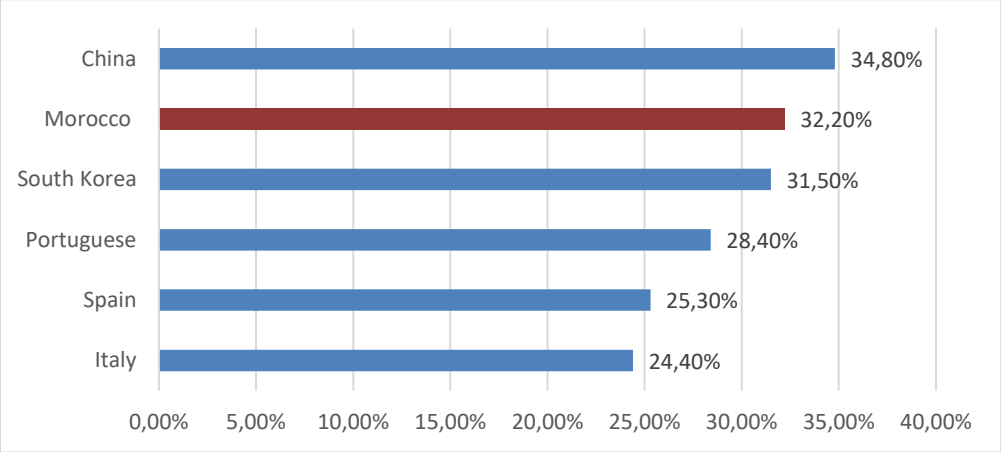
Morocco has been engaged, since the early 2000s, in a dynamic of economic and social reform. Education, training, health, and social protection are pillars of this strategy aimed at modernizing the economy and ensuring inclusive and sustainable development. According to the Bank Al-Maghrib's 2021 report[11], the nation exhibits a rate of investment comparable to that of many nations that have experienced "economic miracles." This resemblance highlights Morocco's potential for strong and sustained economic growth. The Office of the High Commissioner for the Plan reveals a significant increase in the gross fixed capital formation rate (GFCF) as a percentage of GDP between 2000 and 2019. This rate increased from 26% to 32%, with an average annual GFCF growth rate of 6.7%.

The following figure (Figure 1) shows the evolution of investment rates in lower-middle-income countries, allowing a comparison with Morocco's performance.

[11] BAM Annual Report (2021).

DRAFT. Not for publication

Figure.1Rate of investment in (% of GDP)

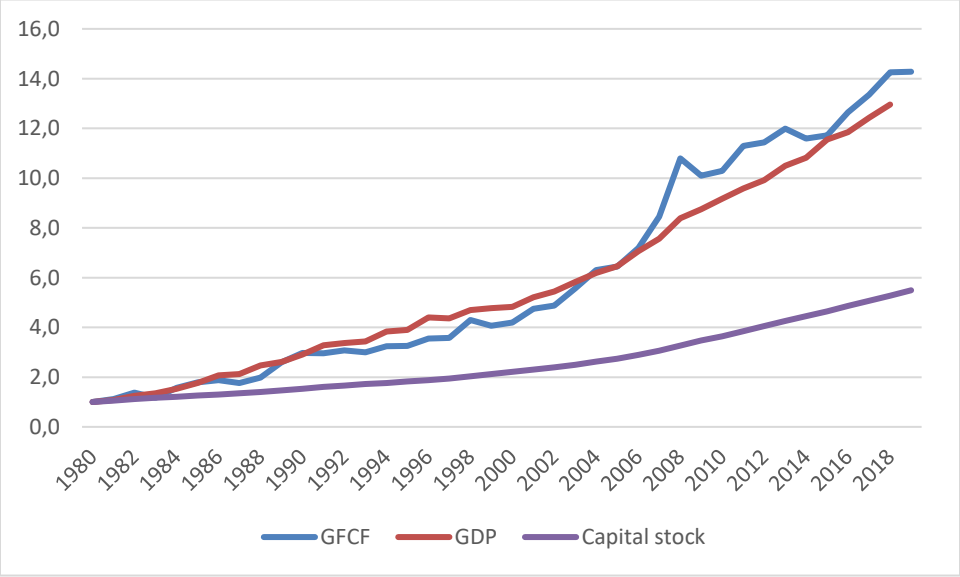


Source : Al Maghreb Bank.

This positive momentum arises from implementing sectoral strategies and structural reforms, marking a break with the Structural Adjustment Plan (PAS) period. Public and private investment programs in the telecommunications and transport sectors have played a crucial role in this development.

As a result, the capital stock increased by 7% per year, reflecting a significant accumulation of physical capital. On an annual average, this stock represents three times GDP and even five times between 2015 and 2019. By comparison, the annual average for the 1980s and 1990s was 3.9%.

Figure.2 Evolution of GDP, GFCF and capital stock (base 100=year 1980)



Source : Calculation of the author from the Penn World Table data.

Do not for publication

The return on investment in capital in Morocco

Despite a promising dynamic, the results achieved due to the reforms undertaken have yet to meet expectations. Contrary to substantial investment efforts, economic growth has not evolved at the expected pace and does not adequately reflect the stock of productive factors, as highlighted (Abouch & Ezzahid, 2018; Abbad, 2017; HCP, 2016), as well as the Office of the High Commissioner to the Plan (HCP, 2016). One major problem remains the significant gap between capital accumulation and the natural wealth generated. This gap highlights the importance of examining the efficiency of investment and the return on physical capital, thus highlighting the need for more in-depth analysis to optimize the use of invested resources.

Return on investment is crucial to a country's economic growth. The marginal capital coefficient (ICOR) is often measured by the number of investment units needed to generate a GDP growth point. The lower the ICOR, the more profitable the investment. In Morocco, the ICOR is on the rise, with an average of 8.8 between 2011 and 2019. This means that more investment is needed to achieve economic growth. This situation is worrying and raises questions about investment effectiveness in Morocco.

In order to examine the evolution of capital and its yield in Morocco, it is essential to analyze all the indicators of the stock of productive factors, including capitalist intensity[12], labor productivity[13], and the overall productiveness of the factors, based on the growth accounting that provides a relevant framework for this analysis. It divides growth into two main elements:

1) Capital accumulation through increased capital stock and investment in machinery and infrastructure.

2) Growth in labor by increasing the number of workers or improving their skills can also contribute to growth.

In addition to these two factors, it is crucial to look at the overall productivity of the factors (PGF). PGF measures the efficiency with which production factors are used to generate growth. A high PGF means that the economy can produce more with fewer resources.

DRAFT. Not for publication

[12] Capital K per worker L.

[13] Production Y per worker.

Capitalist intensity

The capitalist intensity of an economy refers to the proportion of capital to labor. It quantifies the capital used per labor unit to produce goods and services. The evolution of capital investments explains the progress of capitalist intensity[14].

Between 1980 and 1999, the implementation period of the Structural Adjustment Programme (SAP) was marked by moderate investment rates, a relatively steady level of capital stock, and limited economic growth. Since 2000, capitalist intensity has accelerated recovery, with an average annual growth rate of 4.2% between 2000 and 2009, boosted by vigorous investment programs. During this phase, the economic growth rate increased by 4.9 percent annually. However, this progress has slowed despite an acceleration in capitalist intensity, thus highlighting a discrepancy between capital investment and expected economic growth results.

The accumulation of capital and the overall productivity of the factors.

Tableau 1Evolution of capitalist intensity and GDP between 1980 and 2019

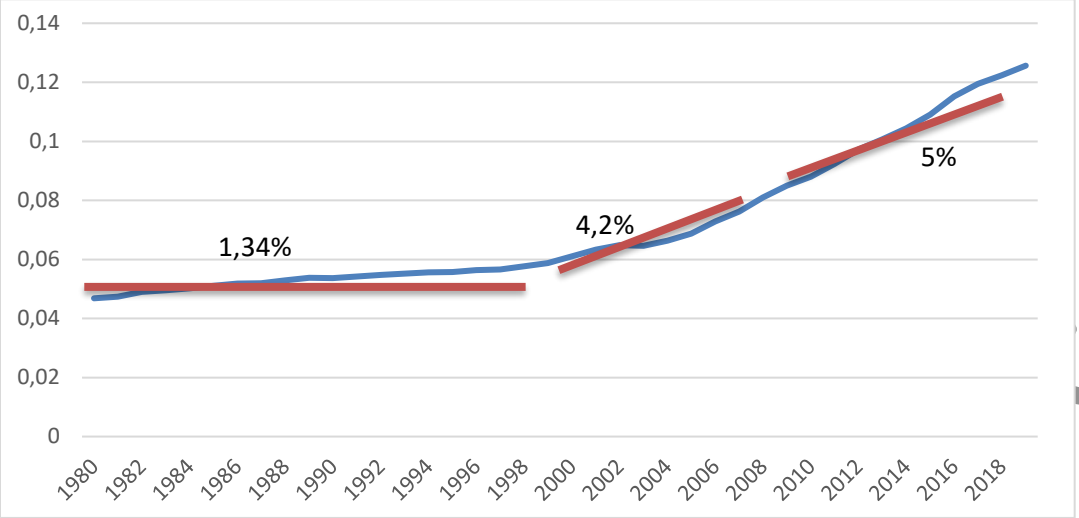
	Capitalist intensity	GDP
1980-1999	1,34%	3,70%
2000-2009	4,20%	4,90%
2010-2019	5,00%	3,50%

Source: Calculations of authors, HCP database.

DRAFT: Not for publication

[14] The change in intensity can be caused by variations in labor factors in the case of disaggregated data.

Figure 3 Evolution of capitalist intensity



Source Calculation of authors, HCP data.

In theory, an increase in capitalist intensity should stimulate growth in the overall productivity of factors (Krugman, 1994). Capital increases work productivity by equipping workers with better machines and tools. Moreover, capital accumulation enables firms to adopt new advanced technologies, improve the quality of products and services, reduce production costs, and increase competitiveness.

Tableau 2Evolution of capitalist intensity, the factors' overall productivity, and labor's productiveness.

	The capitalist intensity in %	Total factor productivity in %	Labor productivity in %
1980-1990	1,56	-0,02	0,8
1991-2000	1,28	-1	0,05
2001-2010	3,75	1,2	3,4
2011-2019	5	1	2,3

Source : Calculation of authors, HCP data.

The table shows a varied evolution in overall factor productivity (GFP) and capitalist intensity in Morocco. Between 1980 and 2000, PGF experienced negative growth. This period was marked by a significant slowdown in capitalist intensity and was impacted by various internal and external

DRAFT : Not for publication

shocks[15]. From 2001 onwards, an improvement of 1% in FDI was observed with a capital increase, with growth of 4.3% between 2001 and 2019.

An analysis of labor productivity growth reveals a positive correlation with capitalist intensification. During the 1980–1990 period, the growth in labor productivity was 0.8 percent. This growth slowed to 0.05 percent before accelerating significantly to 3.4 percent in 2011. Indeed, every period of increasing capital investment has been accompanied by improved labor productivity. Moreover, during 2011–2019, a paradox was observed: capitalist intensity grew significantly, while labor productivity decreased slightly. A reduction in the overall productiveness of the factors has also accompanied this decrease in labor productivity. These observations lead to two important conclusions:

Firstly, if capital is a crucial factor for growth, more is insufficient. As Solow (1957) and Easterly and Levine (2001) noted, capital accumulation does not necessarily lead to increased productivity. Indeed, other factors such as technological innovation**, resource allocation efficiency,** and the workforce's skill level play a crucial role. Moreover, the interaction between capital and overall factor productivity (GFP) is decisive. Improved productivity and increased capital can lead to a more significant increase in labor productivity, as Krugman (1994) pointed out. This highlights the importance of efficient use of capital and creating an environment conducive to the innovation and growth of the PGF, per the observations of Hoff and Stiglitz (2000) and Sala-i-Martin (2001).

Tableau 3Evolution of capitalist intensity, the factors' overall productivity, and labor's productiveness.

	GDP	**The capitalist intensity in %**	**Total factor productivity in %**	**GFP**	**ICOR**
Argentina	3	0,3	1,0	0,5	7
Brazil	2,17	3,2	1,6	-1,3	6
Chile	2,9	3,5	1,0	-0,3	4,4
Egypt	4,5	1,5	2,0	0,6	7,7
Spain	1,7	1,1	1,4	0,1	5,7

[15] The establishment of the PAS, political instability, strikes in 1981, and deterioration of relations with Algeria.

DRAFT : Not for publication

Estonia	3,9	1,1	1,8	1,1	3
Republic of Korea	2,2	3,2	1,0	1,2	2,9
Morocco	2,9	2,4	2,3	0,3	8,8
Malaysia	4,3	3,5	1,7	1,4	3,4
Pakistan	5,5	1,3	2,2	2	3
Poland	3,4	3,5	2,8	0,4	5
Rwanda	6,5	5,0	4,6	0,6	2,4
Tunisia	0,2	2,0	-0,2	0,2	6
Turkey	2,6	5,9	2,6	0,6	5
South Africa	1,2	0,5	-0,7	-1,6	7
Mexico	2,4	2,0	0,5	-1,1	7
Hungary	2,02	1,33	-0,04	-1,00	6
Indonesia	5,26	4,10	3,03	1,09	4,7
Jordan	3,92	0,8	0,47	1,24	6
Peru	3,43	4,90	1,48	-2,03	6,8
Philippines	5,88	2,34	4,01	1,52	5,4

Source : Calculation of the author from the Penn World Table data.

A comparative analysis of the level of capital accumulation in Morocco and other countries revealed that increased capitalist intensity could have contributed to an improvement in overall factor productivity (GFP), thereby resulting in a significant increase in labor productivity. Take the example of Morocco and the Philippines, which have followed similar trajectories in terms of capitalist intensity. Despite this, their PGF results differ greatly, with the Philippines significantly better than Morocco. In the Philippines, the increase in labor productivity has been accompanied by an improvement in PFG. On the other hand, Morocco did not see similar progress in FGM, which helps explain the differences in performance between the two countries. Pakistan offers another interesting example: despite a slower rate of capital accumulation, with annual growth of only 1.3 percent—well below that of Morocco—its low capital intensity is offset by a remarkable efficiency of capital productivity, indicated by a 3 of 3, where GDP grows at 5.5 percent, surpassing the growth of capital stock. This dynamic keeps the PGF at a positive level of 0.5%.

A general observation indicates that countries that experienced a marked rise in capitalist intensity also observed improved overall factor productivity. This trend highlights a positive correlation

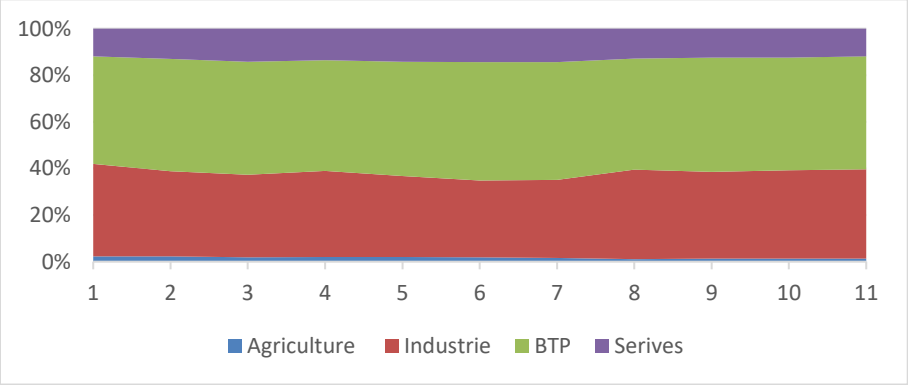
DRAFT: Not for publication

between these two economic indicators (Abbad, 2017; HCP, 2016; Bouhia, 2001). This finding encourages a sectoral investment analysis during the last decade, marked by signs of significant economic performance.

Comparing Morocco with other countries shows that capital yields remain poor. This finding encourages a sectoral analysis of investment during the last decade, a period marked by signs of significant economic performance.

Focus on the accumulation of disaggregated capital

Figure 4: GFCF structure by product



Source : compiled by the authors, HCP data.

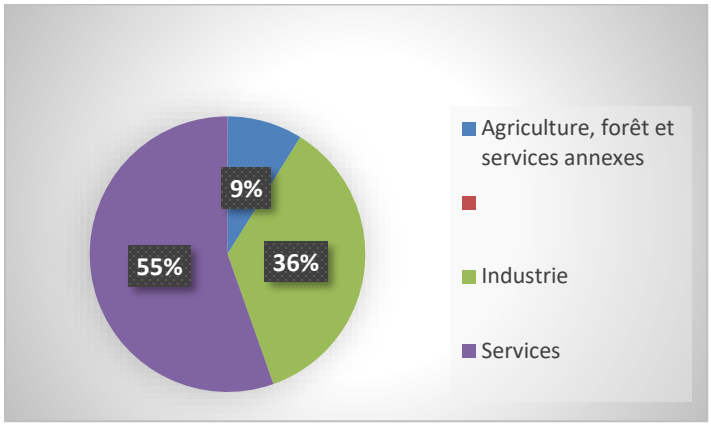
According to the figure above, the building and public works established themselves as the main components of the GFCF between 2009 and 2019. This predominance is **due to the importance of public investment in economic and social infrastructure**[16]. On an annual average, BTP accounts for 49% of the total GFCF at current prices. Investment in BTP products is characterized by an average annual growth rate of 4% over the period under review. It is thus ahead of services (3%) and industry (2,9%). On the other hand, investment in agricultural products is slowing by an average of 2.3 percent annually.

[16] The State's contribution to these investments exceeds two-thirds.

DRAFT. Not for publication

Investment by Sector of Activity and Sectoral Capital Intensity

Figure 5 : Investment rate by sector of economic activity



Source: compiled by the authors, HCP data.

The consideration of investment makes sense when presented in terms of investment rates by sector. This report assesses the share of the added value of each sector dedicated to investment. Between 2008 and 2014, the services sector allocated 55% of its value added to investment annually, while industry devoted 36% and agriculture devoted 9%.

Tableau 4: Evolution of capitalist intensity by sector of activity.

Activity sectors	1998-2007	2008-2014	1998-2014
Agriculture, forestry and related services	1,5%	0,8%	1,2%
Industry	4,8%	5,1%	4,9%
Services	4,6%	5,9%	5,2%

Source : compiled by the authors, HCP data.

Regarding the accumulation of capital at the sectoral level, the services sector was characterized by increasing capitalist intensification between 1998 and 2014. Its growth rate increased significantly, from 4.6 percent from 1998 to 2007 to 5.9 percent between 2008 and 2014. This trend reflects the rise of capital-enhancing technologies in this sector (HCP, 2016).

DRAFT : Not for publication

Tableau 5: Evolution of overall productivity of factors by sector of activity

Activity sectors	1998-2007	2008-2014	1998-2014
Agriculture, forestry and related services annexes	2,7%	9,5%	5,8%
Industry	-3,3%	-1,5%	-2,4%
Services	2,5%	1,3%	2,0%

Source compiled by the authors, HCP data.

Despite the increase in capitalist intensity, overall factor productivity (GFP) in the service sector grew modestly, from 2.5% between 1998 and 2007 to 1.3% between 2008 and 2014. On the contrary, the agricultural sector performed best in GSP, with an annual growth rate of 5.8%. This achievement is remarkable, given the decrease in capital accumulation during the same period. Several factors, such as climate conditions, could offset this decrease. (HCP,2016).

The industry has had a disappointing performance in terms of FPG. Indeed, despite an improvement in its capitalist intensity, the sector's GDP declined, resulting in a 2.4% decline in GDP per year.

The evolution of the sectoral distribution of the total capital stock has significant implications for the Moroccan economy. The growth of the services sector as the primary driver of capital accumulation underlines the importance of this sector for future economic growth. On the other hand, de-industrialization and falling investment in BTP could slow growth (HCP, 2016)[17].

Conclusion

Morocco is engaged in a dynamic aimed at maximizing the impact of investment on economic growth, requiring a profound transformation of economic structures to align the country with the standards of developed economies. Investment in Morocco is perceived as a crucial lever for inducing robust and sustained economic growth. However, to fully capitalize on this advantage, it is imperative to increase investment efficiency by overcoming the barriers that hinder the increase in overall productivity of factors. (Chatri, 2019; Ezzahid, 2019) Adopting targeted sectoral policies and optimum allocation of resources are essential for improving investment efficiency, promoting

[17] In this situation, it appears that Morocco's economic growth regime is based on the accumulation of the factors of production (capital and labor), which is characterized by an extensive regime. This contrasts with an intensive diet, where growth is mainly driven by significant productivity gains.

DRAFT : Not for publication

sustainable and equitable development, and guiding the growth regime of the Moroccan economy towards a more intensive model[18].

In this context, particular attention should be paid to reinvesting the gains of the agricultural sector to increase its capitalization and maximize the value-creation potential of the services sector. The Office of the High Commissioner for Planning (HCP) has highlighted several challenges to the performance of the industrial sector, including a slowdown in capital accumulation, marked by insufficient investment in new technologies and equipment, thereby limiting industrial productivity and growth.

Faced with current challenges, the "Investment Charter 2023" has been launched, guiding investments into strategically essential sectors while creating an enabling environment. The Charter is a fundamental pillar of economic development, highlighting investment's crucial role in productive infrastructure. This encourages us to examine the literature studying the impact of investment in public infrastructure on economic growth and how these investments can significantly contribute to improving the overall productivity of these factors. Well-thought-out investments in infrastructure, especially those that generate positive externalities, can significantly increase productivity, thus positioning the country on a more robust and sustainable growth path.

Literature Review

The productive role of infrastructure

Public investment in infrastructure and its productive role is one of the most fruitful subjects in economic science, in this case, after World War II. In 1945, a big push emerged within the framework of the massive pulse theory, giving industry a significant place for economic takeoff. For it to be effective, it should involve several sectors of activity and lead **to increasing scale returns.** The theory shows that the state must intervene to coordinate investments and make them profitable and effective. In this context, infrastructure significantly promotes market expansion through reduced transport costs and enhances synergies between production sectors.

Neoclassical school theorists view public infrastructure as an essential productive factor, as do labor and capital, which contribute to productive efficiency and increase overall productivity

[18] See William Easterly and Ross Levine (2001), It's Not Factor Accumulation: Stylized Facts and Growth Models, The World Bank Economic Review, Vol. 15, No. 2 (2001), pp. 177-219.

DRAFT. Not for publication

[Meade 1995]. The Arrow and Kutz model (1970) extends the perspective of the role of infrastructure in economic growth by integrating public capital into the Solow model.

The endogenous growth theory has significantly contributed to this field, developing dynamic models that analyze critical determinants of public services. According to this theory, infrastructures play a direct role in long-term growth, and through their externalities, they provide a favorable environment for economic recovery and compensate for the decrease in the marginal productivity of capital (depreciation) over time [Barro 1990].

The Färe et al.'s (1994) study highlights the crucial role of technical change and efficiency in productivity growth in OECD countries between 1979 and 1988. It stressed the importance of public investment in capital accumulation, suggesting that such investment could boost overall productivity by facilitating the adoption of innovative technologies and improving the labor force's skills. This synergy between public investment and capital accumulation is essential for sustainable economic growth.

The analysis by Easterly and Levine (2001) reveals that, contrary to a popular view, capital accumulation and investment are only some of the drivers of long-term economic growth. Instead, the overall factor of productivity plays a crucial role. This means that the way countries use their investments and accumulate capital, in terms of efficiency and innovation, is more determining for growth than the amount of investment or accumulated capital itself. Thus, to stimulate sustainable growth, policies should focus on improving GSP, for example, by promoting innovation, improving education, and creating a business-friendly environment, rather than focusing solely on increasing investment and capital accumulation.

Empirical approaches: mixed and sometimes overestimated results.

Empirical studies that analyzed the relationship between public spending on infrastructure and economic growth revealed mixed results. For example, Aschauer (1989) found that much of the decline in U.S. productivity was closely linked to the fall in public capital investment rates. It observes a more substantial impact of public capital over the period 1949–85 (elasticities between 0.39 and 0.49). Furthermore, in their work on overall productivity in the twelve OECD countries, Ford and Poret (1991) confirmed the significant impact of public capital in only four countries (Belgium, Canada, the United States, and Sweden). Munnell (1993) notes that public capital's impact on economic growth in the United States is more significant in the industry and agriculture than in the services sector. Mera (1973) brings similar results to those of Japanese regions.

DRAFT : Not for publication

Ashauer's work about elasticities has been the subject of many criticisms, calling into question both technical and conceptual issues. For example, Tatom (1991; 1993) and Gramlich (1994) pointed out that the values of public capital elasticities by Aschauer are surprisingly high. They argue that the implicit rate of return on public capital would be between 60% and 80%. For these critics, Ashauer's approach neglects crucial tests such as stationarity and co-integration, which are essential to understanding the behavior of the variables under study and their long-term evolution. (Aaron, 1990).

Where is the insufficiency?

The causal link between economic growth and public capital is also a concern. The econometric methodology adopted in Ashauer's work must provide an exhaustive description of this relationship. The opposite: according to Wagner's law, economic development could increase public spending and quality infrastructure. Other researchers, such as Kwan and Sahni (1989; 1992), Tatom (1993a), and Eberts and Fogarty (1987), have also tried to answer this question of the endogenicity of public spending and investment. Another challenge lies in defining "public capital" and "public infrastructure." According to Ford and Poret (1991), their interpretation and measurement can produce inconsistent empirical results. Moreover, the way investment expenditure is aggregated can also influence results.

Disaggregated analysis of public investment

The nature of the link between public capital and private investment depends on several factors specific to the country's economy and its composition. Indeed, public spending is a privileged instrument for economic recovery in developing countries, but its impact also depends on its structure, i.e., the composition of current spending and investment spending. Hansen (1965) proposed a precise classification of infrastructures. It distinguishes between "social infrastructures," such as education, social services, and health; "physical infrastructure," which participates in the productive process, including roads, highways, and ports; and economic or financial infrastructure," which reflects the particular importance of such a financial system in the development and growth efforts of the different economies of the world.

In this regard, several works have shown a positive impact of public investment on growth. The World Bank's results (1994) concern electricity, water, transport, and communications spending; those of Kocherlakota and Yi (1996) concern public equipment in the United States and England; the results of Fin (1993) concern U.S. highways; and, finally, those of Easterly and Rebello (1993)

DRAFT: Not for publication

affect transport and communication investment in a wide range of countries. Hulten (1996), for its part, emphasizes the quality of infrastructure, including electrical, telephone, road and railway installations. As for Andersson et al. (1990), they observed in a study on Swedish regions a positive impact of road infrastructure on growth. For Deno (1988), transportation equipment is more productive than communications and sanitary equipment.

Methodology and data

Using Moroccan data, we use the PEP-1t (Single-Country, Multi-Period) model by Decaluwé et al. (2013). PEP researchers developed this calculable general balance model. It is designed to evaluate specific economic and trade policies within a small open economy and operates according to a recursive dynamic, where each period is seen as a static balance.

In a framework of pure and perfect competition, companies aim to maximize their profits by adjusting the costs of factors of production, such as capital and labor, until the rate of capital remuneration and wages are aligned with the value of their marginal productivity. Regarding production, each sector (in total, 25) employs a Leontief function to combine added value and intermediate consumption. At the next level, added value comes from combining composite labor and capital through a constant elastic substitution function (CES). Finally, at the third level, composite work combines skilled and unskilled work.

Whether imported or produced locally, demand for goods and services includes intermediate consumption, household and government end-use, investment, and costs associated with transportation and trade margins.

Consumption modeling of households is based on the Stone-Geary utility function, which establishes a linear relationship between their consumption budget and their marginal propensity to consume. It also incorporates a base, or incompressible, consumptive level. Government spending on goods and services is defined as a constant percentage of total current expenditure, adjusted in proportion to demographic change.

Balance is crucial in the markets for goods, services, and factors of production, implying that supply and demand must be balanced for each element. For example, the quantity of a product offered must be equal to the total demand, which includes household consumption, government spending, intermediate demand, and investment. A similar balance is needed for different

DRAFT. Not for publication

categories of labor and different types of capital. Moreover, the total investment must correspond to the savings made by households, government, and external sectors.

The attitude of producers and consumers towards foreign trade is the basis of the behavior of the variables towards this trade. We take the assumption of Argmington (1969), which states that imports are imperfect substitutes for similar products manufactured locally. As a result, consumers receive the total quantity of compound products they have purchased in different proportions on the local and global markets. Consumers' choice between local and imported products is based on the minimization of the cost of acquiring the products, assuming that the total supply follows a function of commercial substitution to the elasticity of constant trade substitution, linking the goods and services produced and sold locally on the one hand, and imports on the other.

This principle also applies to producers, who can sell their products on the local market or export them. The model envisaged here is based on producers' strategy to maximize their income, considering an imperfect transformation between export and local sales. The quantity produced is then adjusted based on a processing function that has a constant elasticity, regulating the ratio between exports and domestic sales.

Data and Parameters

The social accounting matrix represents all the data needed to calibrate the model to an initial balance. This matrix, which we developed for 2019, is based on data from national accounts tables and surveys.

The sectoral composition includes twenty-five economic sectors. The work factor is detailed in three categories, distributed according to the level of education and qualifications of individuals within the household: unskilled work (USK), skilled work (SK), and middle-skilling work (MSK). Moreover, in order to introduce our problem into the model, adjustments have been incorporated, including the evaluation of public capital using the Kamps method (2004), the incorporation of externalities into the production function (Estach et al., 2012), the disaggregation of investment by asset (Lemlin & Robichaud, 2018), and the addition of equations and variables to facilitate the financing mechanism.

Adaptations to the model

Estimate of public capital:

An analysis of the impact of public investment on the economy requires an approximate estimate of the public capital stock in Morocco in 2019. To do this, we applied the method described in the

DRAFT: Not for publication

Kamps study (2004), which was initially used to estimate public capital stock in the 22 OECD member countries.

Our estimate is based on the law of capital movement, as defined by Solow in 1956.

$$KG_t = (1 - \delta)KG_{t-1} + IND_t \quad (1)$$

IND_t : new public investments;

KG_{t-1}: stock of public capital;

δ : the rate of depreciation of capital.

The assessment process is structured around several key stages. We begin by collecting data on public investment from the national accounts, dating back to the year 1980, the oldest available for our analysis, and this must be divided by the implicit GDP index to determine the actual value. We calculate these investments' average annual growth rate from 1980 to 2019. On this basis, we perform a retroactive projection to estimate the initial investment in 1912, assuming that the initial capital stock was non-existent. Considering the rate of capital depreciation, we reconstitute the capital stock year after year until 2015, adding the annual investments made.

The externalities of public capital

The impact analysis of public infrastructure investments involves incorporating public capital into the CES production function that we use, taking into account the positive externality resulting from public investment in infrastructure, which influences the overall productivity of the factors. Based on previous research in the field, we also adopt Savard's (2010) conceptualization of externality while applying the coefficient of externality elasticity suggested by Dumont and Mesplé-Somps (2000)[19].

$$VA_{j,t} = \left(\frac{IT_{PUB_t}}{IT_{PUBO}}\right)^{\sigma_{i,j}} B_j^{va}\left[\beta_j^{VA}\, LDC_{j,t}^{-\rho_j^{va}} + \left(1-\beta_j^{va}\right)KDC_{j,t}^{-\rho_j^{va}}\right]^{-\frac{1}{-\rho_j^{va}}} \quad (2)$$

$VA_{j,t}$ Sector added value j;

[19] Most of the elasticities are estimated by ourselves.

Draft: Not for publication

IT_PUB_t	Public GFCF Stock;
IT_PUBO	Stock of initial GFCF;
$LDC_{j,t}$	Labor Demand in branch of Activity j;
$KDC_{j,t}$	Capital Demand of branch J;
B_j^{va}	Exogenous technical progress not caused by public capital;
β_j^{VA}	Share parameter (CES – added value);
ρ_j^{va}	Elasticity parameter added value;
$\sigma_{i,j}$	Parameter public infrastructure productivity.

The available capital stock, by sector, is determined by the capital stock of the previous period minus depreciation, to which are added the investments made (equation n°1).

Public investment by destination

Investment demand is distributed between gross fixed capital formation (GEF) and stock variations. While stock variations are perceived as exogenous, GFCF is regulated by the balance between savings and investments, and savings are treated as endogenous in this context.

The stock change is deducted from the total investment to calculate the gross fixed capital formation (GEF) in the PEP model. It is essential to emphasize that the GFCF for each property is distributed between a private and a public component, each representing a pre-defined share of the total investment demand for all assets. Our challenge lies in applying a shock to investment by sector of activity in our model called IND, which requires disaggregation at sectoral and asset levels because it is at this level that the adjustment contributes to the capital stock; in fact, we are inspired by the work of Véronique and André (2018)[20].

The model distinguishes different types of assets, each representing specific indices. The total expenditure on an asset, expressed by IT_a, is distributed among various outputs according to fixed proportions, indicated by $\gamma_{i,a}^{INV}$. This allocation determines the final demand for investment for each product, rated $INV_{i,a}$ (the equation). As a result, using the equation above, one can calculate the total investment demand for a specific product as $INVT_i$ I by adding the investment requests related to each asset type.

[20] Agricultural, industrial, social, services, and public construction.

DRAFT: Not for publication

$$PC_i.INV_{i,a} = \gamma_{i,a}^{INV}.IT_a^A \quad (3)$$

$$INVT_i = \sum_a INV_{i,a} \quad (4)$$

Investments in infrastructure aimed at increasing the productive capacity of the public sector ranked $DINV$, are considered exogenous. According to the equation, the total value of public investment is calculated by adding these amounts.

$$DINV_{a,j} = \gamma_{a,j}^{IND}.IND_j \quad (5)$$

$$IT^{pub} = \sum_a PIT_a^A.DINV_{a,pub} \quad (6)$$

The distribution of the investment between the different asset types follows a similar proportion to that observed during the reference period, as indicated in the equation. The total investment for each asset is then calculated by adding demand from all sectors (equation), the price of each assetPIT_a^A is determined by a precise price index.

Simulations and results

We have disaggregated investments by sectoral destination according to five asset types. This paper aims to compare the profitability of infrastructures through their sensitivity to the overall productivity of factors and, subsequently, the added value of sectors. So, we are looking for the kinds of infrastructure that allow for better profitability and greater accumulation of capital.

We developed two scenarios for each simulation based on the funding method[21]. A simulation is an increase in each type of infrastructure equivalent to 10% of the GFCF[22]/GDP ratio. As far as closure is concerned, the financing must be secured either by a domestic debt or by an additional tax on the firm, in which case we provide for the fixing of public savings,

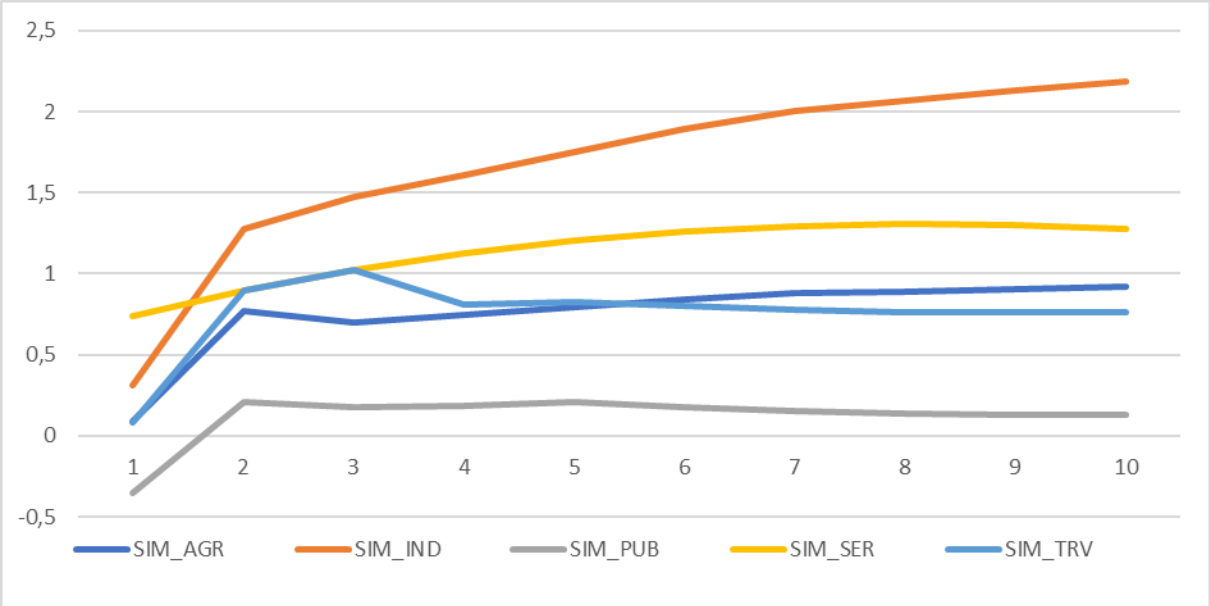
[21] Putting financing modes in the simulation leads us to stay within reasonable limits of public policy.
[22] Public GFCF

DRAFT : Not for publication

Results

The results of the simulations show that investment in agricultural infrastructure increases GDP in the long term by 0.8%, with an almost neutral effect in the first year. Industrial infrastructures have a positive effect in the first year, with an initial growth of 0.4%, followed by a progression that translates into an average annual increase of 1.8% over the next nine years. Infrastructure in the health and education sectors recorded the lowest long-term GDP growth of 0.2 percent, with a slight initial (shock year) decline of 0.35 percent. The services sector (SIM_SER) is marked by a substantial increase of 0.7% from the first year, continuing upward with an average of 1.08%. In contrast, public and building infrastructures show a substantial start-up increase, demonstrating a significant impact on GDP, which tends to decrease over time.

Figure 6:Variation in % of GDP compared to the benchmark: debt financing



Source: GAMS Output

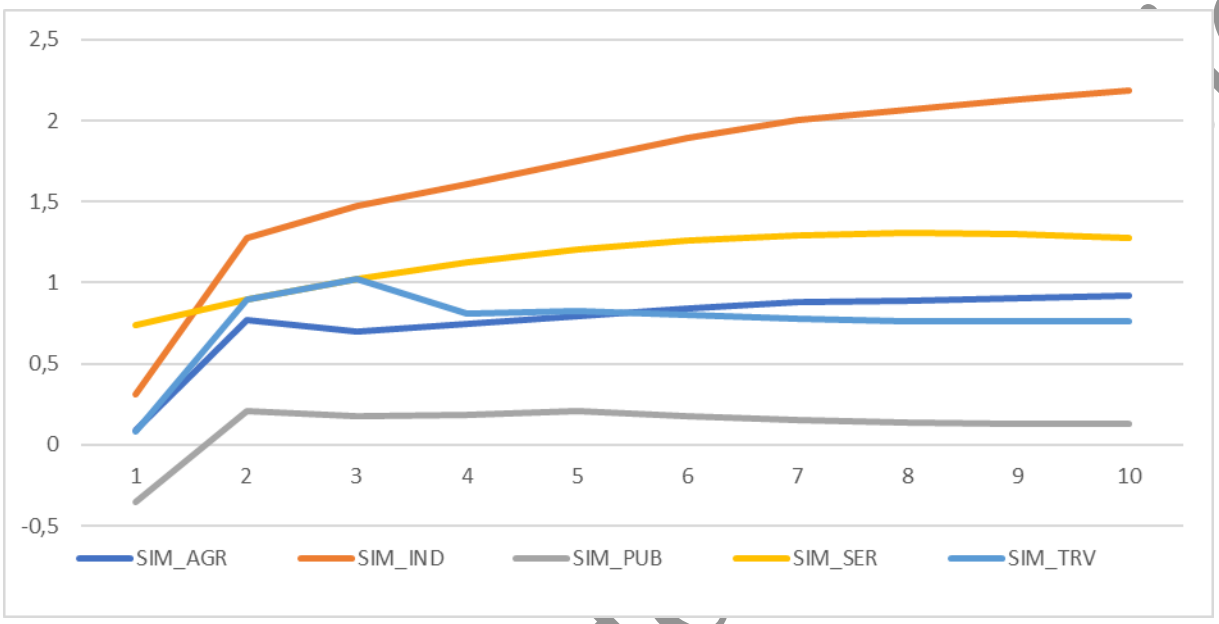
It is important to note that the increase in public investment revives economic growth through the short-term demand effect. Furthermore, the variability in long-term GDP growth rates is mainly explained by the effects of various externalities that stimulated an improvement in the overall productivity of the factors and by an increase in the accumulation level of private capital, i.e., capitalist intensity.

Indeed, private capital accumulation was positive in all simulations, except for the public works and construction sector (F00), where a decrease of 0.2% was observed until the seventh year. Investments in the services sector resulted in a capital accumulation of between 1.5 and 1.2 percent.

DRAFT Publication

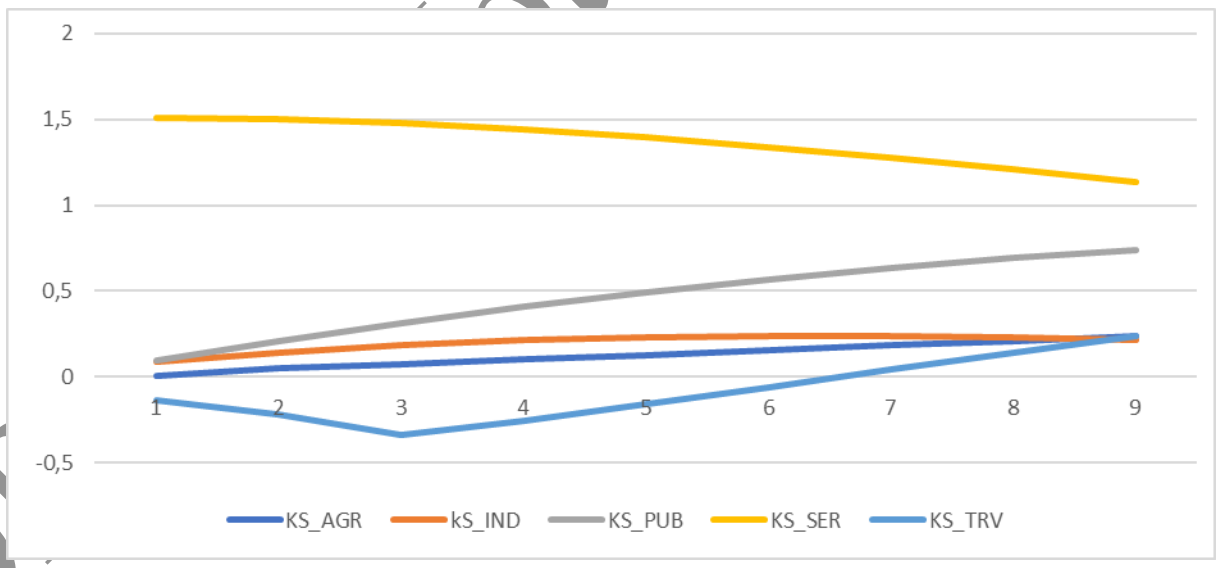
Public, industrial, and agricultural infrastructure generated private capital growth of 0.15%, 0.18%, and 0.57%, respectively. On the other hand, investments in public works and construction infrastructure did not stimulate capital accumulation but had a negative impact.

Figure 7 : Variation in % of private investment compared to BAU: debt financing



Source :GAMS Outpout.

Figure 8 : Variation in % of private capital compared to BAU



Source 1: GAMS Outpout.

Private investment also increased in all simulations from the first year, except public works infrastructure, which saw a decrease until the fourth year. In the long term, private investment has increased by 0.6% annually in the industrial sector, by 1% in the education, health, and

administration sectors, and by 0.5% in the agricultural sector. However, service infrastructure experienced an initial solid increase followed by a downward trend.

This result shows no elimination effect, except in the short term for public works from the first year. However, an eviction effect is observable for public works infrastructures until the fourth year.

The significant impact of industrial and service infrastructures on private investment during the first four years following their establishment should be highlighted, requiring periodic reinvestments to stimulate the momentum of private investment. On the contrary, the agricultural sector has shown remarkable stability over ten years, a situation attributable to the specific characteristics and wear and tear of the infrastructure concerned and their period of use. Furthermore, it is crucial to note that investment in industrial infrastructure has led to a significant increase in GDP and a moderate growth in private capital, demonstrating the effective use of capital that produces significant returns in this sector. The same trend is also visible in the agricultural sector. However, despite accumulating significant capital, services-related infrastructures, including those associated with public administration, health, and education, have yet to reach the industrial sector's growth level.

Generally, investment comes from the sum of the savings of the economic agents of a nation. In this analysis, we look at the impact of domestic credit-funded investments, which make financial resources shorter or more expensive, encouraging companies to turn to their savings. From a macroeconomic point of view, if investments prove to be profitable, they will generate revenue, which, in turn, will fuel savings and contribute to the financing of new investment projects. As a result, selecting profitable investments is a significant choice for public policy to improve national savings and, consequently, project financing.

Effect on the income of households

Household incomes increased in all simulations as early as the second year, except service infrastructures, which registered an initial increase of 0.4 percent before stabilizing at 0.36 percent. The case of agricultural infrastructure is distinguished by an average annual growth rate of 0.6%, the highest rate observed. Similarly, industrial infrastructure has shown an annual growth rate of 0.5%, and education and health infrastructure increased by 0.4 percent, while public works and construction increased more modestly by 0.21 percent.

DRAFT. Not for publication

For firms, education, health, and administration infrastructures significantly impact their income, with an increase of 1.6%. In the first year, the services and industry sectors saw income growth of 1.7% and 1.8%, respectively. However, after having suffered an initial negative impact, public works and construction infrastructure show a positive effect from the fourth year, with a boost of up to 3.5%. These results show that the private investment trajectory follows corporate revenue. This suggests that private investment is linked to corporate income through savings[23].

Figure 9 : Variation in % of household income compared to BAU

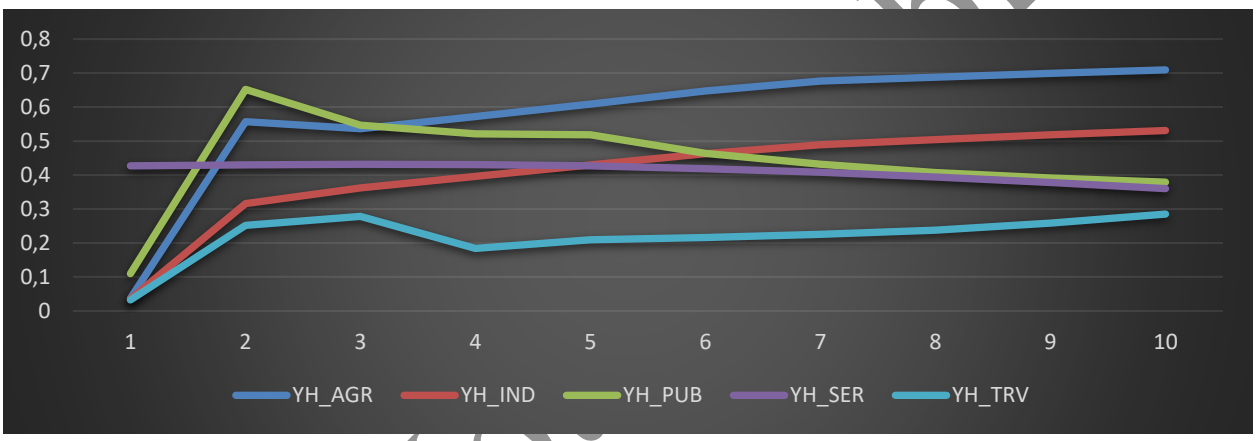
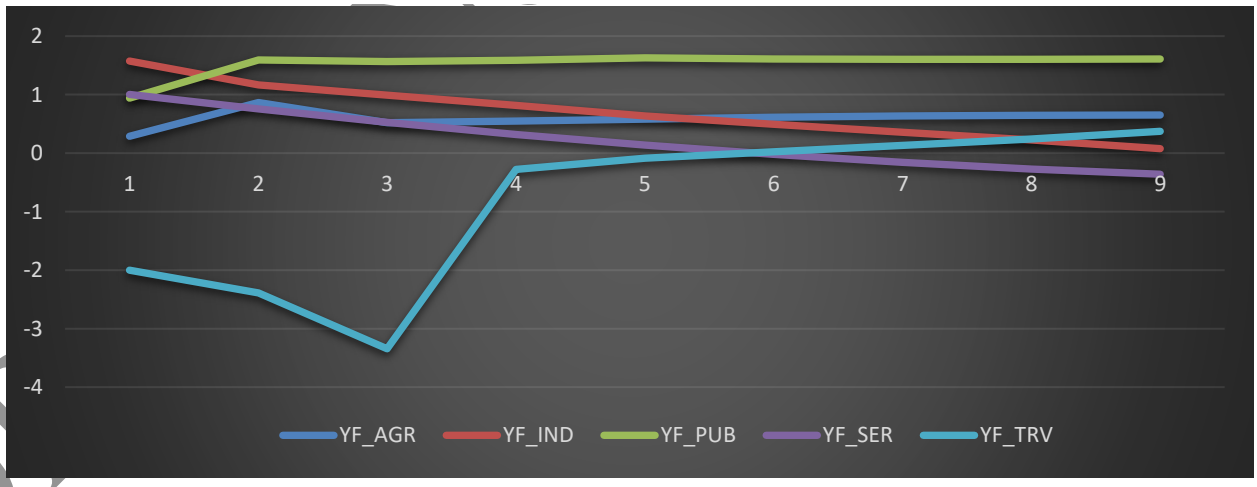


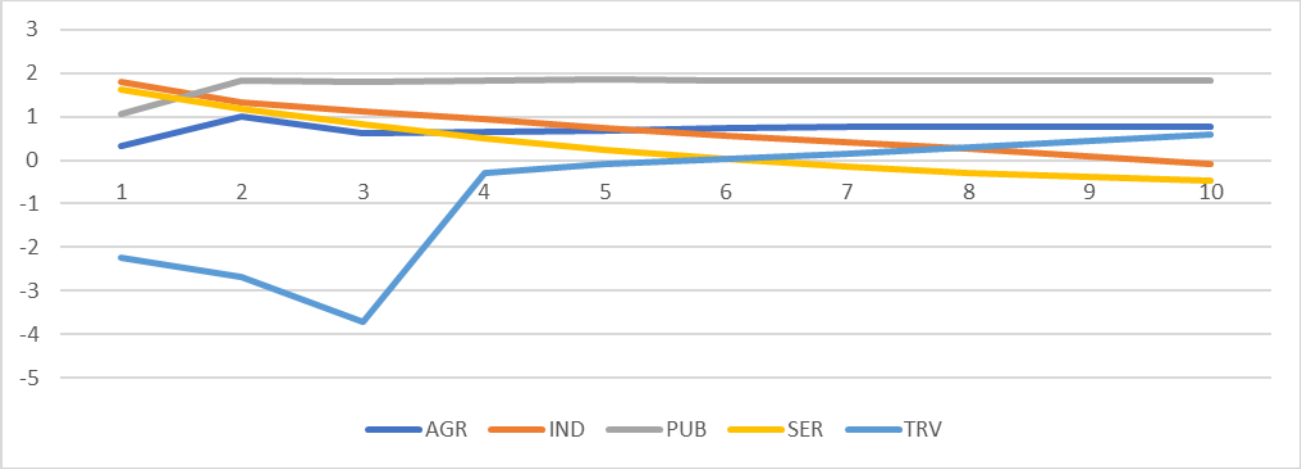
Figure 10: Variation in % of firms' income compared to BAU



[23] According to the figure, Capital remuneration plays an essential role in the income structure of firms.

Draft Publication

Figure 11: Variation in % of capital income paid to firms compared to BAU.



Source: GAMS Outpout.

Sectoral effects

An in-depth understanding of the impact on economic growth requires a case-by-case analysis of capital remuneration rates, added value, and overall productivity factors.

Increased public investment in all types of infrastructure increases the total productivity of factors across production sectors, leading to increased value-added in those sectors.

The figure illustrates that, due to new investments in various types of infrastructure, the majority of industrial and service sectors are experiencing a significant increase in productivity over time. It is also observed that the trajectory of productivity is going upward from the second year, a post-infrastructure period, as the externalities of most of these infrastructures begin to manifest after their implementation. This growth continued until the sixth year when a period of stability began. This may indicate that the sectors concerned have reached a threshold of efficiency or are facing challenges, such as capital depreciation, slowing down their productivity progress.

This trend reflects an increase in the rate of return on capital. The following table illustrates how agricultural infrastructure has generated a significant increase in capital in the agricultural sector in the short and long term, as well as in other industrial sectors, such as CA0 and CF0, and the services sector. (G00). Industrial infrastructure has positively impacted most sectors, such as agriculture and industry, making industrial capital yields more profitable in the long term. It should be noted that, in the case of social infrastructure, capital returns have increased in most sectors in the short term but have become less profitable in the long term. Investment in such infrastructure could lower the yield rate in this public sector. Service infrastructures have positively impacted

DRAFT - Not for publication

capital yields in the services sector and industries. On the other hand, the impact could have been more beneficial in the long term in the case of public works and construction infrastructure.

Here are some critical remarks to highlight:

We see that the results are immediately consistent with the agricultural and industrial sectors. The simulation shows that the accumulation of capital is remarkable in the services sector. In addition, the fluctuation in corporate capital income is less pronounced in the industrial sector, suggesting that the rate of return on capital is significantly increasing in the short term (up to 2.62 percent), followed by a more modest change in the long term.

The second point concerns public works infrastructures. Although they have increased, they do not significantly impact long-term capital income. On the other hand, industry, which has contributed modestly to the accumulation of capital, has been able to generate short-term gains and is continuing its upward trend.

Tableau 6: Capital returns by sector (short-term and long-term % variation compared to BAU)

	AGR		IND		PUB		SER		TRV	
	CT	LT	CT	LT	CT	LT	CT	LT	CT	LT
A00	**2,36**	**1,00**	0,80	7,72	0,96	-2,26	2,28	7,80	-11,40	0,10
A05	**2,30**	**2,10**	1,80	7,70	0,90	-2,20	1,00	1,80	10,0	18,0
B00	0,07	0,10	**1,07**	**0,44**	0,18	-0,12	0,10	0,19	0,45	-0,48
CA0	3,18	1,25	**2,33**	**2,27**	0,96	0,41	0,71	-0,62	2,03	-3,53
CB0	0,10	0,24	**0,16**	**1,55**	-0,26	-0,08	1,29	0,03	0,23	-0,52
CC0	0,55	0,69	**0,66**	**1,07**	0,39	0,04	2,04	0,21	2,45	-0,56
CDE	-0,11	0,01	**-0,08**	**1,50**	-0,15	-0,25	-0,10	0,14	0,03	-0,70
CF0	1,46	1,15	**0,18**	**1,45**	0,15	-0,12	2,11	0,44	-1,93	-1,09
CG0	0,65	0,57	**0,89**	**0,40**	1,98	-0,16	1,09	0,63	5,20	-1,48
CH0	0,10	0,28	**1,41**	**1,58**	0,30	-0,06	2,01	0,12	2,11	-0,59
CK0	0,07	0,13	**0,24**	**1,42**	0,29	-0,13	2,07	0,07	1,27	-0,74
CJL	-0,24	-0,18	**1,02**	**-1,92**	-0,08	-0,23	1,12	-0,16	0,00	-1,26
CIM	0,16	0,34	**0,50**	**0,67**	0,59	-0,05	1,14	0,16	2,78	-0,49
DE0	0,78	0,65	**0,14**	**0,92**	0,41	-0,11	1,42	0,24	-0,01	-0,86
F00	0,55	0,32	1,06	0,43	3,02	-0,16	1,79	0,45	6,77	-2,07

DRAFT. Not for publication

G00	1,36	1,20	-0,18	1,16	1,40	-0,30	**1,45**	**1,32**	1,07	-0,63
H00	0,18	0,36	0,17	0,78	0,09	0,06	**1,16**	**0,17**	0,69	-0,31
I00	1,34	1,25	0,49	1,20	0,11	0,06	**1,19**	**0,08**	0,48	-0,58
J00	0,52	0,50	0,10	0,71	0,09	0,11	**1,08**	**0,42**	-0,09	-0,38
K00	0,90	0,89	0,23	1,25	0,11	-0,03	**2,09**	**0,59**	0,18	-0,15
L68	0,60	0,41	0,49	-0,03	0,78	-0,13	**2,62**	**-0,68**	1,56	-2,35
MN0	0,26	0,48	0,35	0,93	0,11	0,00	**2,13**	**0,16**	1,44	-0,20
O84	0,30	1,61	-0,01	-0,19	**0,19**	**0,00**	2,19	-0,05	-7,02	-3,06
PQ8	1,96	1,46	0,05	0,05	**-0,01**	**-0,05**	2,01	-0,11	-5,75	-2,32
RS0	0,14	0,25	0,08	-2,26	0,05	-0,04	-0,09	-1,20	-2,41	-2,59

Source GAMS Outpout.

New infrastructure development and improved input productivity have been shown to have a significant value-added impact. Indeed, agricultural infrastructure has a positive effect in all sectors, with remarkable performance in the agriculture and fisheries sector (3%), which stands out significantly from other sectors (1%).

In terms of investment in industrial infrastructure, the manufacturing of electrical equipment, transportation equipment, and chemicals sectors benefit most from this investment, with increases of 3.8 percent, 3.2 percent, and 2.9 percent, respectively. The real estate sector, as well as the R&D and construction sectors, follow closely. Overall, all sectors have benefited from improvement.

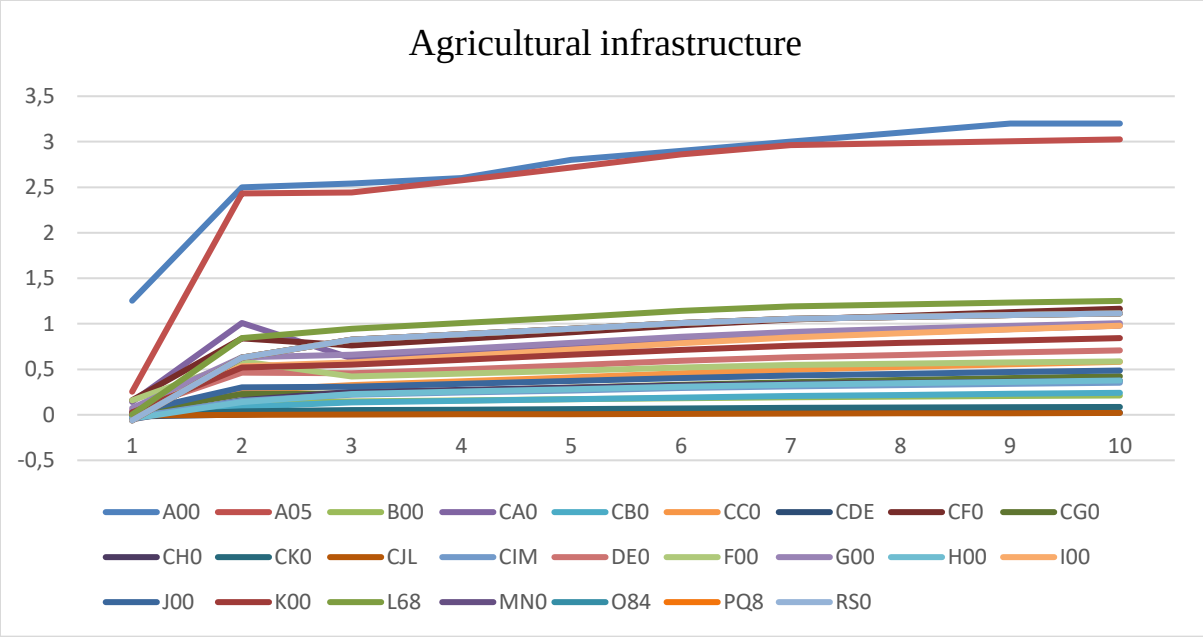
Regarding the development of social infrastructure, there was a positive impact of about 1% on most sectors for two consecutive years, during which the added value of the construction sector increased by 3% before redistributing that benefit to other sectors.

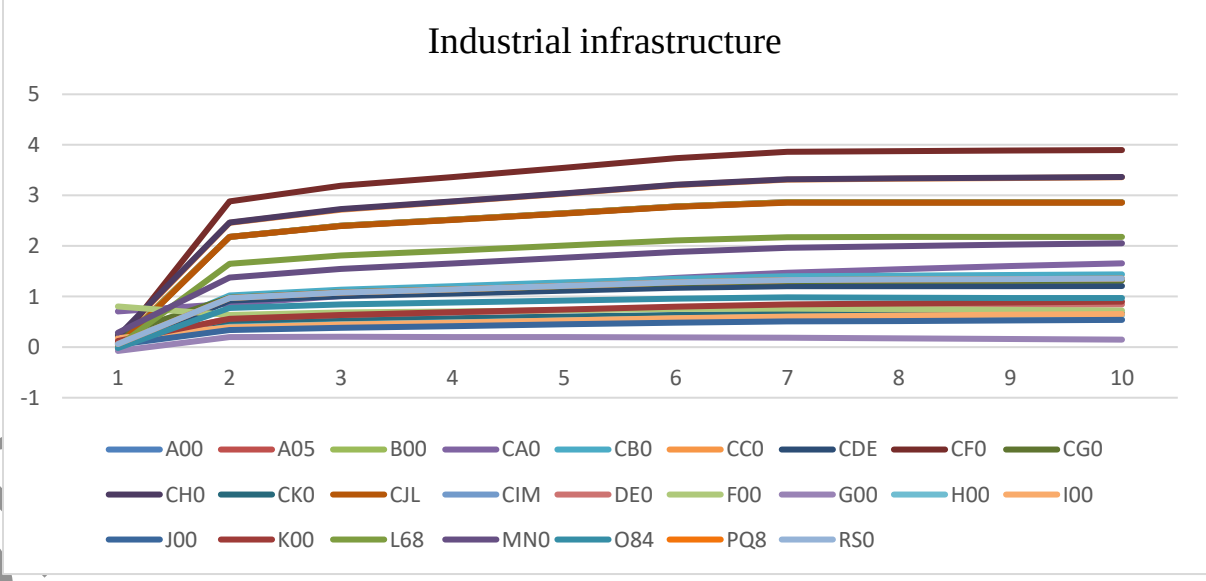
In terms of services and telecommunications infrastructure, the agriculture and fisheries sector and the construction sector made the most progress during the first three years, while the other sectors have seen an improvement of about 1%.

For infrastructure related to public works and construction, the increase in added value ranges from 4% to 1%, with a trend of stability throughout the period under review. It is very interesting to note that, even in the simulation for this construction sector, the added value grew sharply, reaching up to 10%, but only for the first two years.

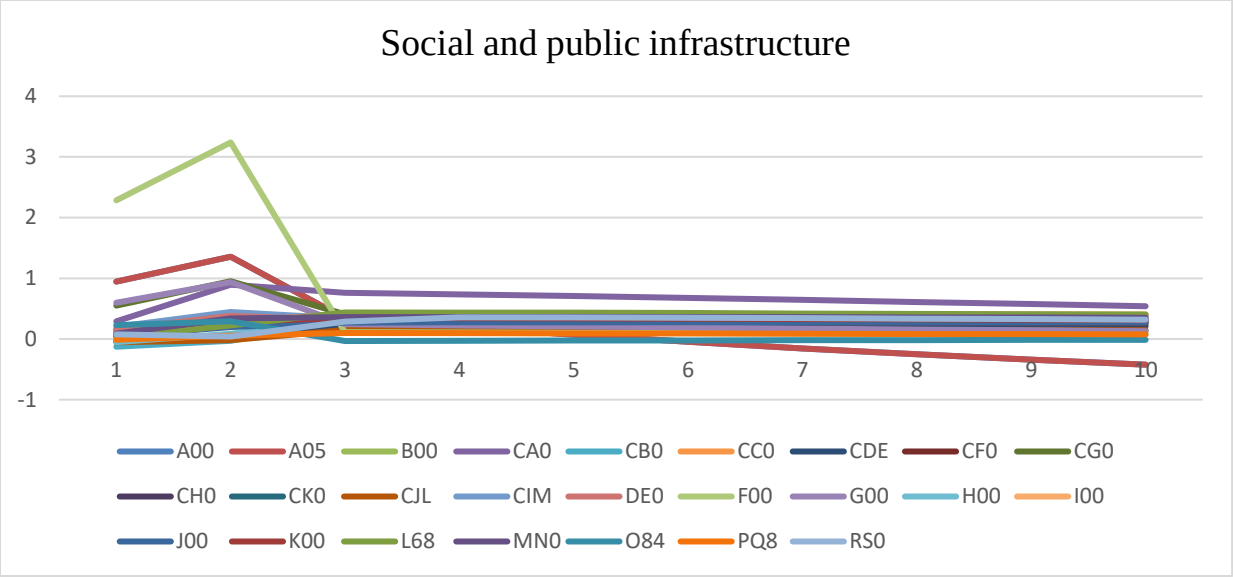
DRAFT: Not for publication

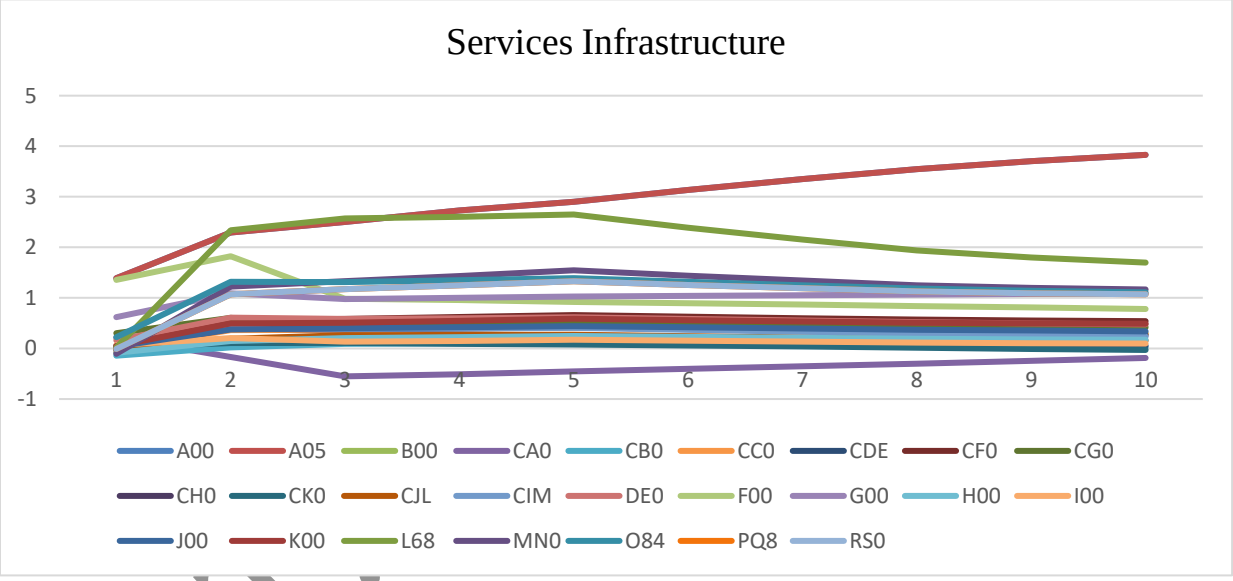
By analyzing the value-added trajectory across all the simulations and comparing the most responsive investments to the change in the overall productivity of the factors, we identify industry and agriculture as key sectors. For social infrastructure and construction, the reaction was noticeable only during the first three years, while in the services sector, the impact lasted until the sixth year.



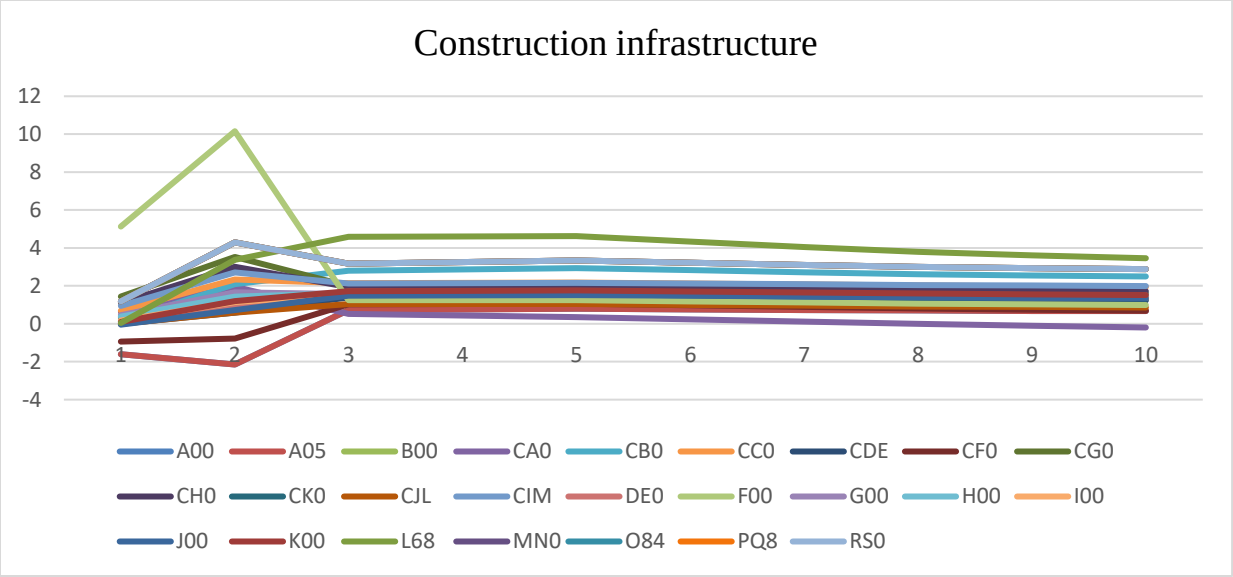


Discussion


Social and public infrastructure
4
3
2
1
0
-1
1
2
3
4
5
6
7
8
9
10
A00
A05
B00
CA0
CB0
CC0
CDE
CF0
CG0
CH0
CK0
CJL
CIM
DE0
F00
G00
H00
I00
J00
K00
L68
MN0
O84
PQ8
RS0


Services Infrastructure
5
4
3
2
1
0
-1
1
2
3
4
5
6
7
8
9
10
A00
A05
B00
CA0
CB0
CC0
CDE
CF0
CG0
CH0
CK0
CJL
CIM
DE0
F00
G00
H00
I00
J00
K00
L68
MN0
O84
PQ8
RS0

DRAFT



Effects on job demand

We have made some changes to the model, including addressing unemployment. Indeed, improved productivity stimulates demand for capital and, consequently, increases demand for labor.

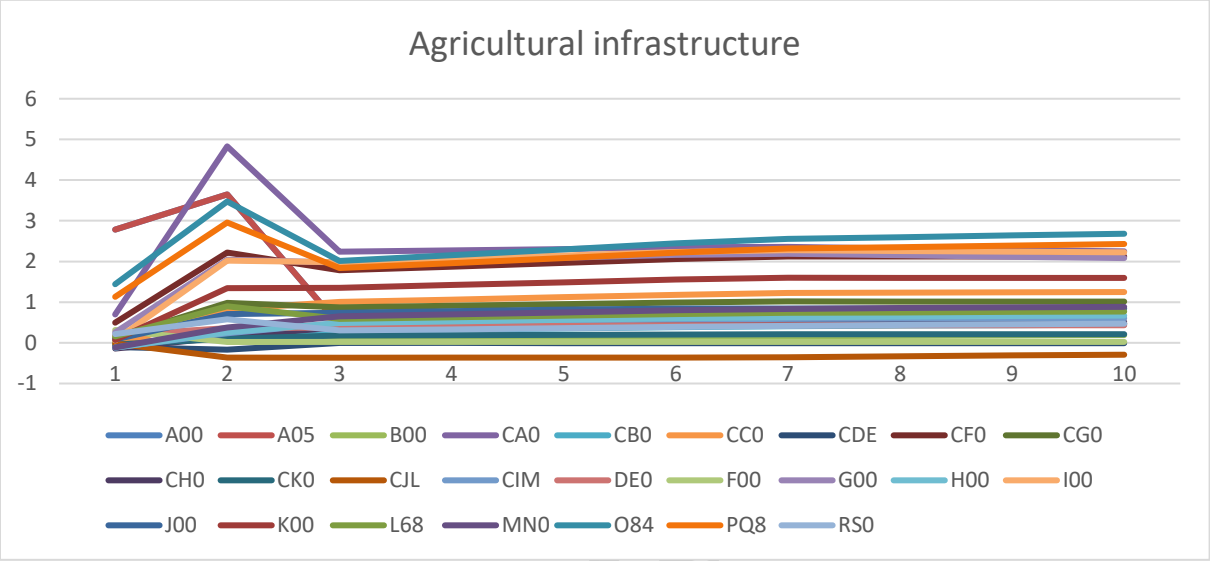
Work demand increased in all sectors during the first two years, at rates ranging from 5% to 1%, before stabilizing at 1%. The most beneficial sectors are agriculture, food manufacturing, education, health, public administration, financial and insurance activities, and pharmaceutical manufacturing.

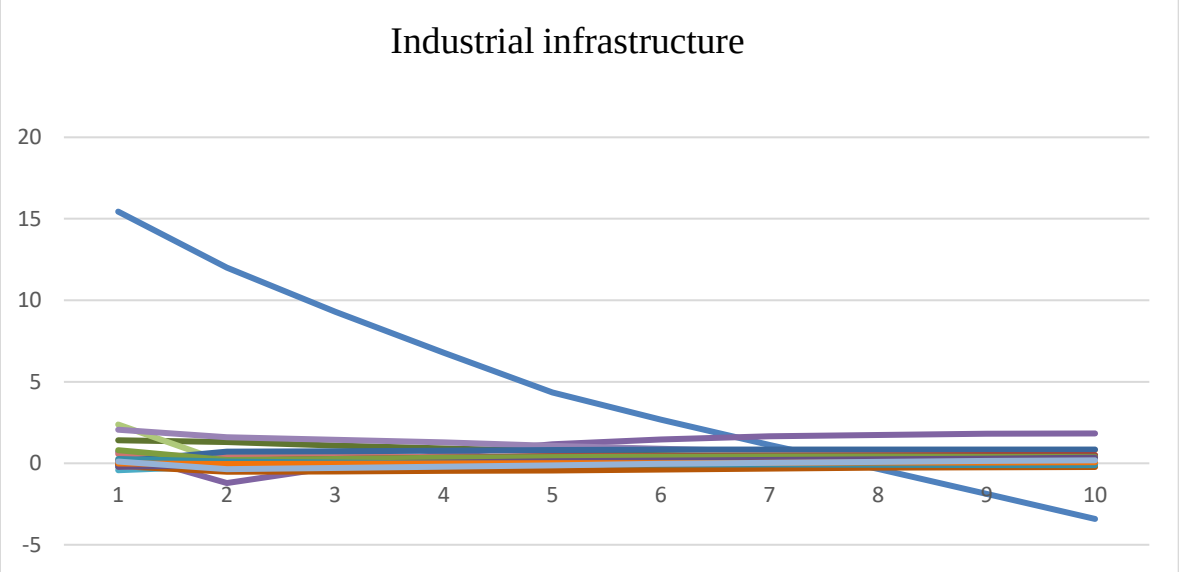
Agricultural infrastructure stimulates job demand in most sectors. We also see a strong increase in labor demand in the agricultural sector, which is consistent with our observations in the first section that this sector has a low capitalist intensity and that any capital injection necessarily generates an increase in labor demand.

Social infrastructure is strongly correlated with health and education services, requiring the mobilization of human resources for any increase in such infrastructure. The results show that the education and public administration sectors grew sharply by 10 percent yearly, while the other sectors experienced growth from 1 to 4 percent.

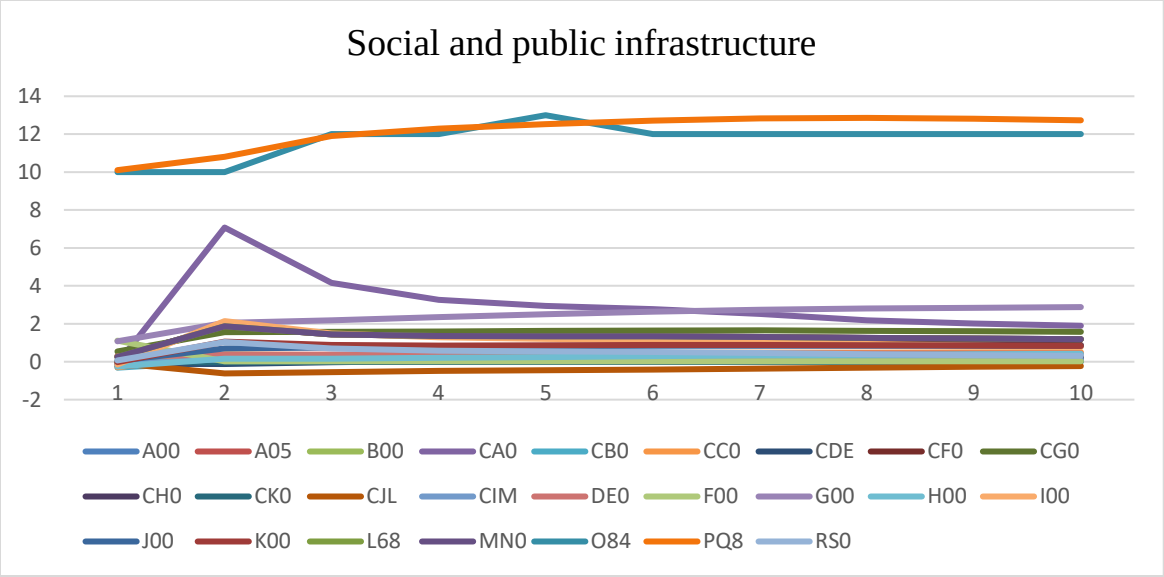
DRAFT - Not for publication

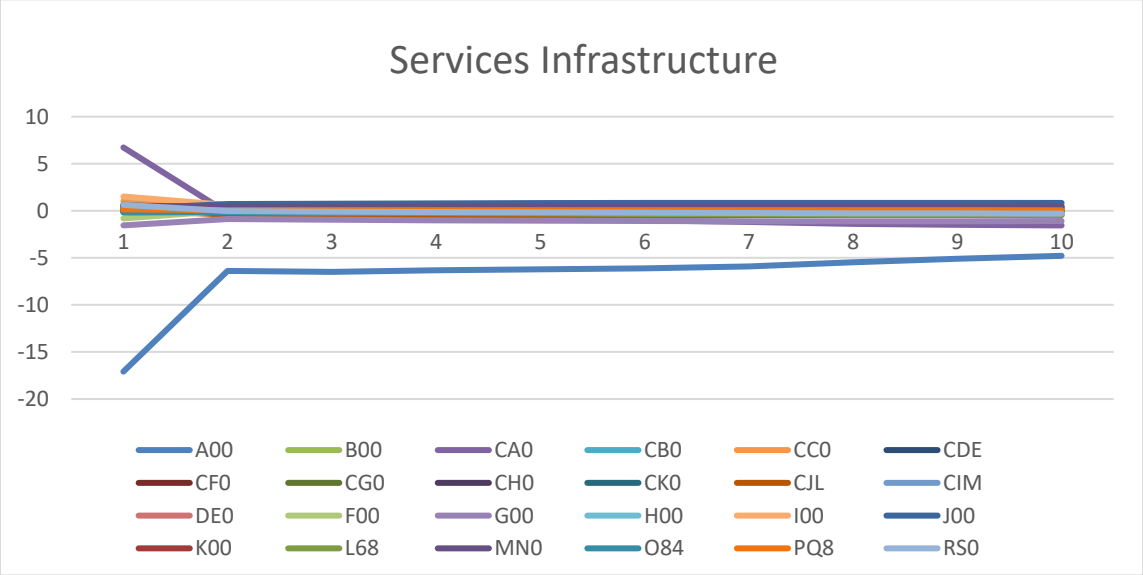
Service infrastructure and public works did not generate more jobs than in the other cases studied. We note that the agricultural sector has deteriorated throughout the simulation period for services and during the first three years for public works, while the results indicate a slight increase for the other sectors.



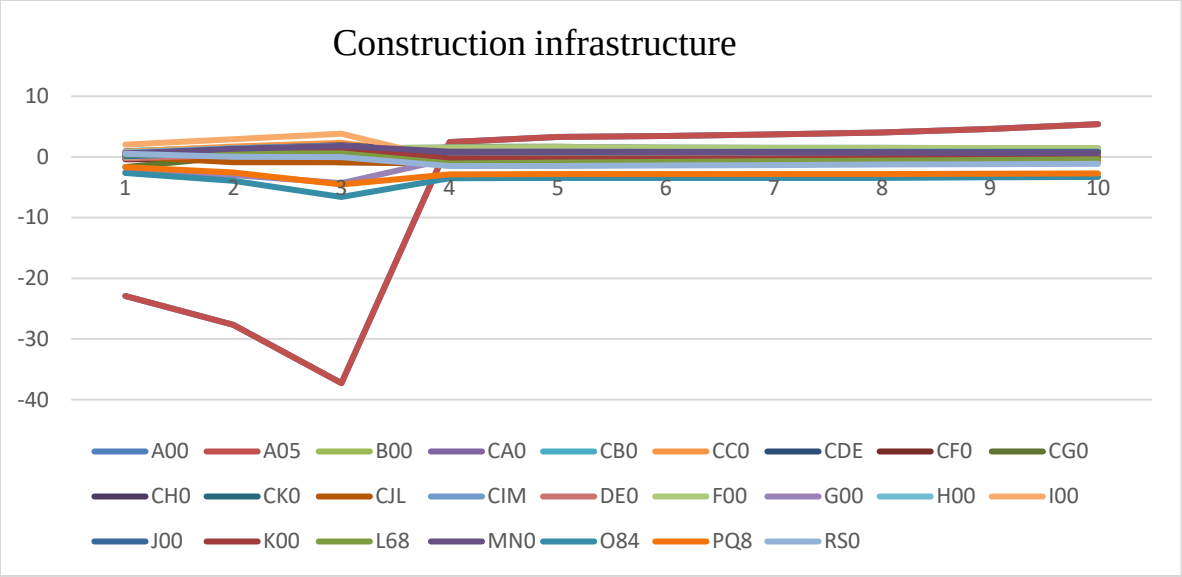


Draft version





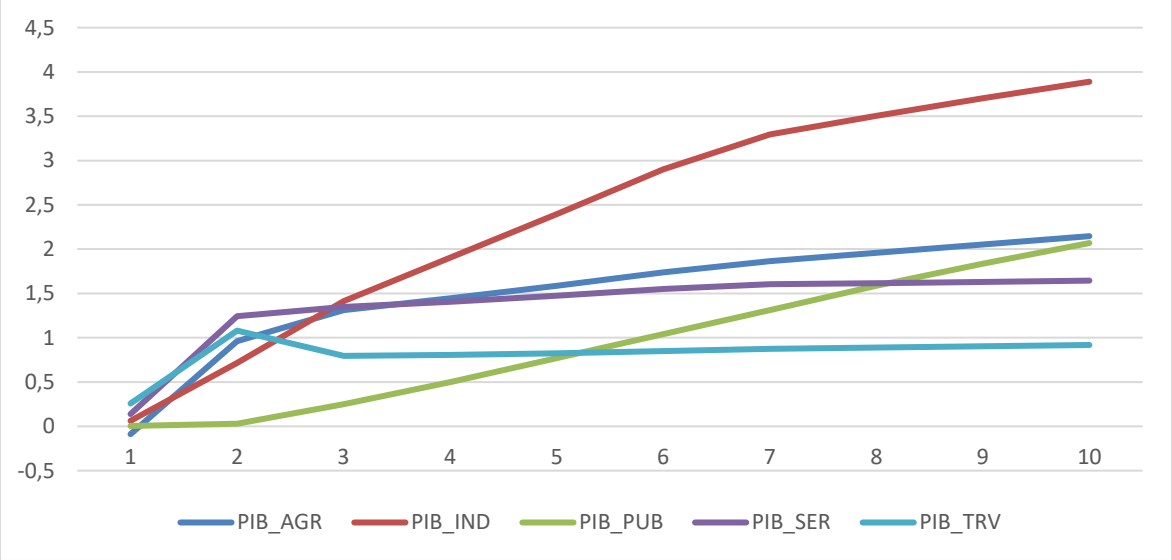
DRAFT for consultation



Source : Sortie GAMS.

Second scenario

Figure 12 : Variation in % of GDP compared to the benchmark situation: financing from the production tax.



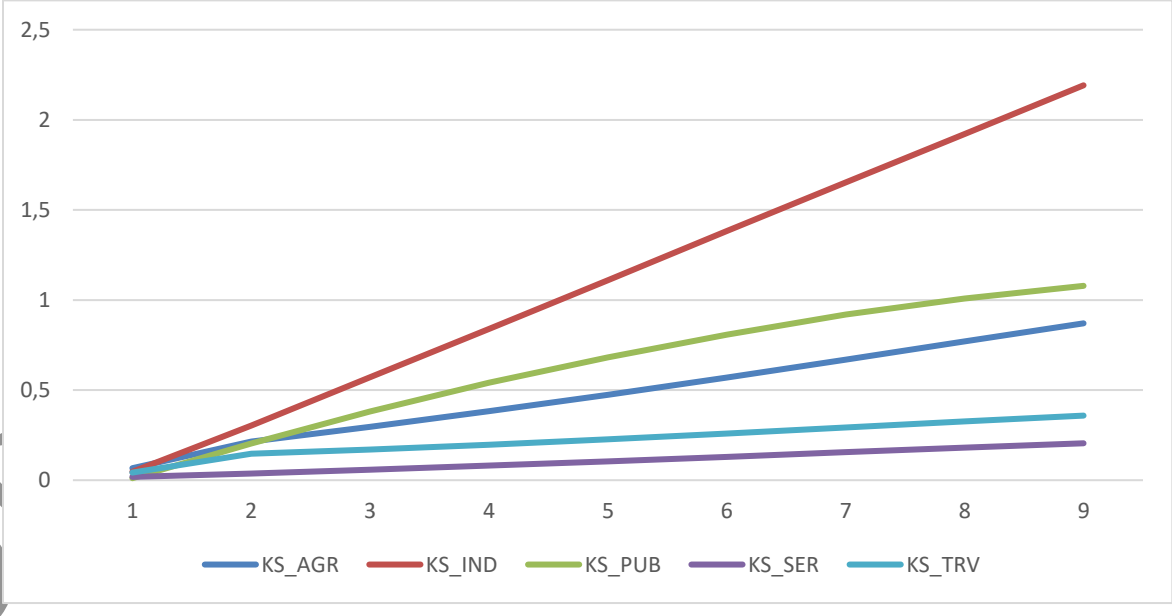
Simulations conducted on various types of infrastructure financed by an additional tax on production reveal various effects on economic growth. Starting in the second year, social infrastructure-related economic growth is accelerating, with a steady growth rate of 1% per year. At the same time, industrial infrastructure is increasing GDP by 0.8% in the short term and 1.6% in the long term, illustrating its influential role in supporting sustainable economic growth. After

an initial decline of 0.05% of GDP, agriculture is rebounding and following a growth trajectory similar to that of industry. In terms of services infrastructure, it has experienced a growth of 0.8% of GDP in the short term, similar to that of industry, but then its growth has become more moderate, reaching 1.3% in the long term as early as the third year. Finally, the construction sector has seen more moderate growth, with an initial growth of 1% of GDP, followed by a slowdown to 0.5% in the third year, before stabilizing at 0.8%.

In the comparative analysis of the two modalities of project financing, investment in industrial infrastructure stands out as leading in terms of economic growth, benefiting more from tax financing than from debt. Regarding taxation, agricultural and social infrastructure projects are more profitable than debt-funded projects, following a similar growth trend in terms of overall productivity factors. This benefit also extends to service infrastructure. Furthermore, the financing of construction projects by taxation is considered more advantageous than debt, but only in the short term.

These observations highlight a significant correlation between the mode of financing and the effectiveness of investments in different infrastructure areas, explicitly highlighting the beneficial effect of debt financing on specific sectors, such as agricultural and social infrastructure.

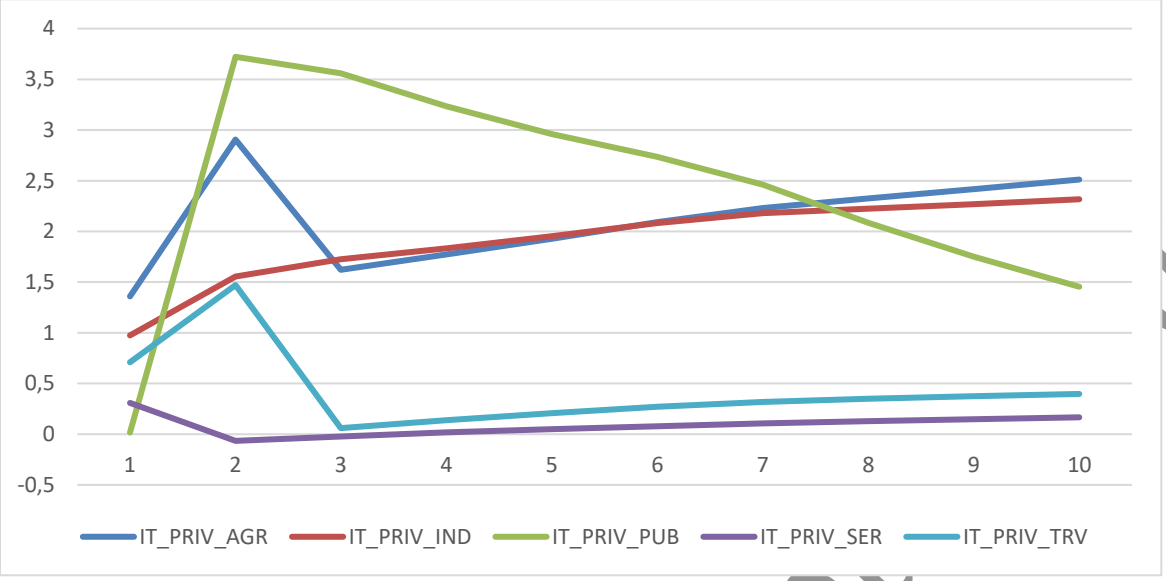
Figure 13: Variation in % of private capital compared to the benchmark situation.



Source GAMS Outpout .

Draft for publication

Figure.14 Variation in % of private investment compared to BAU: tax financing.



Source : GAMS Outpout .

Investment in social infrastructure has resulted in a significant increase in the investment rate, reaching 3.9% in the short term and 2% in the long term. Similarly, in the case of agriculture, initial investment led to growth of 3% in the short term, followed by an increase of 1.9% in the long term. Industry, on the other hand, grew by 2.5% in the short term and 2% in the long term, showing an upward trend similar to that observed in the case of agricultural infrastructure.

Investment in industrial and agricultural infrastructure has led to an increased accumulation of private capital, resulting in an upward trend for private investment despite a difference in capital accumulation. Investment in social infrastructure has resulted in a short-term increase in private investment, accompanied by an upward trend in capital accumulation. Service infrastructures have differences between results achieved through debt and taxation. In the first option, we observed that although capital accumulated well, it had little private investment. On the other hand, in the second option, capital accumulation follows a trajectory similar to accumulating total capital.

When comparing debt financing to tax financing, it is clear that investment rates are generally higher in the case of taxation. This raises the question of the impact of the degradation of national savings and taxes on investment-related output. This concern becomes apparent when looking at the income of economic actors.

DRAFT. Not for publication

In the first scenario, corporate income and savings trajectory correspond to private investment. However, the results of this scenario (taxation) indicate that corporate revenues follow a different path than private investment. This is because state indebtedness in the first option makes national savings financing more limited. On the contrary, in the taxation option, funding relies entirely on national savings, including that of the state, which means that public investment does not affect private investment through national savings. Unlike in the case of indebtedness, taxation generates additional income for the state to offset the tax burden, confirming that taxation does not have an eviction effect and does not deteriorate firms' savings.

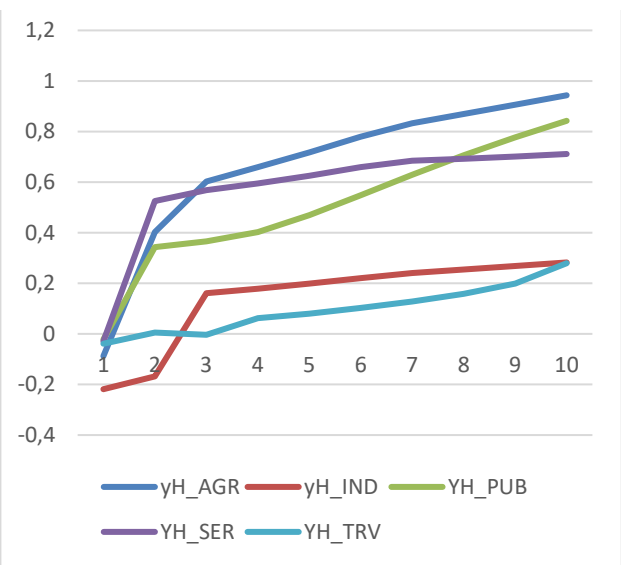
Increasing a production tax could negatively impact production prices and local prices, thereby affecting demand and consumption. However, if this increase is used to finance demand-driven projects, it could offset the adverse effects of the tax hike. It is also essential to consider the positive effects on supply, such as productivity gains that could boost production and factor remuneration rates.

This corresponds to what we observed in the simulation when comparing the two scenarios.

We observe the same interpretation for construction infrastructure, where business savings have been negative. This is mainly due to the low return on capital, especially in the debt-funding scenario, due to insufficient accumulation, which adds to the already low return. This dynamic will be discussed in more detail in the sectoral impact analysis.

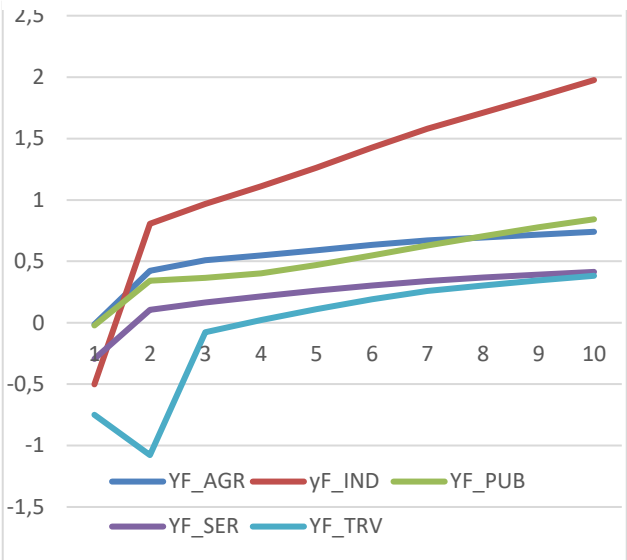
DRAFT : Not for publication

Figure.15 Variation in % of household income compared to the reference situation: case of tax financing



Source : GAMS Outpout.

Figure.16 Variation in % of firms' revenue compared to the benchmark situation: case of tax financing



Source :GAMS Outpout.

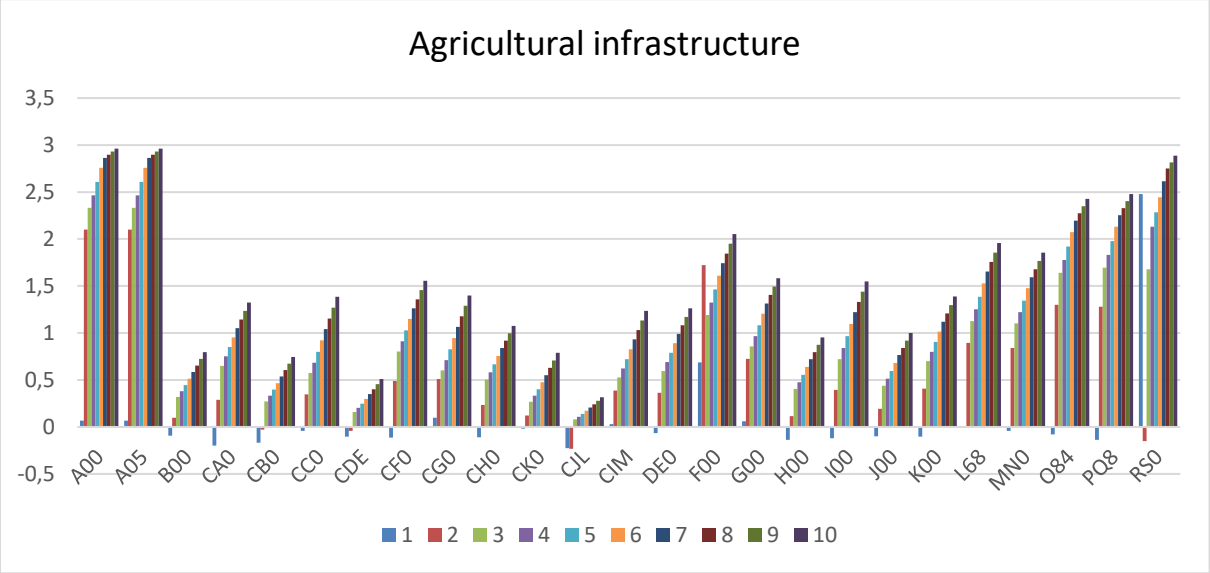
Tableau 7: the Return on Capital by Sector (short-term and long-term % variation compared to BAU): case of financing by production tax.

	AGR		IND		PUB		SER		TRV	
	CT	LT	CT	LT	CT	LT	CT	LT	CT	LT
A00	0,48	1,24	1,14	2,53	-0,03	1,49	-4,20	1,91	-3,56	2,97
A05	-5,45	1,67	-1,14	1,70	1,48	-8,43	-4,23	1,91	-3,77	-5,45
B00	-0,15	0,04	-0,37	2,15	-0,02	0,74	-0,06	0,22	-0,07	0,40
CA0	-0,66	0,92	-2,15	1,44	-0,03	1,31	1,45	0,00	6,45	-3,28
CB0	-0,34	0,02	-0,87	1,01	-0,03	0,55	0,17	0,11	0,82	-0,26
CC0	-0,15	0,73	-0,74	1,52	-0,01	1,01	0,30	0,26	1,16	-0,72
CDE	-0,37	0,35	-0,76	1,56	-0,02	0,25	-0,09	0,08	0,11	0,33
CF0	-0,23	0,80	-0,01	2,15	-0,03	0,53	-0,31	0,52	-1,18	1,05
CG0	0,35	0,88	-0,33	-2,12	0,01	1,36	0,22	0,33	0,82	-0,89
CH0	-0,21	0,24	-0,73	4,36	-0,03	0,90	0,14	0,13	0,65	-1,12
CK0	-0,06	0,04	-0,31	-0,87	-0,01	0,36	0,04	-0,04	0,22	-0,18
CJL	-0,34	0,53	-0,58	1,05	-0,05	0,59	-0,15	0,07	-0,27	-0,04
CIM	0,09	0,48	-0,29	4,64	0,00	0,89	0,21	0,03	0,70	-0,21
DE0	-0,17	0,43	-0,89	0,41	-0,02	0,41	0,23	0,41	0,99	0,42
F00	0,91	0,99	0,51	0,02	0,10	0,02	0,17	0,02	0,41	0,02
G00	0,14	1,04	-0,41	4,24	-0,01	1,74	-0,07	-0,61	-0,18	-0,25
H00	-0,25	0,19	-0,72	2,19	-0,03	1,79	0,16	-0,01	0,70	0,00

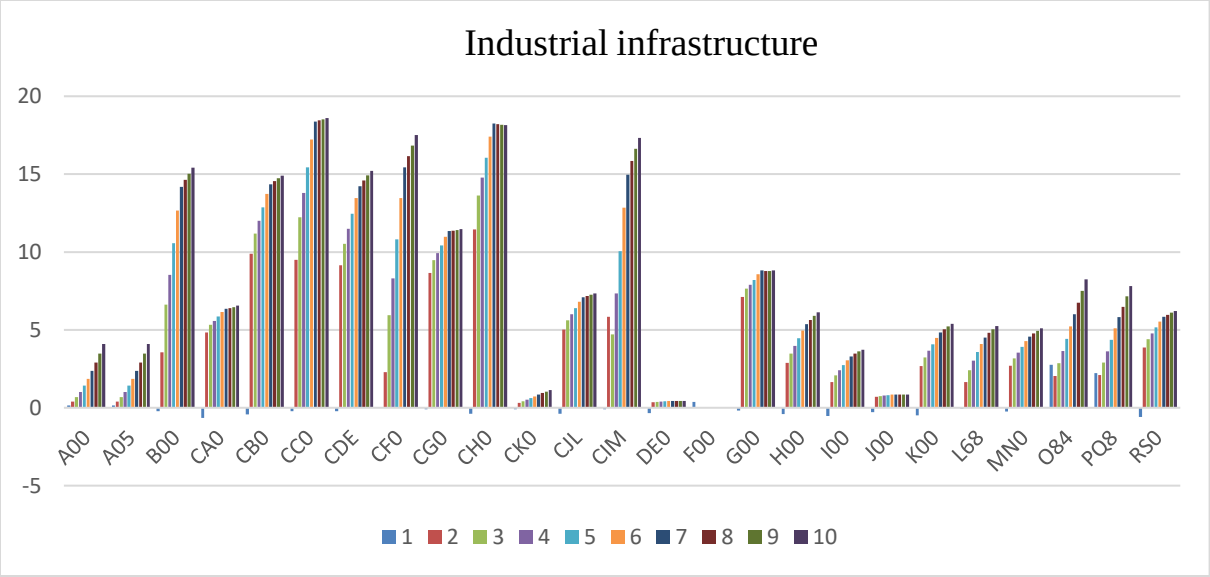
DRAFT. Not for ...on

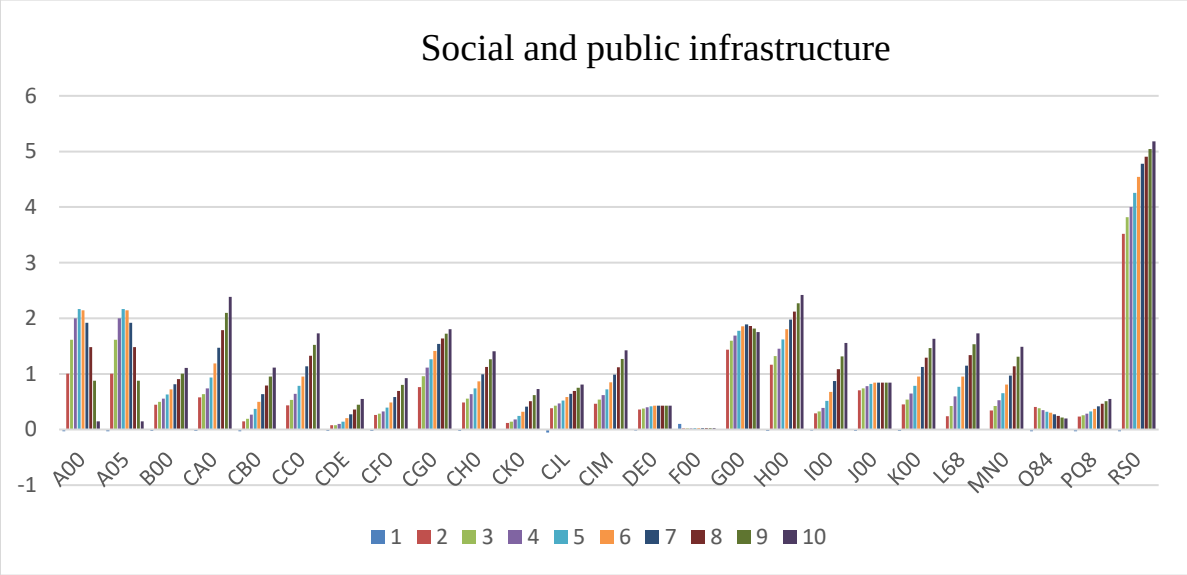
I00	-0,33	1,02	-1,47	0,78	-0,02	0,78	0,70	-0,27	2,81	-0,73
J00	-0,20	0,27	-0,59	0,81	-0,02	0,81	0,07	0,81	0,39	0,82
K00	-0,19	0,69	-0,92	1,88	-0,02	0,99	0,34	0,25	1,37	-0,25
L68	-0,15	0,22	-1,74	1,03	0,00	0,97	0,79	-0,20	3,15	-0,90
MN0	-0,05	0,47	-0,30	1,43	-0,01	0,85	0,17	0,30	0,56	-0,02
O84	-0,06	1,17	2,29	3,30	-0,03	0,30	-1,59	3,64	-6,42	0,40
PQ8	-0,10	1,10	1,69	2,89	-0,03	0,38	-1,17	2,67	-4,78	0,38
RS0	1,40	-0,06	-0,91	0,09	-0,03	4,45	0,30	-1,39	1,22	-0,30

Integrating public investment, perceived as a positive externality in the production function, initiates a significant increase in public capital accumulation, positively impacting overall productivity. This dynamic is directly manifested by increased production and added value in various economic sectors.

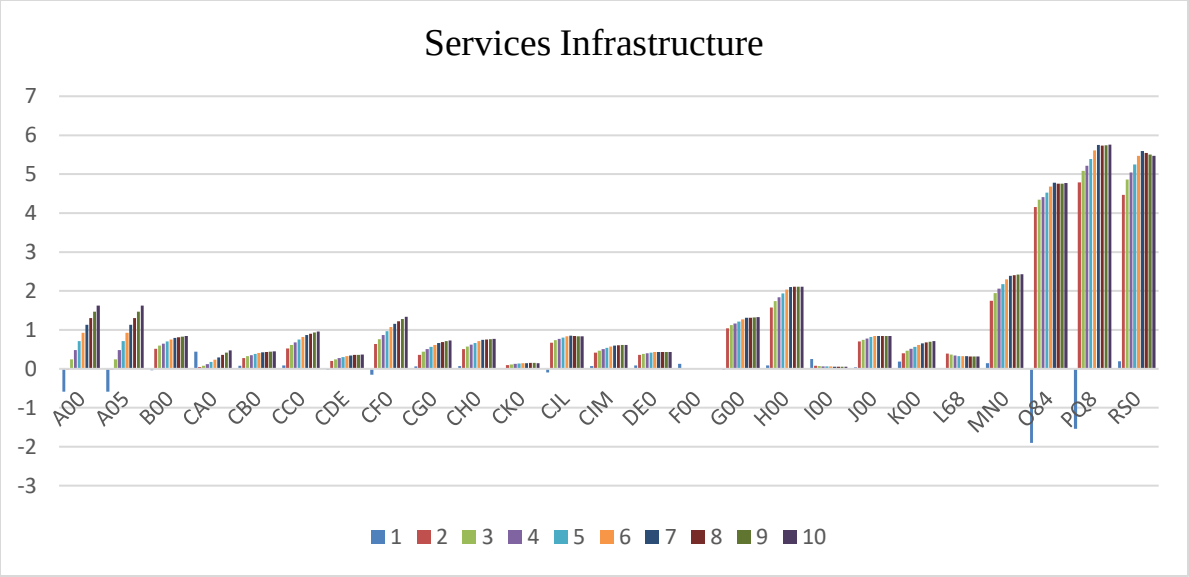


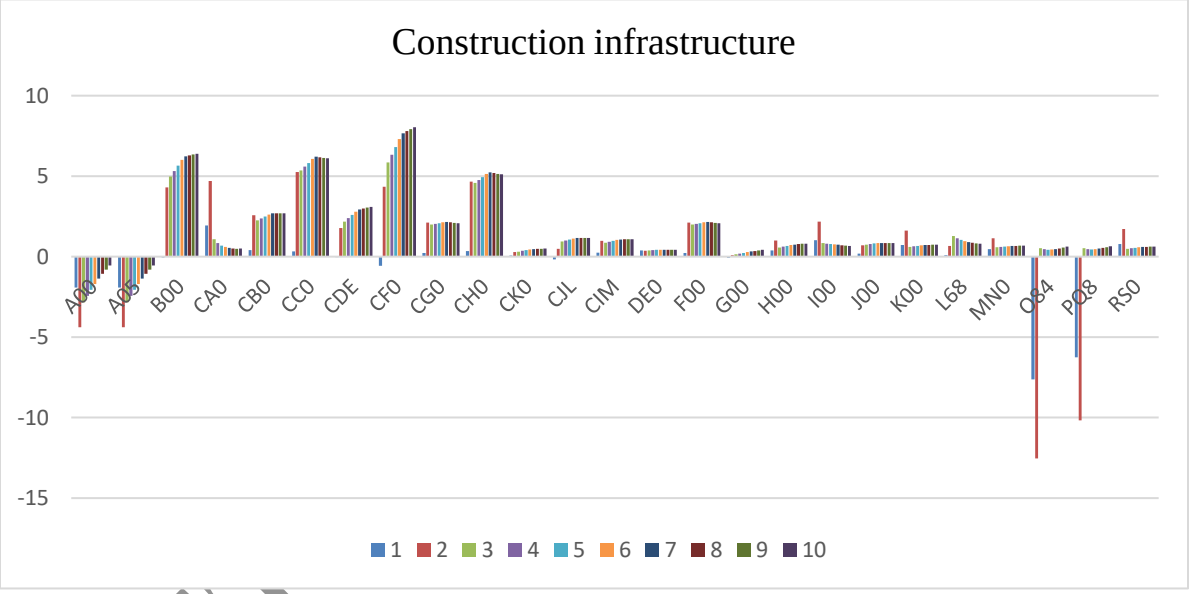
DRAFT Publication


Industrial infrastructure
20
15
10
5
0
-5
A00
A05
B00
CA0
CB0
CC0
CDE
CF0
CG0
CH0
CK0
CJL
CIM
DE0
F00
G00
H00
I00
J00
K00
L68
MN0
O84
PQ8
RS0
1 2 3 4 5 6 7 8 9 10


Social and public infrastructure
6
5
4
3
2
1
0
-1
A00
A05
B00
CA0
CB0
CC0
CDE
CF0
CG0
CH0
CK0
CJL
CIM
DE0
F00
G00
H00
I00
J00
K00
L68
MN0
O84
PQ8
RS0
1 2 3 4 5 6 7 8 9 10

DRAFT





Source : Sortie GAMS.

Indeed, compared to a reference scenario, value-added increases in most sectors, based on five distinct simulations. More specifically, investment in agricultural infrastructure, funded by the production tax, generates an increase in value added in the agricultural and fisheries sectors of 3% in the long term. They also stimulate added value in all industries, including food production (+1.5%), as well as in the construction sector (+2%), not to mention a significant expansion of

DRAFT

services (+2.9%). This development results from the capital accumulation effect and illustrates the multiplier impact of public investment on the economy.

Furthermore, industrial infrastructure is seeing significant growth compared to the reference scenario in the context of debt financing. This growth extends to all sectors, including manufacturing (+20%), including the manufacturing of computers, electrical appliances, electrical equipment and machinery manufacturing, agricultural activities (+5%), and the services sector (+5%). The expansion of social infrastructure and services also contributes to a general improvement in the economy, characterized by stability over time due in part to a slowdown in capital accumulation.

The public works sector also significantly improved the industrial sector (8%) and the services sector (2%). However, it has hurt agricultural activities (-1%) and education, health, and public administration (-1%).

Tax financing does not differ from debt in terms of trajectory or impact on the sector. However, there is a difference in rates: those associated with the tax scenario are more attractive than those associated with the funding scenario. We also add another element: in the case of tax-funded industrial infrastructure, a positive impact is generated in all sectors. This creates a dynamic that encourages private investment and capital accumulation, although the return on capital is slowing initially. On the other hand, public works infrastructures show only a short-term increase in yield rates and do not affect all sectors of activity, including their sector.

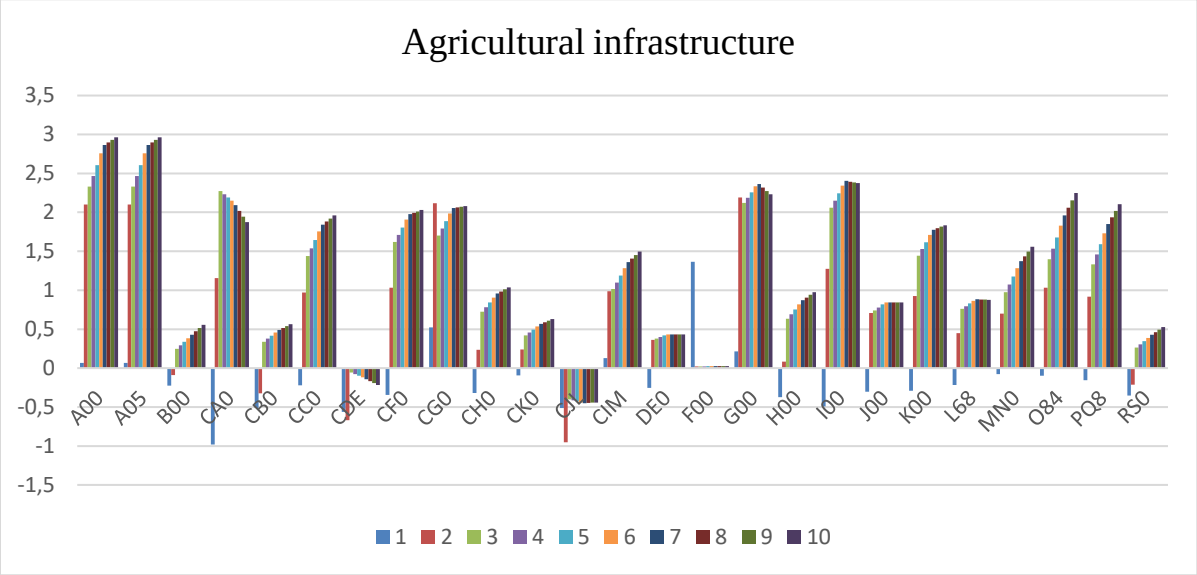
On the other hand, the increase in added value causes a slight additional mobilization of production factors. Indeed, the demand for labor in the simulation of agricultural infrastructure is growing, on average, by 0.8% in the long term for

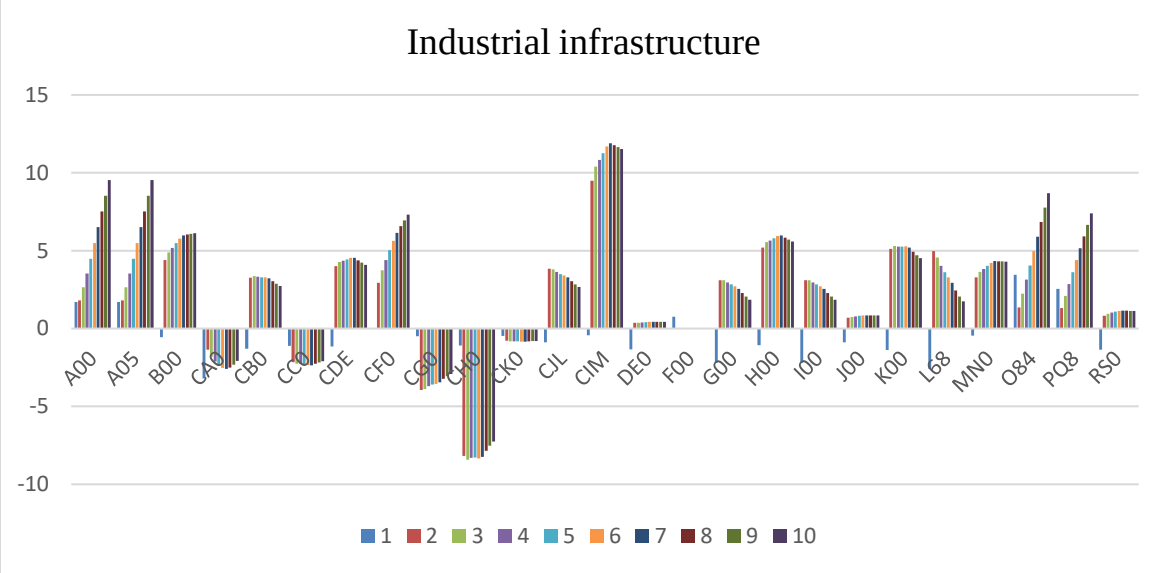
Agricultural infrastructure stimulates job demand in most sectors, except in some industries.

Regarding social infrastructure, the results show that the education and public administration sectors grew sharply by 3% each year instead of 10% in the debt scenario, while the other sectors experienced a similar 3% growth in debt.

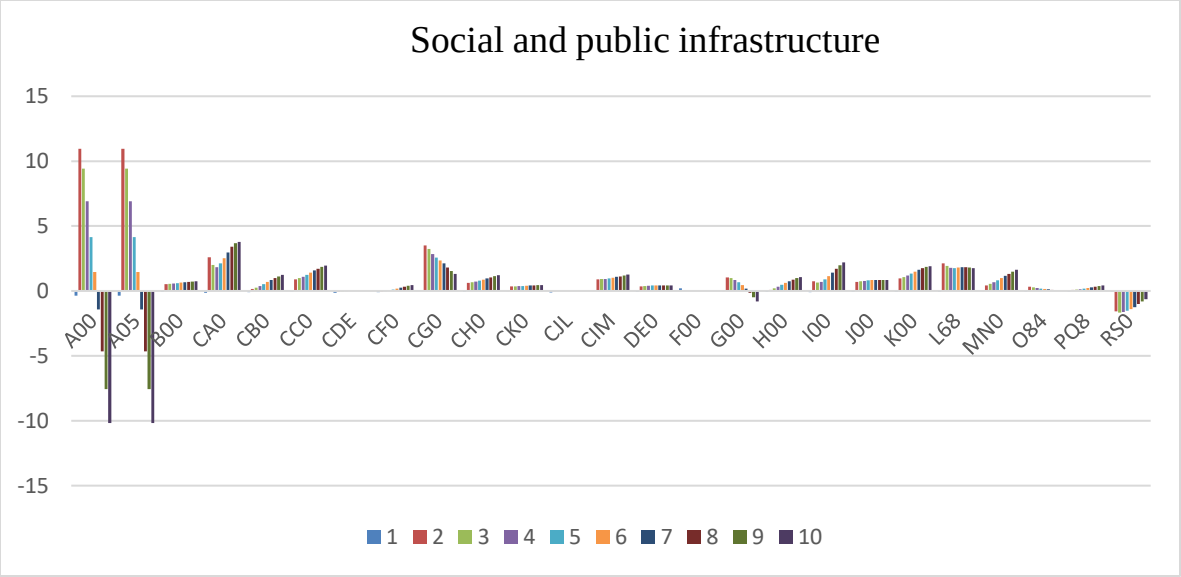
Services infrastructure and public works did not generate more jobs in the debt scenario, but in this case, they recorded high rates in the services sector.

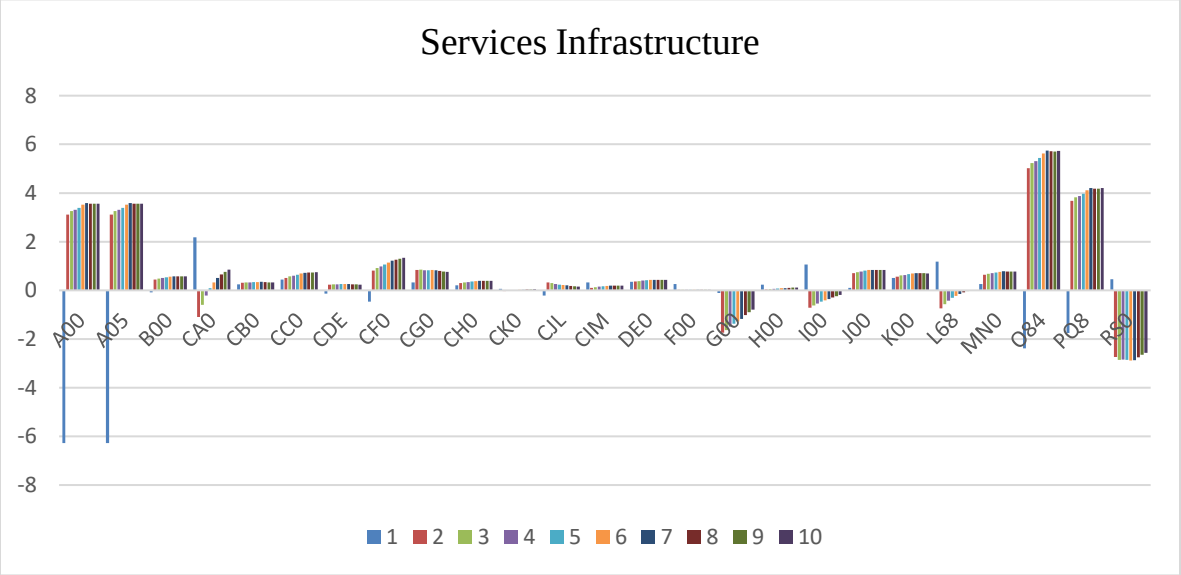
DRAFT. Not for publication


Agricultural infrastructure
3,5
3
2,5
2
1,5
1
0,5
0
-0,5
-1
-1,5
A00 A05 B00 CA0 CB0 CC0 CDE CF0 CG0 CH0 CK0 CJL CIM DE0 F00 G00 H00 I00 J00 K00 L68 MN0 O84 PQ8 RS0
1 2 3 4 5 6 7 8 9 10

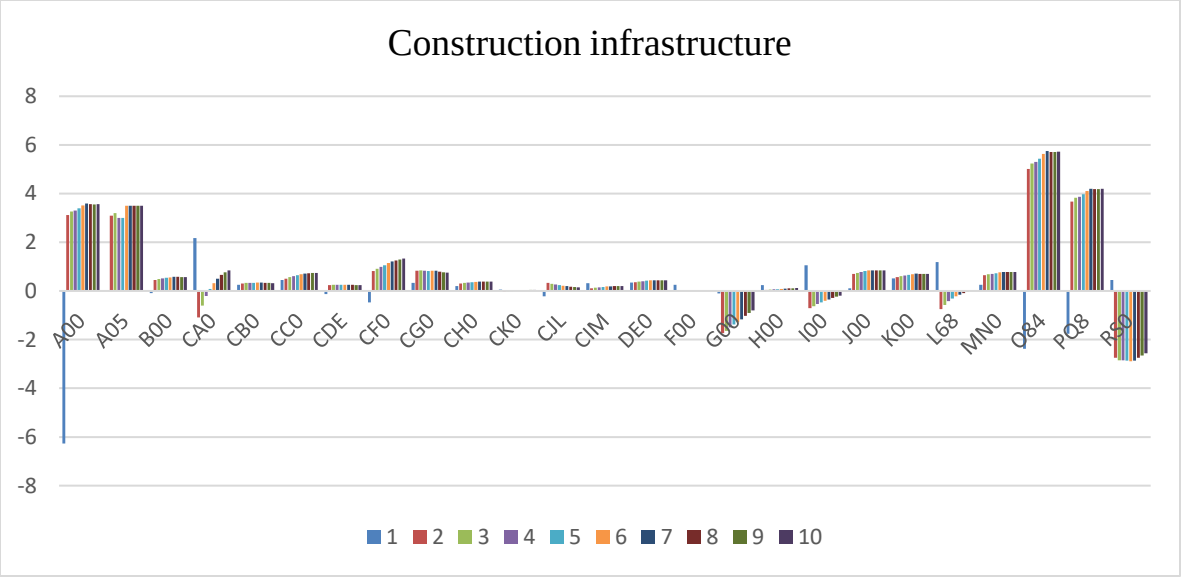

Industrial infrastructure
15
10
5
0
-5
-10
A00 A05 B00 CA0 CB0 CC0 CDE CF0 CG0 CH0 CK0 CJL CIM DE0 F00 G00 H00 I00 J00 K00 L68 MN0 O84 PQ8 RS0
1 2 3 4 5 6 7 8 9 10

DRAFT


Social and public infrastructure
15
10
5
0
-5
-10
-15
A00
A05
B00
CA0
CB0
CC0
CDE
CF0
CG0
CH0
CK0
CJL
CIM
DE0
F00
G00
H00
I00
J00
K00
L68
MN0
O84
PQ8
RS0
1 2 3 4 5 6 7 8 9 10


Services Infrastructure
8
6
4
2
0
-2
-4
-6
-8
A00
A05
B00
CA0
CB0
CC0
CDE
CF0
CG0
CH0
CK0
CJL
CIM
DE0
F00
G00
H00
I00
J00
K00
L68
MN0
O84
PQ8
RS0
1 2 3 4 5 6 7 8 9 10

DRAFT



Source : GAMS Outpout.

Conclusion

Based on the results of these simulations, which consist of increasing the public GFCF ratio to GDP by 10% for both funding scenarios, we can say that infrastructure is essential in improving productivity and boosting growth. This conclusion is supported by several theoretical schools and abundant literature dealing with the relationship between public investment or public capital and public expenditure on infrastructure. Among other things, there is extensive literature on this subject in Morocco. All economists confirm the importance of public capital, especially when the private sector is inadequate. In this work, we are attempting to continue the analysis of these findings, especially since Morocco has made significant infrastructure efforts since the 2000s. This has prompted us to evaluate these investment efforts statistically, analyze the structures of physical capital, and understand the extent of these efforts' profitability and macroeconomic results.

Theorists distinguish two types of economic regimes according to their inputs; in other words, the distinction between intensive and extensive regimes. The first part of this work aligns with several studies that position Morocco among the countries that use capital intensely to increase its production and national income quantitatively. In this regard, we have presented an overview of physical capital in Morocco, mobilizing different statistics and HCP indices, such as capital intensity, which means the accumulation of capital per worker, the overall productivity of the factors, and the ICOR. The results offer many lessons, especially when compared with other

DRAFT - Not for publication

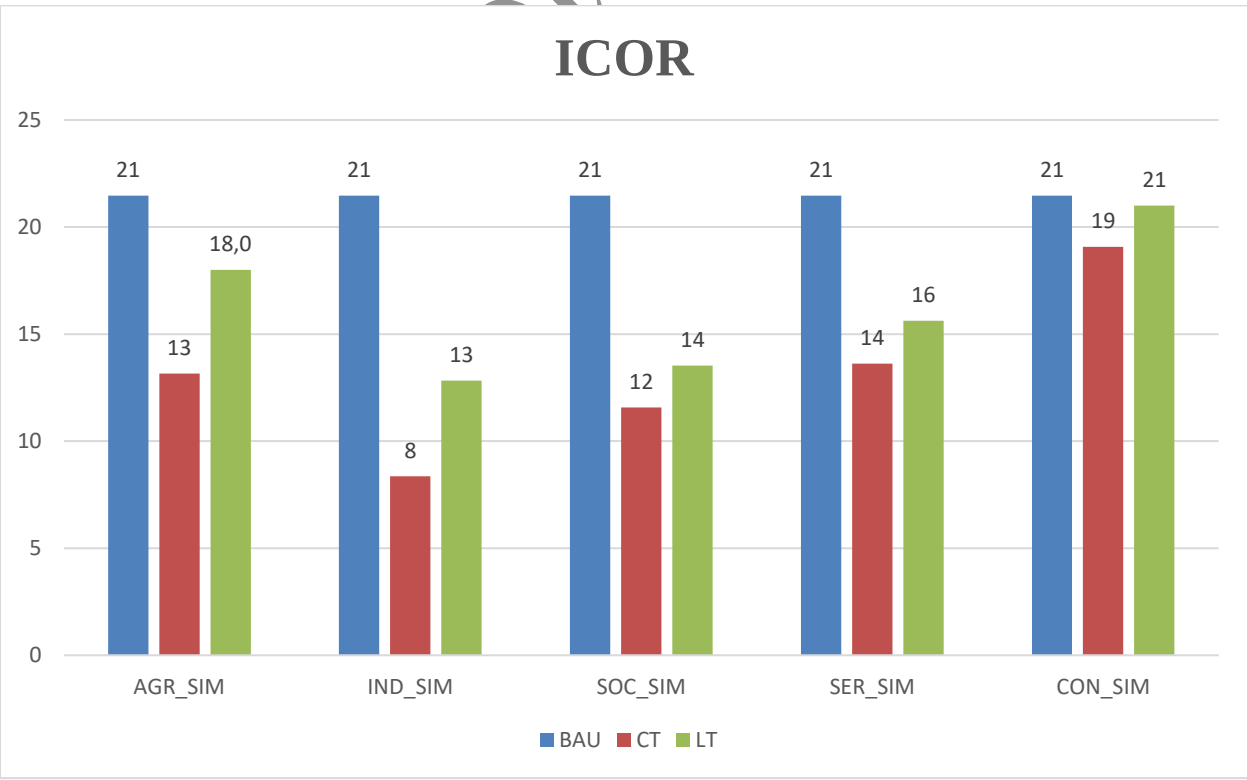
countries. We have broken down public infrastructure into four assets and simulated each asset's impact following a 10% increase in GFCF with two funding scenarios.

In general, the results of all simulations and for different scenarios show that infrastructure has impacted economic growth. Indeed, valuation is based on the performance and efficiency of physical capital. As we had assumed, investment in Morocco requires a reorientation and structural reallocation of the composition of its infrastructure investments.

This work explored the interaction between investment and growth, externalities and productivity, and financing and private investment. The evaluation extends to the impact on the effectiveness of capital invested through the ICOR index.

The results indicate that increasing investment in infrastructure while the old allocation increases GDP by 2%, which seems favorable compared to several other simulations. Indeed, we used another index to compare the two options (old allocation and new allocation): the ICOR.

This once again confirms the importance of wise investment choices. However, without a strategy that sets the priorities of the productive sectors, we could generate high growth rates in the short term, driven by increased final demand, but with adverse effects such as disengagement of private investment or inflation.



Draft for publication

In all these simulations, investment in infrastructure consistently demonstrates its positive impact on various sectors. Indeed, industrial infrastructure could improve the Incremental Capital Output Ratio (ICOR) ratio from 21 to 8 in the short term to 13 in the long term. Secondly, the health and education sector's social infrastructure could improve the ICOR to 12. The agricultural infrastructure has been enhanced to 13, the services to 14, and the construction sector to 19. This confirms that not all infrastructures are equally efficient, although all can create wealth, providing reassurance and confidence in the potential of infrastructure investment.

It's crucial to recognize the importance of strategic planning in infrastructure investment. Industry, for instance, has the potential to enhance the efficiency of most capital, while construction primarily benefits the building sectors. However, the construction sector could also experience growth due to investments in other sectors, such as agriculture, social, and telecommunications. This underscores two key points: firstly, the positive correlation between infrastructure and the construction sector; secondly, the potential for any investment in infrastructure to stimulate the building sector. Therefore, a strategic approach that includes diversifying infrastructure investments can lead to optimal economic outcomes, engaging economists in thoughtful consideration.

Why industry? We can see the impact on production. Indeed, infrastructure has significantly improved the most attractive sectors, including manufacturing machinery, means of transport, and high-tech tools. Technical progress is more significant in these sectors, and its externalities can affect all other sectors, particularly agriculture. Its impact on pharmaceutical production and extraction can also be seen.

The issue of financing is directly related to the return on capital. Investing in sectors capable of generating higher and more profitable returns is essential, as it improves the income of economic actors and, consequently, national savings. This facilitates the financing of public and private projects without recourse to external or internal funding, thus avoiding the effects of eviction. Indeed, yields can vary between sectors, such as construction and agriculture, but at what level?

In these simulations, we can understand that short-term returns encourage companies to invest, which may explain why they prefer the construction and construction sectors. On the other hand, investments in the industrial industry generate higher returns in the long term. It is enough to invest today for long-term returns, while construction requires annual investments. This explains the rise in capitalist intensity and ICOR in the construction sector.

DRAFT. Not for publication

Par conséquent, cette étude propose de réinvestir dans les secteurs susceptibles d'améliorer le rendement des investissements avec un coût moindre et avec le moins d'investissement possible.

DRAFT: Not for publication

Bibliographie

Abdelkhalek, T., Boccanfuso, D., & Savard, L. (2009). Politiques économiques, pauvreté et inégalités au Maroc : Analyses en équilibre général micro-simulé. Mondes en Développement, 4(148), 99-118.

Annabi, N. (2006, March). Functional forms and parameterization of CGE Models. MPIA Working Paper.

Aschauer, D. A. (1989). Is public expenditure productive? Journal of Monetary Economics, 23, 177-200.

Aschauer, D. A. (1993). Public Infrastructure Investment: A Bridge to Productivity Growth?

Chitiga, M., Mabugu, R., & Maisonnave, H. (2016). Analysing job creation effects of scaling up infrastructure spending in South Africa. Development Southern Africa.

David, B., & Bernard, D. (s.d.). Modèle d'équilibre général du ministère des Finances du Québec: Caractéristiques et structure du modèle. Travaux de recherche, N° 002.

Dumont, J. C., & Mesplé-Somps, S. (2000). The Impact of public infrastructure on competitiveness and growth: A CGE analysis applied to Senegal. Mimeo, CREFA, University Laval, Québec.

Easterly, W., & Levine, R. (2001). It's not factor accumulation: Stylized facts and growth models. The World Bank Economic Review, 15(2).

Estache, A. (2007). Infrastructures et développement : Une revue des débats récents et à venir. Revue d'économie du développement, 21, 5-53.

Fofana, I. (2007). Élaborer une Matrice de Comptabilité Sociale Pour l'Analyse d'Impacts des Chocs et Politiques Macroéconomiques. Réseau de Recherche sur les Politiques Économiques de réduction de la Pauvreté.

Ford, R., & Poret, P. (1991). Infrastructures et productivité du secteur privé. Revue économique, 17.

Hoff, K., & Stiglitz, E. J. (2000). Modern economic theory of development. In G. Meir & J. E. Stiglitz (Eds.), Frontiers of development economics: The future in perspective. Oxford University Press.

Lallement, A. L. (2006, May 3). 1859-1959: de Walras à Debreu, un siècle d'équilibre général. Revue économique, 3, 75.

DRAFT. Not for publication

Levine, R., & Renelt, D. (1992). A sensitivity analysis of cross-country growth regressions. The American Economic Review, 82(4), 942-963.

Nelson, R. R., & Pack, H. (1999). The Asian miracle and modern growth theory. Economic Journal, 109(July).

Sala-i-Martin, X. (2001, October 10). Les sentiers de la croissance (entretien). Problèmes économiques, 2731.

Savard, L. (2010). Scaling Up Infrastructure Spending in the Philippines: A CGE Top-Down Bottom-Up Microsimulation Approach. International Journal of Microsimulation, 3(1), 43-59.

Solow, R. M. (1988). La théorie de la croissance et son évolution. Revue française d'économie, 3, 3-27.

Solow, R. M. (1994). Croissance économique : problèmes et perspectives. Intervention au colloque du CNAM, Novembre.

Bouhia, A. (2001). Les sources de croissance de l'économie marocaine. Critique économique, 2.

Abbad, T. (2017, January 1). Accumulation du capital et gains de productivité au Maroc.OCP policy centre.

Lemelin, A., & Robichaud, V. (2018). MegBec un modèle d'équilibre général calculable multirégionaledu Québec. Série Scientifique, 2018s-06. Montréal,

Abouch, M., & Ezzahid, Elhadj. (2018, June 14). Investissement et croissance économique au Maroc : Insuffisance de l'accumulation et faiblesse de la productivité. Repères et Perspectives - Numéro 6.

DRAFT: Not for publication