

The economy-wide impact of investment in energy infrastructure development in Burkina Faso

1. Introduction

Africa's infrastructure challenges are huge so are its potential and opportunities. Recent investigations by the African Development Bank estimate that the continent needs about \$130–\$170 billion a year in infrastructure investment, with a financing gap ranging from US\$68–108 billion (AfDB, 2018). The economic cost of Africa's limited stock and poor quality infrastructure is particularly high (Collier et al., 2015; AfDB, 2018). According to Foster and Briceño-Garmendia (2010), up to 2% of Africa's average per capita growth rates are lost annually due to poor infrastructure. Moreover, Africa's infrastructure stock is low, particularly in power (Dethier, 2015). In this regard, McKinsey (2021) has found that more than two-thirds of the world's population with no access to electricity is based in Sub-Saharan Africa. The insufficient stock of productive infrastructure in power, water, and transport services hinders the continent's industrialisation and its economic growth (Eustache, 2010; Collier et al., 2015). It does so by limiting the comparative advantage of enterprises that struggle to thrive. While the infrastructure deficit is not unique to Africa, it is the continent whose infrastructure lags behind those of other regions in terms of quantity, affordability, and quality. As Eustache (2010) has pointed out, the poorer the country, the more infrastructure matters for health, education and economic growth.

In terms of access to power infrastructure, for instance, it is estimated that more than 640 million Africans have no access to energy (Collier, 2015; AfDB, 2018). African countries' electricity access rate is about 40%, the lowest in the world. While the United States and Europe have 13,000 kWh and 6,500 kWh per capita energy consumption, Sub-Saharan Africa, excluding South Africa, contains just 180 kWh, despite the continent's huge energy potential, especially renewable energy. Africa has a huge potential for solar, biomass, wind, and geothermal energy as well as hydropower but only a fraction of this potential is being utilised.

According to the African Development Bank, the African population with access to electricity was estimated in 2014 to be 47% compared to 97% in Latin America and 89% in Asia (AfDB, 2018). However, there are regional and in-country disparities in electricity access. North Africa has the highest access (98%) while East Africa has the lowest (26%). Within countries, urban households are better served (72%) than rural households (11%).

Like the energy infrastructure, the telecommunication sector also presents a gloomy picture. While, over the last decade, the sector registered a boom in the use of mobile phones and mobile technology, internet penetration remains low.

Regarding affordability, the costs of infrastructure services in Africa, whether for power, water, transport, or ICT, are far higher than those of other developing nations (Foster and Briceño-Garmendia, 2010). In Africa, energy is particularly expensive, especially for countries with small or isolated electricity grids and net fuel importers. It is estimated that “the average effective cost of electricity to manufacturing enterprises in Africa is close to \$0.20 per kWh, around four times higher than industrial rates elsewhere in the world” (AfDB, 2018). Road freight tariffs in Africa, compared to those in the United States, are two to four times higher per kilometer. Travel times along key export corridors are two to three times higher than in Asia.

The quality of infrastructure services is also crucial. Infrastructure quality affects productivity and economic growth. Africa’s electricity is scarce, expensive, and unreliable compared with other developing regions. In addition to being inaccessible and expensive, electricity is also unreliable in Africa. According to the World Bank (2017), 79% of firms in Sub-Saharan Africa experienced power outages — on average, 8.6 power outages a month, with an average duration of 5.7 hours between 2006 and 2016.

Effective and efficient energy provision is crucial in preventing death caused by using wood-burning stoves for cooking. It facilitates the operations of hospitals and emergency services and educational attainment. Access to energy is a key driver of inclusive growth in that it creates opportunities for women, youth, and children in urban and rural areas. Access to energy is crucial not only for attaining health and education outcomes but also for reducing business costs, unlocking economic potential, and creating jobs. Access to energy is vital for health and education and is also key to reducing business costs. Unreliable and poor power infrastructures affect firm productivity, especially power shortages and the resulting additional costs for firms. Additionally, transport bottlenecks are also perceived as the main bottlenecks for about 60% of enterprises operating in Africa (World Bank, 2014). These businesses experience significant constraints in accessing reliable power sources. In Africa, power outages occur a quarter of the year on average, thus resulting in additional costs for enterprises that may have to rely on private generators. In this context, “only firms that have very high returns and engage in well-controlled markets can make a profit by operating in Africa, notably extractive industries in mining, oil production, and allied activities. Firms with high-value addition, broad job opportunities, and wide sectoral linkages face serious setbacks” (AfDB, 2018).

Burkina Faso, as a low-income country currently ranked 144th among 157 countries in the new Human Capital Index established by the World Bank, Burkina Faso, has significant infrastructure deficit. About 40.1% of its population lives below the poverty line (World Bank, 2021). In 2020, real GDP increased slightly by 1.9% due to the Covid-19 shock. Production outputs in the primary and secondary sectors increased in 2020 due to high turnover in subsistence crops and cotton. The

tertiary sector declined by 5% in 2020 due to temporary business closures and social distancing measures amid the Covid-19 pandemic.

According to the World Bank, the current account deficit narrowed from 3.3% of GDP in 2019 to just 0.1% in 2020, primarily due to an improved trade balance supported by increased gold exports and a decline in oil imports. The pandemic, coupled with high food prices and a rise in rental costs and energy prices, led to an increase in inflation (3.2% in 2020). As a result of unexpected expenses to address Covid-19 and insecurity, the fiscal deficit rose to 5.7% in 2020. This fiscal deficit is expected to remain high in 2021 at 5.5% of GDP and gradually return to the West African Economic Monetary Union criterion of 3% by 2024 (World Bank, 2021).



Source: Data are as of December 2020 and are from domestic authorities; figures for 2020 are estimates and figures for 2021 and 2022 are projections by the African Economic Outlook team.

Figure Erreur ! Il n'y a pas de texte répondant à ce style dans ce document.: Burkina Faso's growth in macroeconomic indicators, 2019-2022

Source: African Economic Outlook (AEO) 2021

Burkina Faso Infrastructure Development Index lags in the bottom 24 performers for the continent (Briceño & Dominguez, 2011; 2018), despite significant progress over the last decade. The challenges that Burkina Faso faces with its infrastructure sector include low population density, which is highly concentrated in just a few geographic clusters, especially in the central region of the country, and the fastest population growth estimated at 2.8% annually (World Bank, 2019). In addition, Burkina Faso's geographical position as a landlocked country makes it highly dependent on its neighbours for transit and trade and thus highly exposed to any political instability (Briceño & Dominguez, 2011).

In the energy sector, Burkina Faso is characterized by limited electrification. According to the World Bank, less than 20% of the population in Burkina Faso had access to electricity in 2020 with significant disparities between urban (65.8% in 2020) and rural areas (4.7% in 2014). Supply of power is insufficient to satisfy an increasing demand. Costs of electricity in Burkina Faso are among the highest in Africa (Briceño & Dominguez, 2011).

2. Background of the study

Under Burkina Faso National Plan for Economic and Social Development (PNDES), a first phase of an ambitious programme for infrastructure development was adopted for 2016-2020. PNDES acknowledges the critical role that energy, transport and telecommunication infrastructure will play in transforming the productive base of Burkina Faso's economy. However, in recent years, there have been repeated calls from the public and Parliament for the Government to justify the massive investments in infrastructure envisioned by the PNDES. Our research informs policy makers in Burkina Faso, scholars and development practitioners about the extent to which investment in infrastructure impacts Burkina Faso's economy and proposes potential priority policy changes.

The overall cost of implementing the PNDES over 2016-2020 was forecasted at CFAF 15 395.4 billion. About 63.8% of the total cost of the PNDES is planned to be financed through domestic resource mobilisation. The remaining 36.2% of the total should be mobilised externally through an aggressive resources mobilisation plan that includes debt, public and private partnerships and Official Development Assistance(ODA). Table 1 below shows that forecasted investment in energy infrastructure over 2016-2020 represented 20% of the total forecasts for all economic infrastructure investment.

Table *Erreur ! Il n'y a pas de texte répondant à ce style dans ce document. : Infrastructure investment forecasts in PNDES, 2016-2020*

Infrastructure sector	Planned investment (in billions US\$)	% Total infrastructure investment
Transport	5.32	70%
Energy	1.46	20%
Telecommunication	0.78	10%
Total forecasts	7.56	100%

forecasts in PNDES, 2016-2020

Source: Authors, based on PNDES data

3. Literature review, theoretical and conceptual framework

Over the last two decades, the literature on infrastructure has developed considerably. As a result, scholars have devoted considerable attention to infrastructure and its impact on economic growth. Infrastructure has been widely recognised as a critical contributor to economic growth. It is the backbone of the economy (Collier, 2013) on which economic activities can flourish. Empirical reviews, however, indicate that findings on the relationships between infrastructure development, economic growth, poverty alleviation and the well-being of people have been inconclusive.

3.1 Main empirical studies on economic infrastructure and growth

There are two main strands of studies on the impact of investments in infrastructure on economic growth. The first set of studies (Aschauer, 1989; Barro, 1990; Calderón & Servén, 2004; Calderón et

al., 2011; Chude, 2013; Ogun, 2010; Gramlich, 1994; German-Soto et al., 2014; Lahirushan et al., 2015; Raihan, 2011; Uddin et al., 2014) found a positive effect of infrastructure investments on economic growth. They confirm the nexus of infrastructure investments and economic growth. These studies use various macroeconomic models, econometrics, and computable general equilibrium models.

In Africa, mostly in South Africa, Nigeria and Tunisia, several studies (Bayoudh, 2012; Calderón & Servén, 2010; Fedderke et al., 2006; Kodongo et al., 2016; Mbanda & Chitiga-Mabugu, 2017; Ahmed et al., 2013; Borojo, 2015) also found a positive relationship between infrastructure investment, economic growth, employment and poverty reduction.

The second strand of studies, albeit limited in scale (Estache et al., 2010; Estache & Garsous, 2012; Chipaumire & Ruswa, 2014), found that investments in infrastructure have no impact or, at best, little impact on economic growth and poverty reduction. Methodological issues coupled with conflicting definitions of infrastructure may have further exacerbated the mixed results found in the literature. Furthermore, Eustache et al. (2010) argue that in developing countries, how much and which infrastructure matters in terms of output levels and their growth is not clear-cut.

Aschauer (1989) conducted a regression analysis from infrastructure data for the period 1949-1985 in the US. This study concluded that considerable attention has to be given to public investment decisions, especially investments related to core infrastructure.

Bahan et al. (2011) used data for 1961-2000 and the 2003 SAM for Quebec to develop a dynamic recursive CGE. This study has found that comparative analysis externalities mitigate the negative macroeconomic impact of scaling-up infrastructure investments in the country. Using the 2013 SAM data for Pakistan to develop a CGE model, Ahmed et al. (2013) found that increased public investment in infrastructure through tax versus international debt results in macroeconomic gains and improved poverty levels in the long run. Barro (1990) in the US used data set on public expenditure from 76 counties covering the period 1963-1985. The method of analysis in this study involved endogenous growth models with optimising households and Cobb-Douglas production function. The study has found that the nexus government-growth tends to be robust across the countries under study. Bayoudh (2012) has found that infrastructure investment positively affects aggregate outputs. The study developed a recursive dynamic CGE model with a CES production function based on the SAM for Tunisia. Using time series data for investment in transport infrastructure and data from the SAM for Ethiopia, Bekele and Ferede (2015) developed a dynamic CGE model based on the IFPRI model. This study found that increasing road infrastructure availability positively affects macroeconomic and sectoral indicators.

Boccanfuso et al. (2014) in Quebec conducted a comparative analysis of funding sources. Based on a dynamic recursive CGE model, this study found that income tax has the most positive effects while businesses tax the most negative ones. In an earlier study in Senegal, Boccanfuso and Savard (2010), using a multi-household computable general equilibrium model, Foster-Greer-Thorbecke and Gini indices found that rural areas registered higher gains in times than urban areas. . Borojo (2015) in Ethiopia developed a recursive dynamic CGE model using Ethiopia SAM for 2009-2010. The study found that electricity investment positively impacted real GDP and output of industrial and service sectors in all simulations. Servén and Calderón (2006) found that infrastructure output contribution to the economy is significant. The study was based on data set of infrastructure stocks covering the period 1960-2000 from 88 countries. Panel time-series, panel unit root and cointegration tests, as well as pooled mean group (PMG) estimator, were used in this study. Calderón and Servén (2010) found that infrastructure positively affects long-run economic growth. It has a negative impact on income inequality. This study used data set on infrastructure from more than 100 developing countries over the period 1960-2005 to perform infrastructure-augmented growth and income inequality regressions. Furthermore, using infrastructure data set from 88 countries from the period 1960-2000, panel time-series, long-run aggregate production function estimations, tests of cointegration, as well as PMG estimator (Calderón et al., 2011), found little robustness in long-run parameter heterogeneity across countries. In an earlier study in 2004, using 100 countries' panel data set from 1960–2000, they performed regressions and generalised-method-of-moments (GMM) estimations. This study found that infrastructure stock positively affects growth. Quantity and quality of infrastructure stock reduce income inequality (Calderón & Servén, 2004). Dynkelman (2008) drew on an aggregate variables panel dataset for the period 1996 and 2001 from South African census data to perform OLS regression and IV regression. He found that electrification positively affects employment, especially for women. In a study, Dumont and Mesplé-Soms (2000) used data from Senegal SAM for 1990 to develop a dynamic sequential equilibrium model. The study results indicate a varying manufacturing sector performance depending on the price level and wage rate. Using the SAM data from six African countries, Estache et al. (2010) developed a CGE model based on the EXTER model and Cobb-Douglas function. They found little difference between the effects of different funding sources on a given type of infrastructure. Further, Estache et al. (2010) developed a standard CGE model in a study using SAM data for Mali. They compared various infrastructure investment scenarios and found a negative impact linked to investment types, resulting in foreign aid producing Dutch disease in the country.

3.2 The challenging empirics of the infrastructure and growth nexus

While the theoretical work on the nexus of infrastructure and growth is vast and rich in terms of sources, scope and depth, empirical reviews in Africa remain contentious. However, scholars generally agree that the relationship between infrastructure and growth is heterogeneous and very

much determined by several factors, including the country context, infrastructure types and periods under study (AfDB, 2018).

Several studies found a positive relationship between infrastructure measures and indicators of socioeconomic development such as gross national product (GNP), GDP growth, GDP per capita, employment, and poverty headcount (Arezki et al., 2017; AfDB, 2018). The majority of these studies use cointegration and causality tests. One strand of studies reports a positive bidirectional relation (Arezki et al. 2017) while another set finds a unidirectional positive causality from infrastructure to economic growth (AfDB, 2018). Conversely, another strand of papers finds a lack of relationship between infrastructure and growth (Barro & Sala-i-Martin, 2004).

3.3 Main empirical studies in the energy sector and their findings

In the energy sector, there is an extensive literature investigating the relationship between electricity consumption, supply, and economic growth. Several authors (Bouoiyour & Selmi, 2013; Shahbaz & Feridun, 2012; Acaravci & Ozturk, 2012; Dakpogan, 2019; Acaravci & Ozturk, 2010;; Ozturk & Acaravci, 2011; Solarin, 2011; Shahbaz, Tang & Shahbaz Shabbir, 2011; Niu, Ding, Niu, Li & Luo, 2011) investigated the relationship between electricity consumption, its supply and economic growth. Their findings indicated mixed results.

A first strand of studies (Yang, 2000; Jumbe, 2004; Tang, 2008, 2009; Odhiambo, 2009a; Lean & Smyth, 2010; Ouédraogo, 2010) found a bidirectional causal relationship between economic growth and electricity consumption. A second strand of studies (Aqeel & Butt, 2001; Altinay & Karagol, 2005; Lee & Chang, 2005; Shiu & Lam, 2004; Yoo, 2005; Narayan & Singh, 2007; Yuan et al., 2007; Chandran, Sharma & Madhavan, 2010; Odhiambo, 2009b) established a unidirectional causal relationship running from electricity consumption to economic growth.

A third set of studies (Ghosh, 2002; Narayan & Smyth, 2005; Yoo & Kim, 2006; Ho & Sui, 2007; Mozumder & Marathe, 2007; Jamil & Ahmad, 2010) established a unidirectional causal relationship running from economic growth to electricity consumption. According to these studies, economic growth drives electricity consumption, but not the other way round. The mixed results are due to the differences in the social, economic, and political context of each country, differences in the methodology used, the sample size, the proxies used for the variables, data, and the energy policy of each country (Chen, Kuo & Chen, 2007).

Few studies (Borojo, 2015; Égert et al., 2009; Perrault et al., 2010; Federreke et al., 2008; Mbanda et al., 2011; Agenor et al., 2006; Dinkelman, 2011; Galinis & Leeuwen, 2000; Dissou & Didic, 2011; Aydin, 2010) drew on CGE modelling to assess the impact of investment in power on economic growth. These studies found that investing in energy, which is a key input in the production process,

positively impacted economic growth, most notably real GDP, sectoral output production, trade balance, private investment, household income and employment.

Studying the direction of causality between electricity consumption and economic growth in Burkina Faso, Ouédraogo (2010) found a positive relationship between electricity consumption, GDP, and capital formation. However, the study has found an insignificant causal relationship between electricity consumption and investment in Burkina Faso. Dissou and Didic (2011) investigated the effects of an increase in infrastructure investment in Benin. They found that increased investment in infrastructure positively impacts the private investment for all economic agents in the long run, regardless of the funding source. In a study modelling the effect of disruption to electricity supply on economic growth in Benin, Dakpogan (2019) found that the country has a low capacity to prevent disruptions to the electricity supply. Benin loses about 0.16% of its GDP due to electricity disruption. Furthermore, the study found that in Benin, “electricity supply cause[s] negative shocks to GDP, while positive shocks of electricity supply have no causal effect on positive shocks to GDP” (Dakpogan, 2019). Aydin (2010) assessed the Turkish hydropower infrastructure's economic and environmental impact. This study investigated the potential long-term impact of an increase in hydropower by introducing policy shocks, under a scenario of doubling the production of hydropower, on macroeconomic variables, especially GDP, real consumption, real investment, exports, imports and trade balance. The study found that increased investment in hydropower would result in significant macroeconomic gains for the Turkish economy. The impact included job creation, investment and overall aggregate output production, with substantial effects on sectoral output, trade balance, private investment and overall economic growth.

Perrault et al. (2010) developed a standard CGE to investigate the impact of scaling-up infrastructure in six African countries. They considered different financing scenarios to assess the most efficient funding source. The study found that investment funded by tax income is more favourable for some countries regarding electricity. Sharma (2010) and Squalli (2007) established that energy is a key input in the production process and commonly used in both commercial and non-commercial activities. It, therefore, has a direct on a country's GDP. The channels through which energy impact economic growth may be through consumption, investment or exports and imports, as energy production and consumption affects all these components of aggregate demand (Sharma, 2010). Since electricity is key in production processes such as manufacturing, education, commercial, and construction, a significant relationship is expected between that energy consumption and economic growth. In this respect, energy deficit is likely to result in negative impact on GDP.

In addition, some empirical studies (Sambo, 2005; Aydin, 2010; Girma, 2000; Parasuraman & Sengupta, 2001) also stressed the key role that large dams play in energy provision, irrigation and water supply. They highlighted large dam's contribution to economic growth by generating

employment, enhancing sectoral industries, strengthening countries' capacity for exports, and contributing to overall economic growth. Other studies (Barro, 1998; Kosec, 2014; Sharma, 2010; Fourie, 2006; Galiani et al., 2005; Duflo & Pande, 2007; World Bank, 2003; Sambo, 2005; Stern, 2004; Morimoto & Hope, 2004; Enang, 2010), which employed other methodologies in different contexts have found similar results.

3.4 Channels through which infrastructure impacts economic growth

Researchers' approaches mainly covered two major sets of channels, the direct and indirect channels, through which infrastructure may affect economic growth (Fedderke et al., 2006, Agenor et al., 2006; Fourie, 2006; Cantu, 2017).

Infrastructure's effect on the economy may be direct or indirect. The direct effect is the result of infrastructure being considered a complement to other factors of production. The indirect effect occurs when infrastructure indirectly affects growth by raising total factor productivity and lowering firm costs (Fedderke & Bogetic, 2009).

Agenor et al. (2006) defined several channels depicting how infrastructure may affect growth. The first set of channels is the conventional channel, which relates to the traditional macroeconomic mechanisms through which infrastructure impacts economic growth (i) productivity of private inputs; (ii) complementarity effect on private investment; and (iii) crowding-out effects on private spending. The second set of channels, in addition to the macroeconomic channels referred to above, are additional indirect channels through which infrastructure may affect growth. These new channels are an (i) indirect effect on labour productivity, (ii) effect on adjustment costs, (iii) effect on the durability of private capital, and (iv) impact on health and nutrition.

Federreke et al. (2008) identified five potential relationships between infrastructure and economic growth: (i) infrastructure as a factor of production, (ii) infrastructure as a complement to other inputs into the production process, (iii) infrastructure as a stimulus to factor accumulation, (iv) infrastructure as a stimulus to aggregate demand, and (v) infrastructure as a tool of industrial policy.

Fourie (2006) also found that infrastructure may theoretically provide several benefits through (i) an effect on the efficiency of the economy, (ii) an impact on social equity, (iii) an impact on the environment, (iv) an effect on employment and skills transfer, and as well as (v) an impact on trade, competitiveness, regional integration and tourism.

Several microeconomic studies) have found that infrastructure may have a significant impact on health, nutrition and education outcomes in developing countries. Improved transport networks, for instance can facilitate better access to healthcare services, particularly in rural areas. According to the African Union (2005), data from the National Demographic and Health Surveys in Sub-Saharan

Africa, for instance, indicated that for most women in rural areas, distance and inadequate transport were the key bottlenecks limiting their access to health services. Levy (2004) found that in Morocco, a rural roads expansion programme contributed to reduced production costs, improved market access, and a notable increase in visits to primary healthcare facilities and clinics. The World Bank (2005) reported that in rural and disadvantaged communities in Malaysia and Sri Lanka, improved communication and transportation services combined with an increase in the number of healthcare staff led to a significant decrease in the mortality rate dropping from 2 136 in 1930 to 24 in 1996 in Sri Lanka, and from 1 085 in 1933 to 19 in 1997 in Malaysia..

Similar to its positive effects on health, investment in infrastructure may significantly impact education outcomes. Several microeconomic studies have found that infrastructure, especially roads, power, water and sanitation, directly impact education indicators positively (Brenneman & Kerf 2002; Agenor, 2006).

A better transportation system and a safer road network, especially in rural areas, may help raise school attendance. Agenor (2006) reported that rural road development in the Philippines, for instance, led to a 10% increase in school enrollment. Moreover, dropout rates decreased by 55%. Likewise, in Morocco, Khandker, Lavy and Filmer (1994) and Levy (2004) found that girls' enrollments increased from 28% to 68% in less than ten years. In addition, greater accessibility improved the quality of education by facilitating the hiring of teachers and travel between rural and urban areas.

3.5 Climate change and infrastructure

Climate change has a significant negative impact on the infrastructure sector. Droughts, temperature rises, floods, storms and other extreme events are already impacting infrastructure worldwide, increasing the vulnerability of people and communities to these climate shocks, especially in developing countries such as Burkina Faso. Extreme climate hazards may damage a nation's core physical and natural infrastructure, disrupting the key assets' social and economic services. As a result, economic growth and communities' well-being are negatively impacted with an additional burden on public finances, especially in the context of the Covid-19 pandemic. Infrastructure can positively and negatively influence economic growth and sustainable development (UNOPS, 2021). While climate change affects infrastructure, infrastructure, in turn, can exacerbate climate change. In a landmark report, "infrastructure for climate action" published ahead of the 26th UN Climate Change Conference (COP26), UNOPS, the UN Environment Programme, and the University of Oxford have found that infrastructure is responsible for 79% of all greenhouse gas emissions (UNOPS, 2021). An earlier report, "Infrastructure: Underpinning sustainable development", published by the University of Oxford and UNOPS report, found that infrastructure heavily influences 92% of targets within the 17 Sustainable Development Goals (Thacker, 2018). This report stressed

that infrastructure is fundamental to sustainable development, and achieving the Sustainable Development Goals depends on the right quantity and quality of infrastructure services provided for all people. This report concluded that infrastructure underpins sustainable development (Thacker, 2018). Well-designed infrastructure systems can be key in addressing climate mitigation and adaptation. Resilient infrastructure built upfront across energy, water, transport, and telecommunication are key to addressing climate change. According to the Global Center on Adaptation, “a revolution in the planning, design, financing, and delivery of infrastructure is urgently needed to meet the acute needs of warming Africa. Developing resilience in the transport and energy systems in Africa with a systems approach is much-needed to address climate change and sustainable development on the continent” (GCA, 2022).

3.6 Literature gaps in Burkina Faso

The review shows significant gaps in the literature in Burkina Faso, especially concerning studies on the economy-wide impacts of investments in infrastructure. However, it is worth noting that three important studies on infrastructure are specifically dedicated to Burkina Faso.

The first study on the state of Burkina Faso's infrastructure was carried out in 2011 by the AICD. This study provides a continental perspective of Burkina Faso's infrastructure and summarises the main challenges of the infrastructure sector in Burkina Faso and its potential and opportunities. This study found that by increasing infrastructure spending at the level of the region's middle-income countries, Burkina Faso would register an annual growth of about 3.8 percentage points per capita (Briceño & Dominguez, 2011)

The second paper by IMF (2016) analysed the impact of public investment scaling-up in Burkina Faso. This study found that the scaling-up scenario implied by the PNDES is likely to be inconsistent with long-term fiscal and debt sustainability (IMF, 2016). The study then recommended that Burkina Faso proceed with a more gradual approach to scaling-up investment.

The third study, also from IMF, analyses the macroeconomics of scaling-up public investment in Burkina Faso under alternative financing options, including through foreign aid and a combination of tax adjustment and borrowing (Kabedi-Mbuyi et al., 2016). Similarly to the IMF study referred to earlier, the paper found that “the massive investment scaling-up contemplated under Burkina Faso's accelerated growth strategy, while boosting medium and long-term growth, would lead to unsustainable debt dynamics under a plausible tax adjustment and realistic concessional financing” (Kabedi-Mbuyi et al., 2016)

To conclude on the literature review, it is worth reiterating that despite the abundance of the literature on the effect of infrastructure on economic growth, findings of the various studies from different scholars remain inconclusive. The main takeaway from our review is that studying infrastructure

requires a multidimensional approach. Increasingly, scholars and policy makers are moving away from studying a single dimension of infrastructure to embrace a more holistic approach which entails studying “infrastructure systems”.

3.7 Theoretical and conceptual framework

This study draws on economic growth theories and public expenditure theory to develop a conceptual framework, which uses the SAM and the CGE model to assess the impact of investment in energy infrastructure on economic growth in Burkina Faso. Figure 2 below depicts the four key pillars of the conceptual framework this study draws upon to assess the impact of investment in energy infrastructure on economic growth in Burkina Faso.

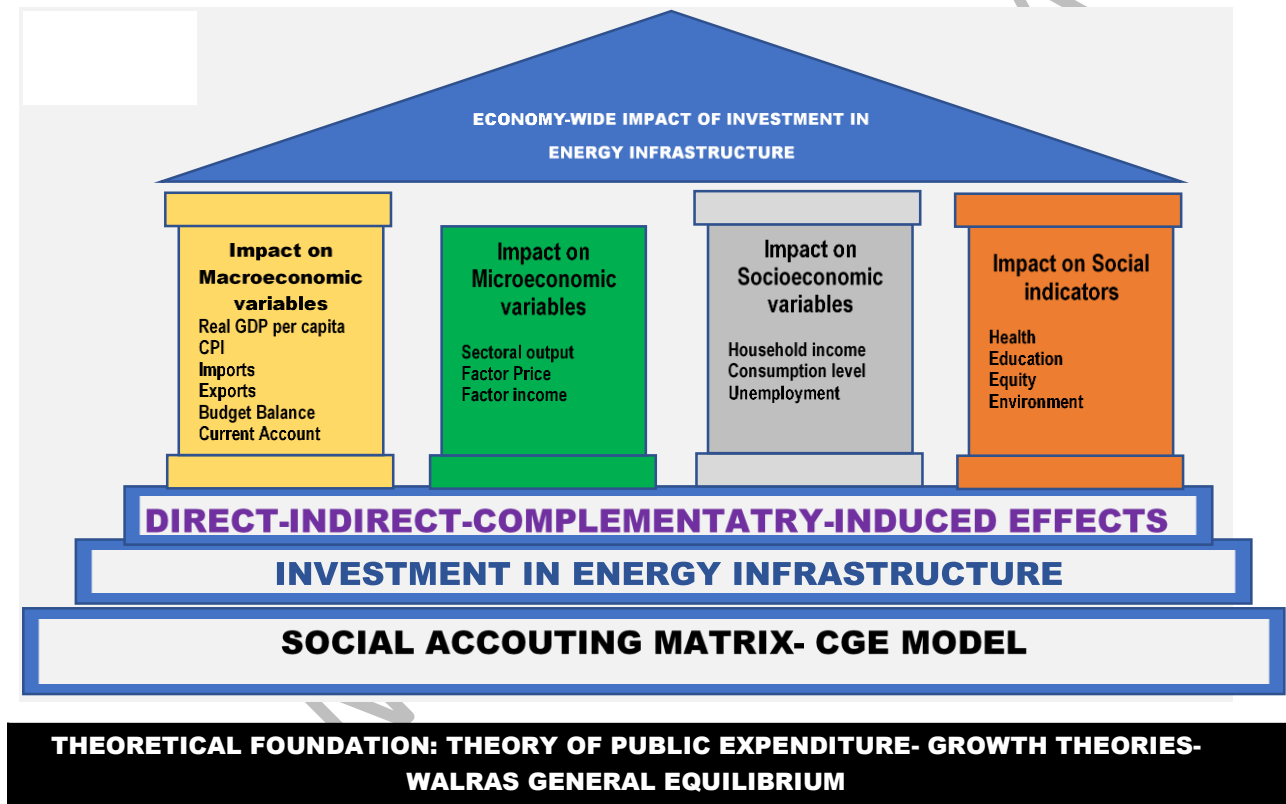


Figure 2: Conceptual framework of the study

Source: Authors

4. Research Methodology

4.1 The Computable General Equilibrium Model

The model for this research draws on the IFPRI (Lofgren et al., 2002) Standard General Equilibrium Model. The IFPRI standard model consists of 48 simultaneous equations that describe the behaviour of the economic agents. Most of these equations are non-linear.

The IFPRI CGE standard model provides a detailed description of all the payments that are recorded in the SAM. As per the SAM disaggregation of factors, activities, products, and institutions, the model also disaggregates these accounts. A set of simultaneous equations form the model. Several of the equations are nonlinear in the model which has no objective function. These equations describe the behavior of the different actors. Fixed coefficients such as ad valorem tax rates, for instance, capture this behavior (Lofgren et al., 2012).

IFPRI CGE Standard Model provides a detailed description of the mathematical model statement which comprises four blocks (prices, production and trade, institutions and system constraints). This study, which builds on the static model, makes use of a recursive dynamic CGE model (Thurlow, 2004; Bayouddh, 2012; Thurlow et al., 2012; Borojo, 2015; Mbanda et al., 2017) to account for the impacts of the between-period policy changes. Unlike static models which provide a detailed representation of a given economy within a particular time-period, dynamic models involve a recursive process in which between-period policy and non-policy adjustments can be traced. In the equations specified for the within-period component, consumers and producers maximize their utility and profits based on factor and prices that prevailed at that period. In the between-period specification, selected exogenous variables in the static model are adjusted based on observed behaviors, trends and past period outputs. A series of equilibria, each for a single year, provide the model solution. Policy-independent dynamic adjustments that are imposed produce the counterfactual or projected growth path. Changes in exogenous parameters reflect policy changes. The economy-wide impact of the policy shock can then be measured as the differences between the policy-influenced growth path and that of the counterfactual.

The impact of changes in policy involves dynamic aspects, such as the time effects of changes in the rate of capital accumulation. Extending the static model to a dynamic recursive model allows for a delineation of the relationships between policy changes, accumulation of factors and changes in productivity. Furthermore, over the period under analysis, changes independent to the policy are likely to occur. The impact of these changes represent a projected growth path or counterfactual for the economy under study.

4.2 CGE model data

The CGE model database has two main components: the SAM and the elasticities database. Burkina Faso's SAM for 2017, produced by the National Institute of Statistics and Demography (INSD), is the main source of data used to develop the dynamic Computable General Equilibrium model. This SAM contains 29 industries and 29 products. In addition to the 2017 SAM, data from the 2014 Continuous Multisector Survey were also used to disaggregate the household account into four categories (rural, urban, rural poor, non-rural poor) to take the economic criterion (standard of living) and the geographic criterion (area of residence) into account.

Also, using the 2013 SAM from the General Direction of Studies and Sectoral Statistics (DGESS) of the Ministry of Agriculture, the labour factors have been disaggregated into three categories (agricultural labour, non-agricultural labour, and agricultural family labour) to account for the importance of the agricultural sector in terms of employment in the economy. In addition, the population growth rate in the model is 2.9% and corresponds to the rate derived from the fourth General Census of Population and Housing (RGPH) conducted by INSD in 2019. As for household composition, it is established using the household structure of the Continuous Multisector Survey (2014).

In addition to the SAM, a CGE model database also includes elasticity parameters. These parameters depict the responsiveness of producers and consumers to changes in income and relative prices. While a SAM provides a snapshot, a static picture of a country's economy at a given time, elasticity parameters help describe an economy's movement from one equilibrium to a new equilibrium following a shock.

In our model, parameters are borrowed from authors who have already worked on the CGE model. For the elasticity of the demand function, an LES-type function is used that allows for subsistence consumption. As no work was found specifying the elasticity of demand of the LES function, the value one is considered. This is consistent with the specification of household demand in the standard model.

The elasticity of the transformation function varies between 0.2 and 1.3. As for the parameter of the Armington function, it varies between 0.5 and 1.8. These elasticities are similar to those used by authors such as Colange and Plane (1996), Janvry et al. (1995), Nabil et al. (2002) and Jan et al. (2009).

Concerning the substitution elasticity of production factors, in line with what is considered in most CGE studies, it is assumed that the primary factors used in the production process are substitutable. This elasticity is set at 1.2 (Jan et al., 2009). The elasticity of the consumption function varies between 0.7 and 1.1 and depends on the product type and household category (Zerbo et al., 2002).

This dataset is used to transform the generic IFPRI model in a way that mimics the Burkinabè economy, taking the specificities of this research into account. These include incorporating unemployment, accounting for substitution between different categories of labour and capturing the capital accumulation behaviour of investment in energy infrastructure.

4.3 Simulation plan and scenario selection

4.3.1 Model closure

Model closure refers to the decision-making process in which the modeller selects which variables are endogenous and exogenous. Concerning the choice of numeraire, the flexible CPI was chosen as cash. The Producer Price Index is, therefore, flexible. Investment is exogenous, and the Investment Adjustment Factor (YDI) is fixed. Change in the marginal propensity to save for the domestic institution is fixed (DPMS); however, the marginal propensity to save is endogenous. Thus, the propensity to save scale factor (MPSADJ) is flexible. The real exchange rate is flexible (EXR), while foreign savings are considered fixed (FSAV), given that the national economic system does not control foreign savings. This closure makes it possible to make choices on the methods of financing investments while adding other constraints. For example, by adding the constraint of exogeneity of public savings, it is possible to analyse the impact of increased investments in infrastructure financed exclusively through taxes.

On the other hand, by making taxes exogenous, analysing the impact of increased public investment through public savings is made possible. For capital and land constraints, all factors except labour are sector-specific (WFDIST and QFS). Concerning government constraints, public savings are considered to be endogenous (GSAV). The government decides on a level of savings after meeting its expenses. Tax rates are generally regulatory, and changing tax revenue, instead of tax level, is generally viewed as improving the efficiency of tax collection. Therefore, the adjustment factor for direct taxes is exogenous (TINSADJ). Also, the adjustment factor for institutional tax rates is fixed (DTINS). On the other hand, the share of public expenditure in absorption is endogenous. However, the public expenditure adjustment factor is fixed (GADJ) for the purposes of simulating an increase in public expenditure.

4.3.2 Simulation approach

Four simulations have been performed to assess the impact of a 5% increase in energy infrastructure investment on Burkina Faso's economic growth. These simulations consider three financing sources, namely debt, tax and ODA. A benchmark equilibrium which serves as a baseline is established in the first instance. The impact of the policy simulation on economic variables is then measured and compared against the baseline.

To quantify the impact of investments in energy infrastructure, IFPRI Standard Model production function has been modified as follows:

$$QVA(a) = \alpha_{f,a}^{va} \cdot (\sum_f (\delta_{f,a}^{va} \cdot sim(f, a) \cdot QF_{f,a}^{-\rho_a^{va}})) \frac{-1}{\rho_a^{va}} \quad (1)$$

$$WF_f \cdot \overline{WFDIST}_{f,a} = PVA_a \cdot (1 - tva_a) \cdot QVA_a \cdot (\sum_f (\delta_{f,a}^{va} \cdot sim(f, a) \cdot QF_{f,a}^{-\rho_a^{va}}))^{-1} \cdot \delta_{f,a}^{va} \cdot sim(f, a) \cdot QF_{f,a}^{-\rho_a^{va}-1} \quad (2)$$

with $Sim(k, a) = \frac{INV(k,a)}{QF(k,a)}$, representing the ratio between the planned investment and the initial capital stock of activity sector a.

An equation which materialises unemployment is also added to the standard model. This equation is calibrated as follows:

$$\sum_{Flab,a} QF_{Flab,a} = QFSLABAVA * (1 - unrte) \quad (3)$$

Adding this equation requires choosing a closure variable. The total quantity of available labour (QFSLABAVA) is, therefore, chosen as the closing variable in view of the interest presented by the observation of the unemployment rate. It is updated annually through the trajectory of demographic growth.

Financing increased investment through taxes assumes that other sources of finance are held constant. Under this assumption, government savings (GSAV), the savings rate of non-governmental institutions (MPS) as well as foreign savings (FSAV) remain unchanged. Thus, tax revenues adjust to meet the constraint between savings and investment.

$$\sum_{insd} MPS(insd) * (1 - TINS(insd)) * YI(insd) + \overline{GSAV} + EXR * \overline{FSAV} = \sum_c PQ(c) * QINV(c) \quad (4)$$

Financing increased investments by public savings assume that taxes (TINADJ), private savings (MPS) as well as foreign savings (FSAV) are fixed. Under these conditions, government savings adjust to ensure equilibrium following increased investment.

$$\sum_{insd} MPS(insd) * (1 - \overline{TINS(insd)}) * YI(insd) + GSAV + EXR * \overline{FSAV} = \sum_c PQ(c) * QINV(c) \quad (5)$$

When increased investments in infrastructure are financed by external aid, we can note an increase in external aid to satisfy the constraint of this equation:

$$\sum_{insd} MPS(insd) * (1 - \overline{TINS(insd)}) * YI(insd) + GSAV + EXR * \overline{FSAV} = \sum_c PQ(c) * QINV(c) \quad (6)$$

5. Study findings and analysis of results

Economic theory suggests that investment in infrastructure may positively impact economic growth. This research's findings support the view that investment in energy infrastructure would promote growth in Burkina Faso. A 5% national investment in energy infrastructure had a positive effect on Burkina Faso's economic fundamentals. Table 2, Table 3 and Table 4 below summarise the macroeconomic, microeconomic, and socioeconomic impacts of a 5% increase in investment in energy infrastructure in Burkina Faso.

5.1 Macroeconomic effects of an increase in investment in energy infrastructure

As reported in Table 2 below, Burkina Faso's economy would register several macroeconomic gains should the country increase investment in the electricity, water, and gas infrastructure.

Table 2: Macroeconomic effects of an increase in investment in electricity-water-gas infrastructure

Macroeconomic variables	Percentage change		
	Debt	Tax	ODA
Real GDP per capita	1.94%	1.42%	0.32%
CPI	0.01%	0.01%	0.01%
Imports	3.43%	2.44%	0.21%
Exports	0.16%	-0.51%	0.26%
Budget balance	18.81%	0.00%	0.00%
Current account	7.68%	6.37%	0.12%

Real GDP per capita increased, regardless of the funding source. It rose by 1.94%, 1.42%, and 0.32% for debt, tax and ODA financing for increased investment in the electricity, water, and gas infrastructure.

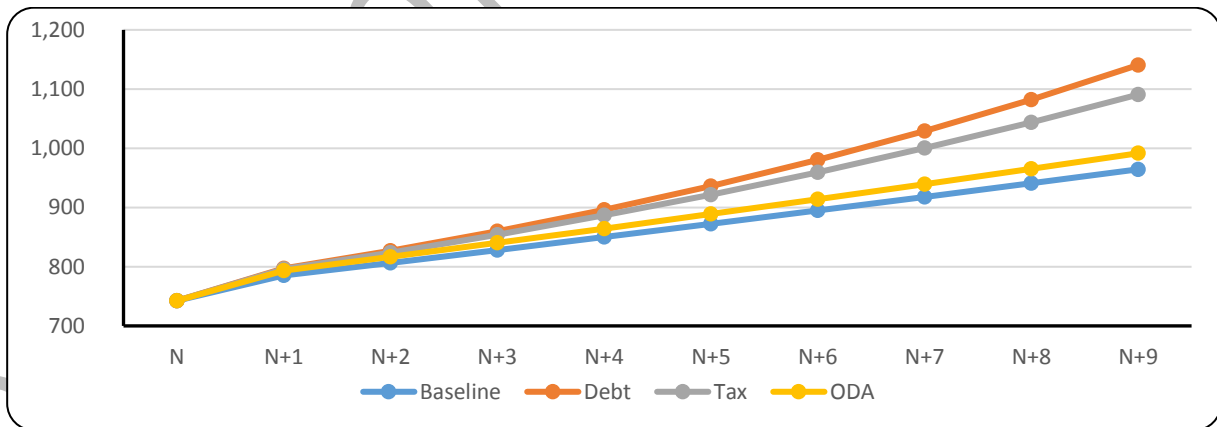


Figure 3: Trends in real GDP per capita following an increase in investment in water, electricity, and gas infrastructure

Real GDP per capita increased plus imports (see Table 2 above), sectoral output production and factor income (see Table 3), and household income and consumption levels (see Table 4) all rose.

CPI increased marginally by 0.01% for all funding sources following increased investment in the electricity, water, and gas infrastructure. The slight increase in CPI reflected a rise in the inflation rate, meaning declining consumer purchasing power in Burkina Faso. However, despite the slight depreciation of consumer purchasing power, consumption levels increased due to an increase in household income.

Imports rose following increased investment in the electricity, water, and gas infrastructure, regardless of the funding source. As a result, imports increased above the baseline by 3.43%, 2.44%, and 0.21% for debt, tax, and ODA financing, respectively.

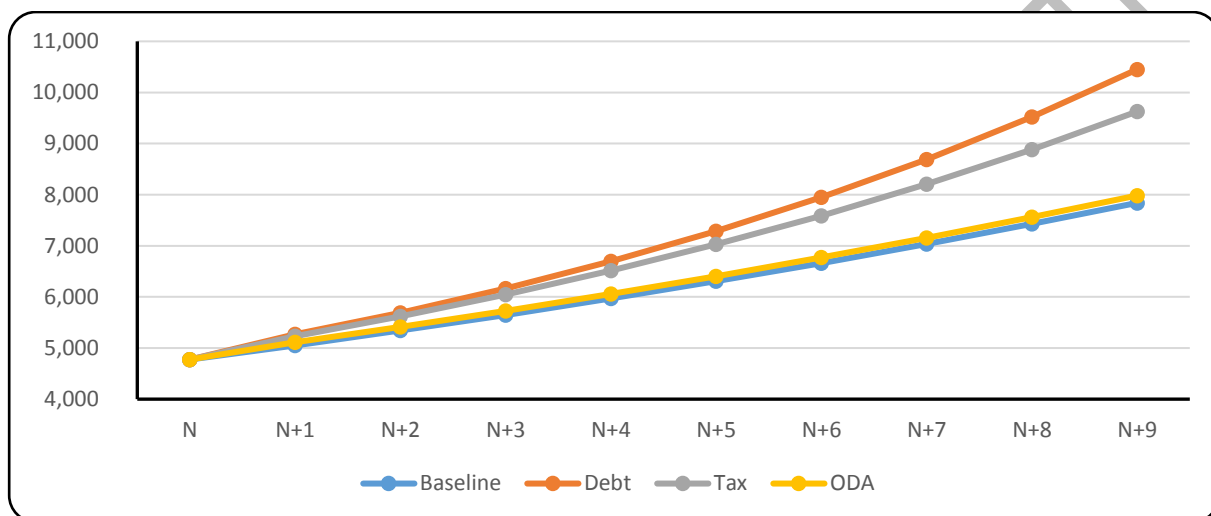


Figure 4: Trends in imports following increased investment in the water, electricity, and gas infrastructure

Exports also increased following increased investment in electricity, water, and gas, except for tax financing. Exports rose by 0.16% and 0.26% after an increase in investment in electricity, water, and gas financed by debt and ODA, respectively. However, it fell by 0.51% against the baseline for an electricity, water, and gas infrastructure financed through tax.

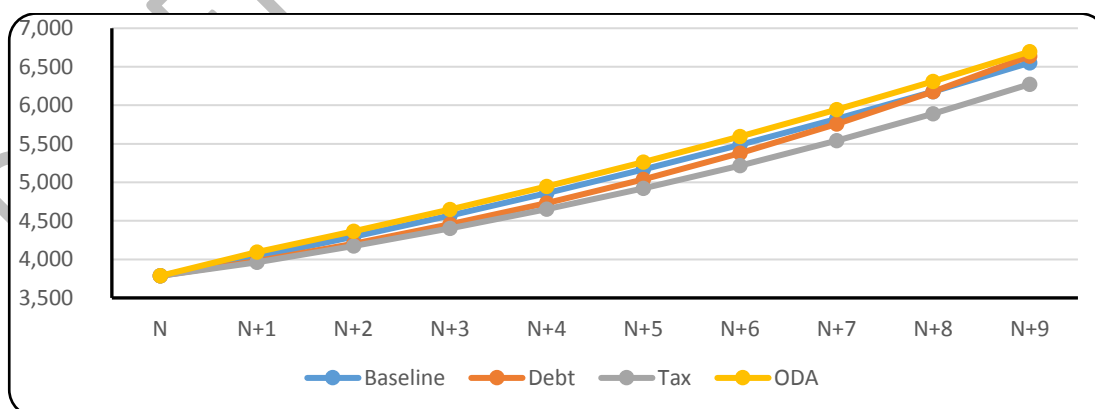


Figure 5: Trends in exports following increased investment in the water, electricity, and gas infrastructure

The budget balance increased sharply in the scenario of an increase in investment in the electricity, water, and gas infrastructure via debt. It increased by 18.81%, meaning a significant negative impact on Burkina Faso's budget balance. However, it does not have any impact on the budget balance if investment is channelled through tax and ODA (see Figure 6)

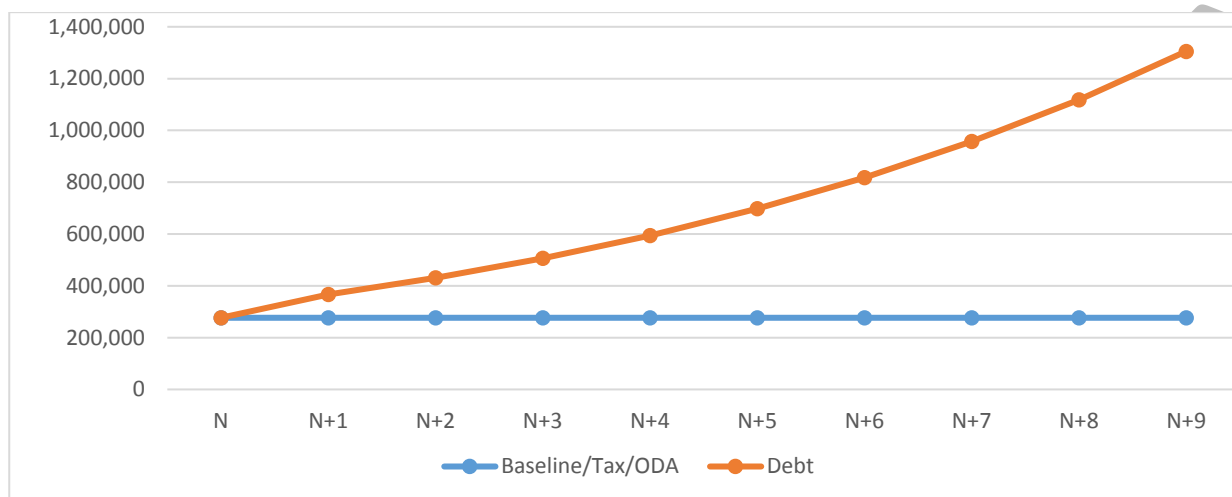


Figure 6: Evolution of budget balance in the baseline scenario and per financing source following increased investment in water, electricity, and gas infrastructure

The negative trend in Burkina Faso's budget balance in the scenario of a debt-financed increase in investment in telecommunication infrastructure may be an indication that deficit financing of infrastructure in Burkina Faso may result, in the long term, in debt unsustainability.

Burkina Faso's current account recorded a significant decrease of 13.19% and 11.55%, respectively, for debt and tax, following an increase in investment in electricity, water, and gas. No impact was recorded in the scenario of ODA financing. The findings of this study showed that irrespective of the funding source, financing the electricity, water, and gas infrastructure further decreased the Burkinabè current account (see Figure 7).

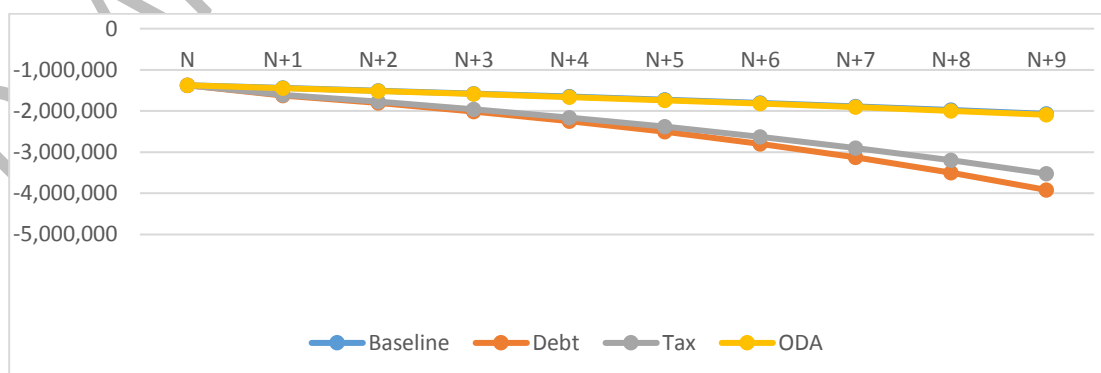


Figure 7: Evolution of current account in the baseline scenario and per financing source following an increase in investment in water, electricity, and gas infrastructure

This negative impact grew over time. The current account declined by 7.68%, 6.37%, and 0.12%, respectively, for debt, tax and ODA-financed increase in electricity, water, and gas infrastructure.

As the balance of trade is a key determinant of the current account, its deficit negatively impacts it. Our results indicate that Burkina Faso's exports grew at a lower rate than imports over the period under study, meaning that the current account deficit widened. In addition, financing the electricity, water, and gas infrastructure, in particular by tax, resulted in an increase in the costs of private enterprises in terms of tax and an increase in the prices of local products on the domestic market. As a result, foreign product imports were privileged at the expense of exports. Moreover, the economic gains, including a balanced current account, derived from an increase in investment in power infrastructure may be offset by an infrastructure deficit in other infrastructure sectors such as transport and telecommunications. It may also imply that a 5% increase in investment in the electricity, water, and gas infrastructure in Burkina Faso is below the threshold needed to affect the country's current account positively.

The findings of this study support early empirical studies (Borojo, 2015; Égert et al., 2009; Perrault et al., 2010; Federreke et al., 2008; Mbanda et al., 2011; Agenor et al., 2006; Dinkelman, 2011; Galinis & Leeuwen, 2000; Dissou & Didic, 2011; Aydin, 2010) that drew on CGE modelling to assess the impact of investment in energy on economic growth. These studies found that investment in energy, which is a key input in the production process, positively impacted economic growth, most notably real GDP, sectoral output production, trade balance, private investment, household income and employment. Borojo (2015) found that in Ethiopia, investment in electricity positively impacted real GDP and output of the industrial and service sectors in all simulations. These findings are very much in line with the results of our study, in which investment in electricity positively impacted real GDP per capita and sectoral output production, irrespective of the funding source. Investment in infrastructure, including electricity infrastructure, positively affected domestic private and foreign direct investment by reducing production costs (Borojo, 2015). Furthermore, it positively affected total factor productivity, thereby enhancing enterprises' contribution to economic growth. The findings of our study also corroborate, in part, the study of Perrault et al. (2010), who found that for electricity, investment funded by tax income was more favourable for some countries. Our study found that debt-financed investment in electricity followed by tax tended to be more beneficial to Burkina Faso. Furthermore, the findings of our study supported Aydin (2010), who found that in Turkey, increased investment in hydropower would result in significant macroeconomic gains for the Turkish economy. The impact included job creation, investment and overall aggregate output production, with substantial effects on sectoral output, trade balance, private investment and overall

economic growth. In addition, the results of our study corroborated the findings of several other studies (Barro, 1998; Kosec, 2014; Sharma, 2010; Fourie, 2006; Galiani et al., 2005; Duflo & Pande, 2007; World Bank, 2003; Sambo, 2005; Stern, 2004; Morimoto & Hope, 2004; Enang, 2010), which found that electricity had a positive impact on aggregate output. Overall, our findings supported the view of ecological economists (Stern & Cleveland, 2004; Stern, 2010), who posited that energy has a significant role in economic growth. They established that energy is a key factor of production spurred by capital and labour.

6.4.2 Microeconomic effects of increased investment in the electricity, water, and gas infrastructure

Increased investment in the electricity, water, and gas infrastructure in Burkina Faso would result in microeconomic benefits, as recorded in Table 3 below. These microeconomic gains are relative to sectoral output production, factor production costs, and factor production income.

Table 3: Microeconomic effects of increased investment in the electricity, water, and gas infrastructure

Microeconomic variables	Percentage change		
	Debt	Tax	ODA
Sectoral output production			
Primary	2.14%	1.75%	0.12%
Secondary	2.17%	1.70%	0.17%
Tertiary	2.14%	1.60%	0.23%
Factor production price			
Agri-labour	2.14%	1.75%	0.12%
Non-agri-labour	-0.02%	-1.04%	0.28%
Family labour	2.17%	1.70%	0.17%
Capital	2.14%	1.60%	0.23%
Factor production income			
Agri-labour	0.09%	0.11%	0.47%
Non-agri-labour	0.08%	0.07%	-0.21%
Family labour	0.09%	0.11%	0.47%
Capital	0.16%	0.16%	0.23%

Primary sector production increased regardless of the funding source. For example, a 5% increase in the electricity, water, and gas infrastructure would raise the production of the primary sector by 2.14%, 1.60% and 0.23% for debt, tax and ODA financing, respectively, with the former recording the highest percentage change.

Production of the secondary sector also rose. It grew by 2.17% for debt-financed electricity, water, and gas infrastructure, 1.70% for tax-financed electricity, water, and gas infrastructure and 0.17% for ODA financing. Similarly, the output of the tertiary sector also increased. It rose by 2.14%, 1.60%, and 0.23% for debt, tax and ODA financing, respectively, for increased investment in the electricity,

water, and gas infrastructure. Growth in consumption levels recorded in Table 6.9 drove sectoral output production. As economic output increased, it positively impacted GDP formation.

Costs rose for labour in the agricultural sector. Agricultural labour costs rose by 2.14% for increased infrastructure investment through debt. It also increased by 1.75% in the tax-financed scenario. ODA financing resulted in an increase of 0.12% in the cost of labour in the agricultural sector. The cost of labour outside the agricultural sector marginally fell. It went down by 0.02% if an increase in electricity, water, and gas investment was financed through debt. The cost fell by 1.04% in the scenario of tax financing and by 0.28% if the increase was financed through ODA. Family labour costs also increased marginally by 2.17%, 1.70%, and 0.17%, respectively, for debt, tax, and ODA-financed increases in the electricity, water, and gas infrastructure. Capital costs rose by 2.14% in the case of an increase in the electricity, water, and gas infrastructure financed via debt. It also increased by 0.60% and 0.23%, respectively, for tax and ODA-financed increased investment in the electricity, water, and gas infrastructure. Income from factor production increased irrespective of the funding source, except for labour outside the agricultural sector, which fell by 0.21 in the scenario of ODA financing. Income from agricultural labour increased by 0.09%, 0.11% and 0.47%, respectively, in increased investment financed through debt, tax and ODA scenarios. Family labour income also increased by 0.09% if the increase in investment was debt-financed. It rose by 0.11% in the case of debt and 0.47% in the ODA financing scenario. Similarly, capital income increased by 0.16% for debt and tax-financed scenarios. It rose by 0.23% if the increase in electricity, water, and gas investment was financed through ODA.

As highlighted by the World Bank (2014), an unreliable and poor power infrastructure affect firm productivity and infrastructure, especially power shortages and costs, and transport bottlenecks are perceived as the main bottlenecks for about 60% of enterprises operating in Africa (World Bank, 2014). In this regard, increased investment in electricity supply is expected to result in positive gains in firm productivity, sectoral output production and private capital formation. The results of our study support the earlier empirical studies that found that investment in power infrastructure positively impacts economic growth. It does so by improving productivity and as a direct input and complement to other production process inputs. The findings of this study also support Agenor et al. (2006), who found that by raising the marginal productivity of all factor inputs, infrastructure lowered marginal production costs and increased the level of private production. This, in turn, may lead to higher private investment, raising production capacity over time and making the growth effect more lasting. Fourie (2006) also found that infrastructure may have an indirect positive effect on the productivity of input factors. Using electrical equipment, one unit of labour per hour would be more productive than one hour's manual labour. The results of our study also corroborate the findings of several other studies (Stern & Cleveland, 2004; Stern, 2010; Borojo, 2015; Dissou & Didic, 2011; Aydin, 2010; Sambo, 2005; Girma, 2000; Parasuraman & Sengupta, 2001), which found that investment in

electricity had substantial positive effects on sectoral output production, factor production and income.

6.4.3 Socioeconomic effects of an increase in investment in the electricity, water, and gas infrastructure

A 5% increase in investment in the electricity, water, and gas infrastructure positively affected household income and consumption levels for poor and non-poor households in Burkina Faso, irrespective of the funding source (see Table 4).

Table 4: Socioeconomic effects of increased investment in the electricity, water, and gas infrastructure

Socioeconomic variables	Percentage change		
	Debt	Tax	ODA
Household income - poor	1.81%	1.36%	0.32%
Household income - non-poor	1.57%	1.20%	0.28%
Consumption levels - poor	1.53%	1.59%	0.36%
Consumption levels – non-poor	1.45%	1.36%	0.31%
Unemployment rate	0.07	0.07	-0.17

* The unemployment rate is expressed as percentage point changes

Household income increased for poor households by 1.81%, 1.36%, and 0.32% for the debt-financed, tax-financed and ODA-financed scenarios, respectively. Non-poor household income rose by 1.57% in the scenario of increased investment in the electricity, water, and gas infrastructure financed through debt. Their income increased by 1.20% and 0.28% for the tax and ODA-financed scenarios, respectively.

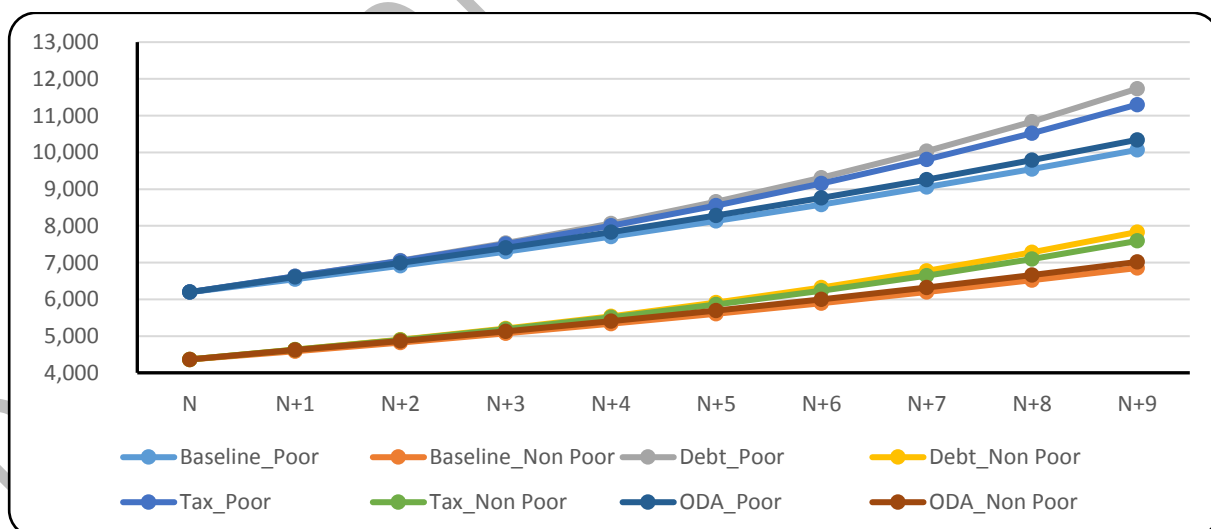


Figure 8: Trends in household income following an increase in investment in electricity, water, and gas infrastructure

Poor households' consumption levels would increase by 1.33% if an increase in the electricity, water, and gas infrastructure were financed by debt. It increased by 1.59% in the tax financing scenario

and by 0.36% for the ODA financing scenario. Consumption levels for the non-poor households rose by 1.45%, 1.36%, and 0.31% in the debt financing, tax, and ODA financing scenarios, respectively.

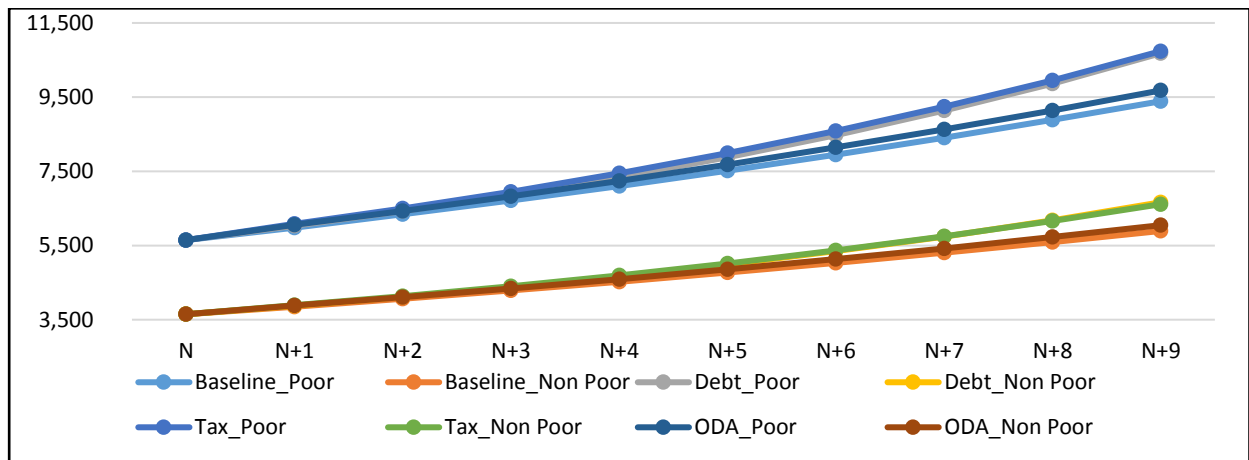


Figure 9: Trends in household consumption levels following an increase in investment in the water, electricity, and gas infrastructure

The unemployment rate reduced marginally by 0.17 percentage points in the case of an ODA-financed increase in electricity, water, and gas investment, while it grew by 0.07 percentage points in the debt or tax financing scenarios.

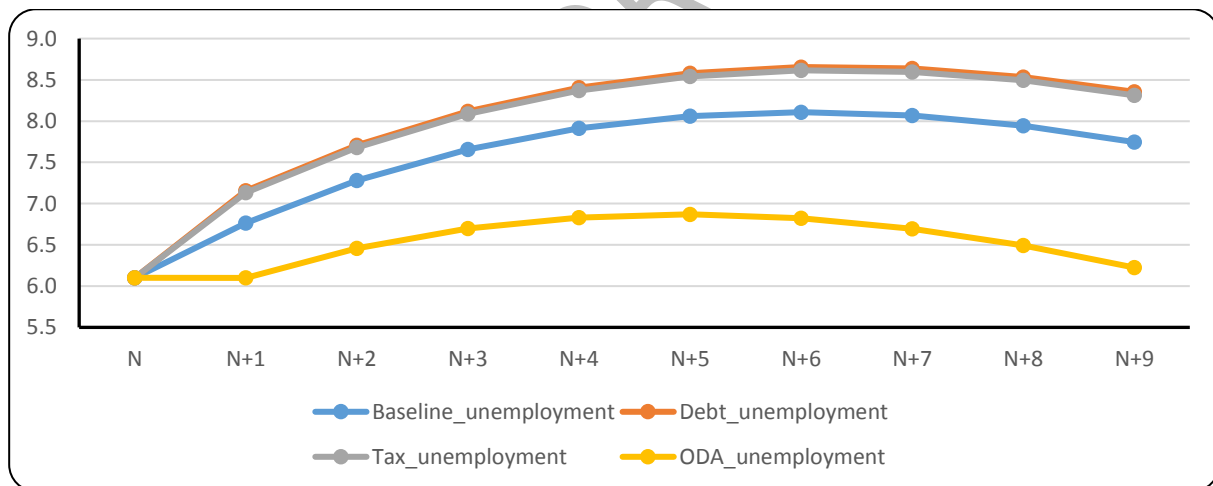


Figure 10: Trends in unemployment rate following an increase in investment in the water, electricity, and gas infrastructure

The above results supported some of the past empirical studies (Borojo, 2015; Aydin, 2010), which found that investment in power positively impacted household income and consumption levels. In addition, it also corroborated the findings of some empirical studies (Sambo, 2005; Aydin, 2010; Girma, 2000; Parasuraman & Sengupta, 2001; Borojo, 2015; Aydin, 2010), which also found that energy provision, irrigation and water supply generate employment.

6. Conclusion and policy implications

Overall, our research findings showed that an increase in investment in energy infrastructure would have a positive impact on economic growth in Burkina Faso. As economic theory predicts and is evidenced by a wide range of empirical studies, infrastructure is a key determinant of economic growth in developing countries such as Burkina Faso.

6.1 *Contribution of the study*

As theory predicted, our findings confirmed that investment in infrastructure is key to economic growth in Burkina Faso. This study theoretically contributes to growth theories by providing evidence that investment in infrastructure may positively impact economic growth, especially in low-income countries with significant infrastructure deficits. Furthermore, because the GCE model is built on WALRAS general equilibrium, our study provides a practical application of this theory in the context of a developing country in Sub-Saharan Africa.

Our study enriches the limited existing literature by investigating the impact of investment in infrastructure on economic growth in Burkina Faso. Except for a few studies undertaken by Briceño and Dominguez (2011) and the IMF, which we touched on earlier in the literature review, very little research has been specifically dedicated to Burkina Faso. While some cross-country studies drew on existing data related to Burkina Faso, their findings provided limited detailed country-specific insights. Our study, by investigating the effect of investment in infrastructure on twelve macroeconomic, microeconomic and socioeconomic variables, provides critical insights into the economy-wide impact of investment in energy infrastructure and economic growth in Burkina Faso. Our study provides evidence covering a wide range of economic variables, not only aggregate output but also microeconomic and socioeconomic variables that very few studies on infrastructure in Burkina Faso provided.

Moreover, our study also expands the literature on the subject in Sub-Saharan Africa. It is worth noting that in Africa, most studies utilised macroeconomic and econometric models to assess the impact of infrastructure on growth. In this regard, this study draws on CGE modelling and makes an important contribution to the subject through the various simulations performed. Furthermore, the comparative analysis of funding sources this study carried out brings an important point of view to the debate about the best-performing source of finance.

This study brings three major methodological contributions. First, our study develops a CGE model that mimics the structure of the Burkinabè economy and analyses the impact of power infrastructure investment in the country. Second, this study incorporates unemployment into the IFPRI model since Burkina Faso's economy is not at full employment, as assumed in the IFPRI model. Third, our study

brings important contributions to CGE modelling in the context of infrastructure investment, particularly for developing countries.

This study provides evidence to policymakers that investment in energy infrastructure contributes significantly to Burkina Faso's economic growth. Furthermore, our study's findings support Burkina Faso's current public policy strategy, especially the Plan National de Developpement Economique et Social, in which energy infrastructure is a key strategic pillar that is expected to significantly contribute to the structural transformation of the Burkinabè economy.

The review of literature and the findings of our study show that financing sources matter as economic benefits derived from investment in energy infrastructure may vary by funding source. In this respect, it would seem reasonable for Burkina Faso to target a mix of funding sources combining debt, tax and ODA with a strategic view of debt sustainability. However, As Ewuosho put it, "attracting investment is one thing but channelling the investment in the most useful context that maximises the outcomes for a given population is a separate challenge" (Ewuosho, 2020).

In Burkina Faso, while infrastructure strategic and operational plans exist, they fail to account for the wider value and benefits that infrastructure investment is expected to provide to the country. As Flyvbjerg (2007) notes, a key feature of failed infrastructure projects is the lack of clearly articulated value and benefits. Moreover, developing disjointed pieces of infrastructure would unlikely deliver an economic impact at scale since the underlying foundation for cross-cutting infrastructure strategic planning involving various stakeholders is not in place. Therefore, our study recommends that policymakers in Burkina Faso clearly articulate and quantify the value and benefits that could be derived from power infrastructure outside its core function in their strategic planning.

While our research brings some important contributions to the theory and empirics of infrastructure and economic growth, as well as methodological and policy contributions, there are limitations in our study.

The first limitation of the study largely emanates from the limitations of CGE modelling. There is often uncertainty over parameters, specifications, and experimental design. In CGE modelling, the benchmark equilibrium implies functional forms requiring a choice of elasticities and other parameter values based on empirical work. In addition, CGE models focus on the relationship between relative price changes and the flow of goods and services, not levels of prices. Moreover, data requirements of CGE models are substantial as CGE models are data-demanding and do not tolerate inconsistencies in data. Therefore, CGE models are not ideally suited to handling some macroeconomic questions. It is worth noting that CGE models do not answer all the questions. Hence, it should be ideally used together with other tools and models. The second limitation of our study is that our model does not capture the induced social benefits of increased investment in

infrastructure. In addition, our model, which is mainly quantitative, does not account for infrastructure's quality and access dimensions.

Finally, we also formulate four potential areas of interest for future research direction. First, researching infrastructure requires a multidimensional approach. Scholars increasingly embrace a more holistic approach to studying infrastructure as a system. In this respect, infrastructure type or right amount, infrastructure best geographical area or optimum level, and integrating all dimensions of quantity, quality and access should be duly considered. This study recommends researching infrastructure as a system in the context of Burkina Faso.

Second, empirical reviews suggest that power infrastructure has large externalities and spillovers, especially in the health and education sector in low-income countries in Sub-Saharan Africa, such as Burkina Faso. Given the crucial role that health and education play in the country, future studies on the economy-wide impact of investment in power infrastructure in Burkina Faso should attempt to capture and quantify these externalities. Agenor (2006) stipulates that rather than increasing direct spending on health or education, “the best way to increase production of health services, raise output growth, and improve welfare may be to invest more in infrastructure” (Agenor, 2006). In this regard, and given the limited financial resources at play in Burkina Faso, this study recommends that due consideration be given in future research to testing Agenor’s assertion in the context of Burkina Faso.

Third, amid climate change impact in developing countries and given that adaptation finance to date compared to mitigation still receive a small portion of climate finance, building resilient infrastructure systems upfront in Burkina Faso would be key in the long-term economic growth of the country. According to the Global Commission on Adaptation, every \$1 invested in making new transport infrastructure resilient to climate change, for instance, could yield almost \$5 in benefits (GCA, 2022). Investing in a resilient energy infrastructure, therefore, makes sound economic sense. Our study recommends that future studies consider options to draw on CGE modelling to investigate the wide economic impact of climate-resilient energy infrastructure in Burkina Faso.

Finally, given the severe impact of Covid-19 on developing countries’ economies, a future study delineating its impact on the power sector in Burkina Faso would be welcomed as it would provide additional recommendations for policy measures.

Overall, our research findings showed that an increase in investment in energy infrastructure would promote growth in Burkina Faso. This research provides evidence in support of the PNDES in which investment in energy is a key strategic pillar. At the same time, this study calls on policymakers to carefully consider the funding source as it may negatively impact some economic variables. Moreover, this research urges policymakers to consider accounting for the wider value and benefits of power infrastructure in Burkina Faso’s infrastructure investment strategic planning.

DRAFT: NOT FOR PUBLICATION

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