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analysis

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Abstract

Ever since the end of the Biafra war, re-exportation has become an important economic activity for Benin's economy. One of the reasons for the existence of this type of commerce resides in the disparity in economic policies between Benin and Nigeria. We model this sector and its interrelations with the remainder of the economy as well as on public finances. A CGE model was developed with data from Benin's social accounting matrix for 1999. In the model, we distinguished between formal and informal households (households that work in the informal sector) and a distinction was incorporated into the model in regards of the re-exportation industry by dividing the latter into its 8 most important re-export sectors. We simulated a 10% depreciation of the CFA F and a 20% decrease in import tariffs. Our findings demonstrate a great sensitivity of government's revenues to the activity of this informal sector. For one simulation, public savings dropped by almost 25%, but in both cases, the government's income was strongly affected.

JEL Codes: F10, H61, C68

Keywords: CGE model, informal trade, Benin, Nigeria, public finance

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Introduction

In Africa, like in South America, informality is often analysed through its labour markets. Taxes are difficult to collect in remote places, and institutions are often porous and corrupted. In 1993, the informal sector accounted for 41% of the total employment in Benin and 27.3% of the total GDP (Charmes, 2000). Although these informal activities happen throughout the economy, one of the most important components of the Beninese informal sector is the trans-border trade with its neighbours. According to Tassou (2007), the government's share of trade tariffs collected from informal trade would represent about 14% of all fiscal revenues in Benin. The Integrated Framework (2005) claims that informal trade represents about 15% of all fiscal revenues and around one third of trade revenues. Most of this commerce is done with one of its most importing trading partners and neighbours, namely Nigeria. The Integrated Framework (2005) assessed that about 7% of official exports were intended to Nigeria over the 2000-2002 period and re-exportations are believed to represent about 6% of the total GDP of Benin. Several reasons explain the existence of the informal trade, among which figures a much greater level of barriers to trade in Nigeria compared to Benin. In 2004, the average tariff was around 28% in Nigeria compared to about 12% in Benin (Integrated Framework 2005). The Nigerian domestic market protection opens the path to smuggling through the porous borders between the two countries. Beninese illegal re-exportations is sensitive to changes in relative prices between the two markets. Indeed, Beninese import goods arrive formally from around the world and economic agents in Benin re-export them afterwards directly to Nigeria, illegally. Some goods, such as used cars, used clothes, or wheat are banned from being imported into Nigeria while other commodities (e.g. rice, tobacco, and sugar) face tariffs up to 110% of their value. Prohibition of imports has often been focused on agricultural products such as meat, cereals, and manufactured goods (e.g. textiles) (Bankole *et al*, 2005). The presence of two different currencies, the Naira in Nigeria and the CFA Franc in Benin, instead of a single one opens the door to speculation on the future value of the currencies and some price negotiations¹. In addition to this, there are two prevailing exchange rates: the formal one and the parallel one. Although,

¹ This situation does not prevail with other neighbors to Benin as they all use the same currency. Moreover, trade policies are quite similar in other countries albeit the import duties are the lowest of all UEMOA countries.

differences exist between the two exchange rates, the gap is usually small, except for the 1994-1998 periods where there was a noticeable difference between the competing exchange rates.

This type of commerce is made possible through various factors among which we have : 1) a modern road network and water ways or routes difficult to access by custom officers; 2) warehouse-cities such as Cotonou which have developed a major infrastructure to serve as gathering and distribution centres; 3) border markets that act literally as negotiation centres between most of the concerned agents; and 4) frontier-warehouses allow stocking and adjustment to the Nigerian demand (Igue and Soule, 1992). The aforementioned authors also propose that economic policy disparities between Nigeria and Benin are, in fact, the main elements responsible for both the preponderance and growth of this economic activity.

Notwithstanding infrastructures already put in place, Flynn (1997) describes the culture of the border that facilitates the circulation of goods to Nigeria. Border residents are permitted to travel across the border without having to pay a passage fee when the trip is made to visit relatives, to participate in religious ceremonies, or for local consumption and distribution of exchanged goods. Obviously, that relative liberty of movement is being exploited to finalise and ease the re-exportation process. Flynn (1997) also suggests that some level of complicity exists between border residents and frontier guards, which allows, through the corruption of the latter, a persistent informal trade flow.

In 1984-85, the Nigerian military government closed the border in order to control the flow of commerce between Nigeria and Benin, but reopened it a few months afterwards because of the relative inefficacy of the measure. In addition to the obvious tensions that the policy created, the episode provoked a severe variation in Benin's fiscal revenues, making clear and observable the dependency that Benin maintains with its neighbour. During this period, the Beninese government was required to ask for International Monetary Fund (IMF) support through this period. Although gathering income taxes and export taxes on informal trade is nearly impossible, depriving Benin of considerable revenues, the State benefits from the informal sector because imports are formal and, therefore, taxable. The amount is sufficiently important to make any discussions on informal trade status relatively ambiguous. More recently, in 2003, using a concern with national security as a pretext, Nigeria once again ordered to shut down the frontier with Benin. This chapter of the unsteady commercial relationship between the two

countries only lasted days and did not affect Benin as much as longer events but contributed to fuel tensions once again.

As more and more African countries constructed social accounting matrices, combined with the fact that computers allowed for the resolution of complex models, more computable general equilibrium (CGE) models were developed for African economies and Benin was no exception. The reliance upon partial equilibrium models to explain complex phenomena with several ramifications can cause both misguidance in the design of public policies and misunderstanding of the real effects of an exogenous shock. Therefore, CGE models for Benin have been developed in recent years for Benin, which inspired us in the elaboration of our model.

Savard and Adjovi (1998) constructed a CGE model to investigate the externalities of health and education expenditure in Benin in the context of trade liberalization, and they integrated unemployment in their model. As it has been exposed, Benin relies heavily on import duties to finance public expenditures. The standard CGE models generally find that a reduction in import duties improve households' welfare. The authors show that in presence of unemployment and when externalities are accounted for, the decrease in government expenditures, subsequent to lower tariff revenues, might indeed reduce households' welfare. This paper contributes in showing that policies which modify tariff revenues can strongly impact the welfare of Beninese.

Gautier (2000), in his model, focused on trans-border trade. He modeled the informal goods as being part of a monopolistic market, and also analyzed the potential impact of an endogenous mark-up compared to the effects of a fixed mark-up in the re-exportation sectors. However, we will sever from this hypothesis in our model. Indeed, while there are certain barriers to entry within the Yoruba group, there are also other organised groups that exert the same re-exportation profession. Furthermore, the role of intermediary played by local border residents suggests a much greater implication than the mere transport of merchandise to Nigeria. It is a well organized trade in which several agents interact with one another in a complementary way and in which one can hardly imagine that some entry barriers could be maintained and exist to justify the existence and persistence of imperfect competition. He concluded that a liberalization of trade Nigeria would provoke a net deterioration in revenues for the Beninese

economy. This study disaggregates the economy into formal and informal, and provides information on the importance of the informal sector in Benin.

Decaluwe, Adjovi, and Robichaud (2008) studied the impact of trade liberalization in Benin on poverty. More specifically, they investigated the elimination of import duties combined with the introduction of a value added tax. Their study revealed the vulnerability of rural poor households who suffered and increase in poverty rate.

The objective of this paper is to analyse policy changes in Nigeria that affect informal trade between the two countries with a CGE model of Benin that takes into account the re-exportation sector. We have simulated an appreciation of the exchange rate between the CFA Franc and the Naira of 10%, and an import tariff decrease. More precisely our objective is to understand what will be the likely effects of these measures on the economy and especially their fiscal impact.

B. Methodology

Benin's economy is described through a social accounting matrix (SAM) elaborated by Fofana and *al* (2004). The structure of the SAM contains a total of 23 production sectors - 15 formal sectors and 8 informal branches². The formal sectors include the subsistence agriculture, industrial agriculture, agro-industry, cotton shelling, agro-crafting, other modern industry, textile industry, transport and communication, other commercial services, electricity and water, other crafting industries, banks and insurance, other public services, public health, and public education. We performed some modifications in order to incorporate the re-exportation sector. Gautier (2000) identified 10 "key products" of re-exportation that account for 90% of the total value of the commerce. We retained eight of them- the most important ones- and left the other two in the formal branches given the lack of data available on these two sectors. Since imports intended for re-exportation purposes are declared in the local consumption category, we used import data related to the key products contained in the SAM, provided by the Beninese ministry of finance (2006) as a starting point. The latter SAM offered the advantage of being much more detailed concerning product-by-product foreign trade. Re-exportation of imports would

² We refer to informal sectors as the ones involved in informal trade with Nigeria. Hence, some sectors traditionally considered informal such as subsistence agriculture are grouped in formal sectors in our model.

constitute about 66.5% of all imports of “key products” and the value added rate is estimated around 32% in those sectors (Gautier, 2000). Informal sectors include meat, milk and other dairy products, drinks, alcoholic beverages and vinegar, sugar, textiles and tissue, second-hand clothes, vehicles, and rice. There are two factors of production: labour and capital. The agents in the model are the government, households, firms, the rest of the world, and Nigeria. Usually, models only include the rest of the world, but since we want to isolate the impact of the trade with Nigeria on Benin, we included Nigeria as a separate agent. Furthermore, households are separated into two categories: formal and informal. Informal households are households that work in any of the informal sector of re-exportation while formal households are the ones employed by any other sector of the economy. We suppose that people working in the informal sector do not work simultaneously in the formal sector. We assume that re-exportation sectors are more capital-intensive and that thus, the value added is comprised of 70% capital and 30% labour. In these sectors, we make the assumption that the total amount of input is imported and that everything is sold to Nigeria. While some informal commerce exists with other neighbouring countries, the most important client for this type of commerce is undeniably Nigeria. Consequently, we consider that domestic sales of the “key products” are included in other sectors, already incorporated in the SAM. For example, there is a sector called “textile industries” and also an informal sector entitled “textiles and fabric”. To balance out our SAM, we assumed that all sales in the local textile market, as well as all formal exports to the rest of the world, we done by the formal sector “textile industries”, whereas all re-exportations to Nigeria were drawn from in the informal “textiles and fabric” sector. Since re-exportation does not involve any production capacities of the good itself, it is logical to assume that the production of textiles is done by a different set of workers than the re-exportation business. Nevertheless, intermediate consumption of the informal branch is not solely limited to the consumption of its own product, since we have included other intermediate consumptions grouped into three sectors that represent other costs that the informal firms need to perform their activity (e.g. transport, gas and storage costs).

Our model is a modified version of EXTER of Decaluwe et al (2001). It is a model of a small open economy. Production is determined by a three-level system: output (XS), value added (VA), and intermediate consumptions, all related by a Leontief function. The relationship determining the value added uses a Cobb-Douglas relationship between labour (LD) and capital

(KD). Intermediate consumptions are calibrated as fixed shares corresponding to the coefficients input-output computed in the matrix.

Households' income is a function of factor payments (labour and capital) to which are added all exogenous transfers from other agents. We assume that "informal households" do not receive exogenous transfers either from the government or from firms, but receive a proportional part of transfers coming from the rest of the world. These exogenous transfers can take the form of remittances. One of the reasons that justify the absence of exogenous transfers from the government to informal households resides in the relative lack of financing of infrastructures by the government in frontier regions dedicated to trans-border trade. According to Flynn (1997), border residents perceive the government both as a catalyst and a culprit for many of their economic woes. This belief is enhanced by the fact that few or no support for economic development and infrastructure development is provided by the government in remote places where informal trade is more developed. Combined with lack of social nets, this situation creates a spirit of solidarity between households in border regions. In such circumstances, it seems reasonable to omit an exogenous transfer toward informal households.

Firms' revenues are composed of the capital payment not attributed to households plus all exogenous transfers from other agents. Finally, the government's revenues come from sales taxes, income taxes, import and export tariffs, to which exogenous transfers from other agents are added. Households and the government spend their budget on goods and services, on exogenous transfers and savings. The negotiation process that allows goods to illegally cross the border includes bribing border officials. These bribes are mostly fixed fees and are not proportional to the value of the merchandised being transported. Therefore, the bribes are included in the exogenous transfer made by informal households to Nigeria.

The price equations are standard. World prices of import and export are exogenous except for the informal sector. The informal re-exportation price is determined by the production price adjusted to the prevailing exchange rate, which means that Benin exerts an influence over the export price for the Nigerian market. Taxes are imposed on domestic goods and a tariff is imposed on exports and imports. Once again, informal goods escape domestic sales taxes and the export tariff but they face import duties. A GDP deflator is used as a price index and hence is supposed exogenous in our model.

To determine exports on the two foreign markets we have two type of hypothesis. First we have the formal exports and then the informal exports. For the formal exports, we use a nested CET system. This function reflects the hypothesis that products sold locally are differentiated from those exported. At the first level, we decompose the total production into the portion sold on the domestic market and an aggregate export good. We use a constant elasticity of transformation function (CET) to determine the supply of those two goods on the export and local markets. We then use another CET function (nest) to decompose the aggregate export good and determine on which of the two foreign markets it will be sold, namely the rest of the world and Nigeria. The exports supply derived from these CET function results from the firm's revenue maximisation problem. Obviously, export demands from the rest of the world are influenced by the relative prices between the Nigeria and the rest of the world and the transformation elasticity of the given good.

On the informal market, as was stated, all imported goods are re-exported and hence the function is a strict equality. However, for these goods, the exporters will face a demand with a finite elasticity in the Nigerian market. The exchange rate between the Naira and CFA franc and the brides will intervene to influence the supply of informal export on this market. For the formal goods, we that exports sectors face a demand with an infinite elasticity, which is to say that there is no constraint to the quantity on the two markets.

As for imports, we also distinguish between the formal and informal sector goods. For the formal market we also have a nested system based on the on the Armington (1969) assumption and hence we use a CES function to model the local demand for an aggregate import and locally produced good. The aggregate import is then decomposed by goods originating in Nigeria and the ones coming from the rest of the world. The relative price of the goods coming from the two markets will play a key role in the demand as well as the elasticity of substitution between the goods of the two markets. The demand for informal imports is determined by the intermediate demand of a given sector that will re-export this good in Nigeria.

We close the model by fixing the world prices, the exchange rates, employment, and the level of government expenditures. Investment and the two current accounts balance are endogenous.

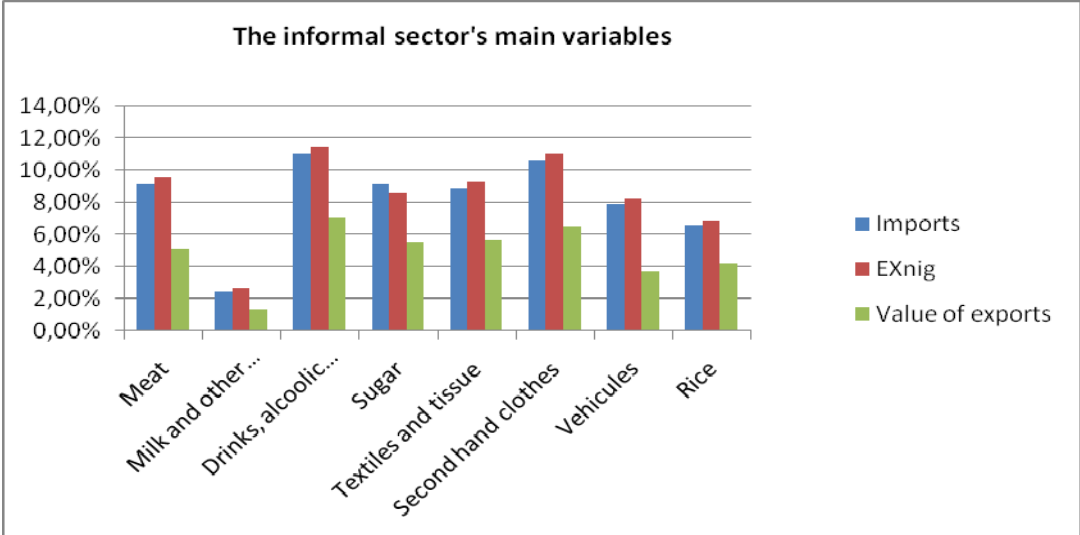
C. Simulations and analysis

C.1 Simulation 1: decrease in tariffs

We simulate a decrease in import duties in the model. Interestingly, the effective tariffs in the Sam are higher compared to the administrative tariffs dictated by the UEMOA agreements of the Common External Tariffs. We simulate a 20% decrease in Tariff rates.

At the informal level, the decrease in the import price provides the informal sectors with a comparative advantage over their rivals since they can provide cheaper goods at the border³. This modification in the relative price, caused by this new trade policy, stimulates the demand for Beninese re-exportations and for informal imports. As expected, sectors with the higher tariffs are the most strongly stimulated. Accordingly, the sectors of “*drink, alcoholic beverages and vinegar*” and “*second-hand clothes*” are the biggest beneficiary. The value of re-exportations increase as depicted in Graph 1.

Graph 1: Trade in the informal sector (simulation 1)



³ Their competitors can come from other neighboring countries or within the country itself.

With output increasing, informal employment is strongly stimulated as well. A consequence of this effect is the growth in informal household revenues and savings by about 10%. Finally, the important rise in re-exportations explains the strengthening of the current account surplus with Nigeria by 5.6%.

For imports of formal branches, the tariff decrease produces a modification of the relative price between imports and domestic demand, making imports relatively more interesting for the domestic consumers. This translates into an increase in total imports by all formal sectors⁴. On the other hand, since import tariffs with the rest of the world are not the same as those with Nigeria- those with the rest of the world being equal or superior- there is a reallocation that takes place in terms of the origin of import. This increases the portion of imports coming from the rest of the world and reduces those coming from Nigeria. The increase of imports from the rest of the world by Benin's importing firms widens the current account deficit observed with the rest of the world by 34.8%. The value of global imports slightly diminishes notwithstanding an increase in the informal sector's value of imports, which is mainly attributed to the deterioration of the imports value in the most important importing formal sector, "*other modern industries*".

Also, even though informal households enjoyed an increase in their revenues, whereas formal households' revenues remained relatively unchanged, their small weight in the economy and the government's inability to collect income taxes or export duties account for the fact that there is relatively little compensation for the government at the fiscal level for the stimulation of this informal sector in the Beninese economy. As is shown in Table 1, income taxes slightly decrease for both households and firms.

Table 1: Government's revenues

Variables	Sim 1 ($\Delta\%$)
Sales tax	-1.60%
Import duties	-16.89%
Export taxes	-0.59%
Houshold income tax	-0.23%
Firm's income tax	-0.41%
Government spending	0.18%
Government income	-7.53%
Government savings	-24.73%

⁴ With the exception of *other commercial services* for which we will provide an explanation later

Notwithstanding the significant imports increases in the informal sector, customs revenues have decreased severely for most of the sectors; the 20% import tariff reduction creates a decrease in import tariffs revenues of nearly 17%. The main consequence of this lessening in revenues has been to decrease the government's revenue and savings by 7.53% and 24.7% respectively. Although the informal sector is relatively small, lower duties in this sector account for 20.7% of the total deterioration of import duties revenues and 19.4% of the government's revenues decrease.

Let us now concentrate our analysis on the impact on the six formal importing sectors. First, we observe the first order effect aforementioned for all formal sectors. The subsistence agriculture sector does not change much given it's the small portion of imports in the composite good supplied on the local market. The reduction in output of this sector is explained mainly by the reduction of investment demand.

Table 2: Value added variations in the formal sector (sim 1)

Variable	Sectors	Reference	Sim 1 ($\Delta\%$)
Value added (VA)	Subsistence agriculture	461187	-0.48%
	Crop agriculture	95009	0.17%
	Agro industrie	17294	2.08%
	Cotton transformation	14640	1.54%
	Cottage agro-industry	48600	-1.32%
	Modern Industries	17212	-1.46%
	Electricity & Water	11419	2.43%
	Textile industries	10881	-1.24%
	Other cottage industries	72111	-0.61%
	Transport & communication	92167	3.64%
	Banks & insurance	25466	1.44%
	Other commercial services	359236	-0.04%
	Other public services	56970	0.18%
	Education services	29886	0.18%
	Health services	6538	0.18%

Since the crop agriculture sector does not import much, it is less exposed to competition from imports and slightly increases its output (+0.17%). The “agro-industry” sector is one of the most positively affected by this simulation with an increase of just over 2%. The “*textile industries*” and “*modern industries*” sectors are relatively similar in terms of their economic structure and behaviour. With the most elastic demand for imports, these sectors increase their

imports and decrease their supply on the local market coming from domestic production. This effect in combination with the decrease in price of imports allows for a decrease in market price of than 3% each. The *textile industries* also suffer from a reduction of output and market price. For this sector, the reduction in investment demand also plays an important role in the total output of the sector. As for *other commercial services*, the low ratio nearing imports in total supply (10%) is at the source of the effects on this sector. As oppose to other importing sectors, it is the only one to diminish imports following the simulation. This comes from the low initial tariffs and the reduction in demand on the local market.

As for prices, the producer price diminishes for all sectors in response to a decrease in the import price and the domestic goods price, the only exception being the “banking and insurance” sector which does not import any services and it experiences a relative demand increase resulting since the reduction in investment demand does not affect this sector. Re-exportations sectors observe the most notable and significant variations, which are between 1% and 4%.

Table 3: Variations of the production prices in the simulation 1

Variable	Sectors	Reference	Sim 1 (Δ %)
Production price (P)	Subsistance agriculture	1	-0,03%
	Crop agriculture	1	-0,22%
	Agro industrie	1	-0,43%
	Cotton transformation	1	-0,10%
	Cottage agro-industry	1	-1,00%
	Modern Industries	1	-1,77%
	Electricity & Water	1	-0,01%
	Textile industries	1	-1,61%
	Other cottage indutries	1	-1,83%
	Transport & communication	1	-0,82%
	Banks & insurance	1	0,34%
	Other commercial services	1	-0,67%
	Other public services	1	-0,18%
	Education services	1	-0,18%
	Health services	1	-0,18%
	Meat	1	-3,74%
	Milk and other diary products	1	-1,10%
	Drinks, alcoholic beverages and vinegar	1	-3,56%
	Sugar	1	-2,47%
	Textiles and tissue	1	-2,92%
Second-hand clothes	1	-3,67%	
Vehicles	1	-3,88%	
Rice	1	-2,20%	

Finally, on the macro level, the wage rate is slightly increases since the sectors most negatively affected are more capital intensive. As for total investment, it decreases by 3.15%, which is mainly attributable to the drop in the government savings (-24.73%). As we have seen, this drop in total investment plays a role on the demand for a number of sectors. The current account deficit with the rest of the world has increased substantially and the surplus with Nigeria as also increased by only by 5.6%. This reflects the fact that the re-export sector has been stimulated by the reduction on cost of its inputs (imported goods to be re-exported)

Table 4: Macroeconomic variables in simulation 1

Variables	Reference	Sim 1 (Δ %)
Formal households' revenue (YM1)	1285343	-0.23%
Informal households' revenue (YM2)	34822	9.81%
Wage rate (S)	1	0.41%
Firms' revenue (YE)	172360	-0.41%
Current account (Rest of the world)	40565	34.81%
Current account (Nigeria)	-176196	5.59%
Total investment (IT)	493600	-3.15%
GDP	2450555	0.38%

C.2 Simulation 2: An exchange rate diminution

Historically, as underlined in Igue and Soule's book (1992), the Naira was often devaluated compared to the CFA F. Notwithstanding, socio-anthropological factors and, even more, economic policy disparities, the authors stress the role that the coexistence of two separate currencies can have on informal trade changes. Simulating an exchange rate variation provides an illustration of the extent of Benins' vulnerability to Nigerian Central Bank policy changes. In this context, we simulate a 10% appreciation of the naira compared to the CFA F.

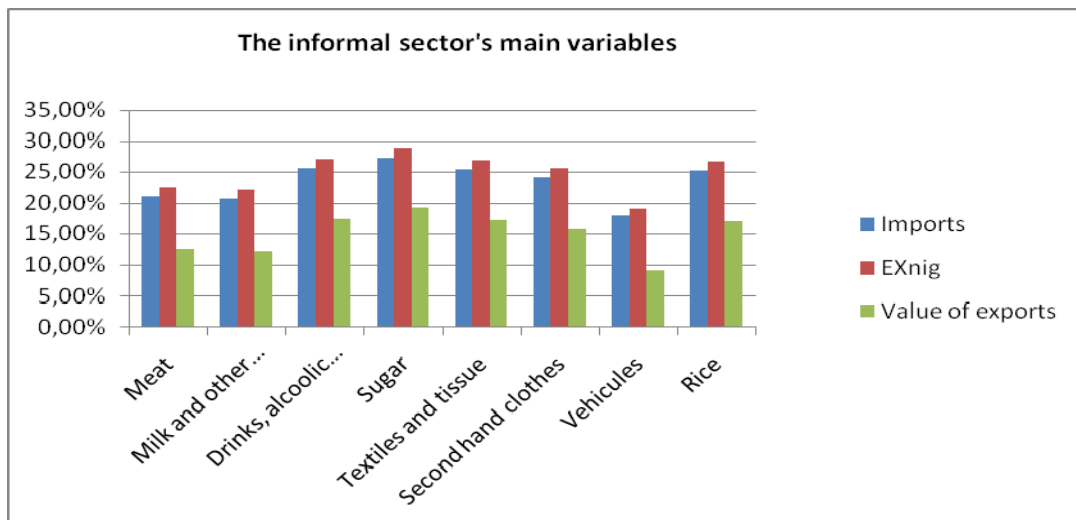
The naira appreciation produces an increase in competitiveness for Beninese re-exporter as well as the formal sectors exports. Hence, the Nigerian demand for Beninese re-exports and export grows. Since re-exporters need to increase imports to respond to the increase in demand, the informal sector will grow and stimulate informal employment. Indeed, informal employment increased, by 78.97% to 132.81% depending on the sector. Benin's informal households income will also increase substantially (+32.56%).

Table 5: Prices in the informal sector

Variable	Sectors	Reference	Sim2 ($\Delta\%$)
Production price (P)	Meat	1	1,09%
	Milk and other dairy products	1	1,25%
	Drinks, alcoholic beverages and vinegar	1	1,55%
	Sugar	1	1,87%
	Textiles and tissue	1	1,60%
	Second-hand clothes	1	1,39%
	Vehicles	1	0,81%
	Rice	1	1,65%
Market price in domestic currency	Meat	1	-8,10%
	Milk and other dairy products	1	-7,96%
	Drinks, alcoholic beverages and vinegar	1	-7,69%
	Sugar	1	-7,39%
	Textiles and tissue	1	-7,64%
	Second-hand clothes	1	-7,83%
	Vehicles	1	-8,36%
	Rice	1	-7,59%

The “sugar” “drinks, alcoholic beverages, and vinegar” sectors are the two most stimulated sectors in the informal economy with an increase in output of nearly 30%. The government also benefits from the informal branches’ stimulation, since import duties on goods to be re-exported sectors have grown by more than 23%⁵.

Graph 2: Trade variables in the informal sector (simulation 2)



⁵ The 6,07% increase in duties presented later includes all sectors. Tariffs from re-exportation sectors are a stimulus since they increase by more than 23%.

The total amount of import taxes collected does not change in the formal sector (less than a tenth of a percent) whereas re-exportation provides about new revenues from import duties for the government. Overall, including the export tariffs variation, it accounts for a 6.03% increase in tariff revenues for the government. The income tax from formal households decreases by 0.9% and by firms for -0.53%. On the other hand, sales tax decrease more significantly by 1.79%, it is mainly the increase in import duty revenues caused by the stimulation of the informal sector that explains the 2.17% increase in the government's fiscal revenue and the 7.11% in its savings.

Table 6: Government's revenue (simulation 2)

Variables	Sim 2 ($\Delta\%$)
Sales tax	-1,79%
Import duties	6,07%
Export taxes	-0,98%
Household income tax	-0,90%
Firm's income tax	-0,53%
Government's spending	-0,53%
Government's income	2,17%
Government's savings	7,11%

The appreciation in the exchange rate also changes domestic prices in favour of Benin for exports and in disfavour of Benin for imports when imports come from Nigeria. These price changes are translated by a reallocation of exports and imports. It becomes more interesting for Beninese to export to Nigeria than to sell on the domestic market and to buy resources from domestic sources rather than importing them from Nigeria. Also, because exports to Nigeria are more interesting compared to the rest of the world, there is a reallocation between the two destinations by the exporters. Similarly, importers prefer to import from the rest of the world rather than from Nigeria. Therefore, the current account deficit with the rest of the world, increases by 78.55%, and the current account surplus with Nigeria, grows by 20.26%.

Notwithstanding the rise in public savings, the effect of the worsening current account deficit with the rest of the world has pushed total investment in the economy downwards by 4.19%. The *subsistence agriculture* sector, *crop agriculture*, *modern industries*, *commercial services*, and *textile industries* are all affected to the reduction in total investment and by reallocation between imports and local production. Although exports to Nigeria increase, the

impact on total exports is relatively negligible, being inferior to 1% in all sectors. This is explained by a relatively low share of exports to Nigeria in total exports. The “*electricity*”, “*Banks and insurance*”, and the “*agro-industry sectors*” are the ones increasing the most since they import the least and are not affected by the decrease in investment demand.

Table 7: Value added in the formal sectors (simulation 2)

Variable	Sectors	Reference	Sim 2 ($\Delta\%$)
Value added (VA)	Subsistence agriculture	461187	-1,01%
	Crop agriculture	95009	-0,77%
	Agro industrie	17294	1,44%
	Cotton transformation	14640	0,76%
	Cottage agro-industry	48600	-2,23%
	Modern Industries	17212	-0,42%
	Electricity & Water	11419	2,77%
	Textile industries	10881	-0,92%
	Other cottage industries	72111	-2,31%
	Transport & communication	92167	0,74%
	Banks & insurance	25466	1,55%
	Other commercial services	359236	-1,12%
	Other public services	56970	-0,53%
	Education services	29886	-0,53%
	Health services	6538	-0,53%

The “*cotton transformation*” also increases its total production, as well as its employment level, because of the strong exports and it benefits from its competitive gains on the Nigerian market. The “*banking and insurance*” sector increase its production by 1.55% whereas the “*other cottage industries*” decrease its production by -2.31%. Branches that do not export or for which the export/domestic demand ratio is low are the main losers in the simulation since they are relatively incapable of taking advantage of the appreciation of the Naira to increase their production. The three public sectors (*other public services, education and health services*) sectors are more negatively impacted compared to simulation 1. The increase in the cost of their intermediate inputs and the wage rate is at the source of the reduction of output in volume. All public sectors decrease by 0.53%.

As for the factor payments, the real wage rate⁶ increases slightly by 0.78% given the pressure put on the labour market by the informal re-export sectors. In regards to the rental rate of capital, we observe increases for sectors expending their production.

Table 8: Macroeconomic variables (simulation 2)

Variables	Reference	Sim 2 (Δ %)
Formal households' revenue (YM1)	1285343	-0.90%
Informal households' revenue (YM2)	34822	32.09%
Wage rate (S)	1	0.78%
Firms' revenue (YE)	172360	-0.98%
Current account (Rest of the world)	40565	78.55%
Current account (Nigeria)	-176196	20.26%
Total investment (IT)	493600	-4.19%
GDP	2450555	0.85%

D. Conclusion

The simulated changes strongly influence the wealth of informal households, but have very little impact on formal households. Although no welfare analysis was conducted, it is reasonable to assume that informal households are worse off than formal households for the first simulation and the opposite is observed in the second simulation. In the first simulation, the income of formal household increased substantially and in the second one, an even greater increase is observed for the informal household. One of the reasons to justify the fact that we did not perform a welfare and distributional analysis resides lack of information in household surveys on involvement or non involvement in the informal trade with Nigeria. A number of issues would be interesting to analyse in this context. Indeed, petroleum is often sold informally at a relatively advantageous price for Beninese, which clearly benefits low income households. It is reasonable to believe that a border shutdown or a much more severe control of the borders would have a stronger and more negative effect than the impacts described above for re-exporters. Moreover, the objective of this paper was to model the re-export trade and its interaction with the rest of the economy, and that is why informal imports were not integrated as well as distributional analysis. Nevertheless, it would certainly be interesting to incorporate them in a later work.

⁶ The wage rate, S , is in fact the nominal wage rate, but since the level of price is exogenous to the model, it can be understood as being also the real wage rate,

The second simulation demonstrated more clearly at what point the re-export sector interacts relatively strongly with the rest of the Beninese economy, and, more specifically, on the government's revenues. This simulation on a hypothetical exchange rate change between the naira and the CFA F illustrates this strong link and its importance for public policies reforms. On the one hand, the informality of the re-export trade deprives the State of fiscal revenues linked to the interior taxation on products and households, but, on the other hand, re-exports can prove to be a stimulus to the Beninese economy. Being dependent upon the Nigerian demand for re-exports, the government's revenues are volatile and vulnerable, which undermines the Beninese government sovereignty of economic policies. In the second simulation, informal trade and the tariffs revenues are at the source of the increase in the government's revenues, whereas in the first one, the informal sector contributes slightly less than 20% of the decrease in the government's revenues. The latter demonstrates a strong dependency upon tariff revenues, and this can lead to a greater concern: fiscal revenues, employment and total output can be strongly influenced by countries with which Benin trades, especially Nigeria. The empirical facts presented by Igue and Soule (1992) confirm the fragility of Benin's economy exposed to decisions that might be taken outside of the country and that could have strong consequences in Benin. Finally, Gautier's (2000) CGE model did not have the same objectives as ours, and the modeling of the re-exports sector was also different. Nonetheless, when he simulates an increase in tariffs, he discovers that under the hypothesis considered, the government also registers an increase in fiscal revenues between 18.7% and 19.1%. Their results are compatible with ours with numerous different hypotheses which reinforce our conclusion on the importance of this sector for the Beninese economy and the vulnerability of the government to outside economic policies.

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F. 2 Complete model

F. 2.1 Production

$$F. 2.1.1 \quad X_{S_i} = \frac{io_i * VA_i}{vi_i}$$

$$F. 2.1.2 \quad CIT_i = io_i X_{S_i}$$

$$F. 2.1.3 \quad Va_{mar} = A_{mar} Ld_{mar}^{\alpha_{mar}} Kd_{mar}^{1-\alpha_{mar}}$$

$$F. 2.1.4 \quad Va_{snm} = Ld_{snm}$$

$$F. 2.1.5 \quad LD_{MAR} = \frac{PVA_{MAR} * \alpha_{MAR} * VA_{MAR}}{S}$$

$$F. 2.1.6 \quad LD_{SNM} = \frac{P_{SNM} * XS_{SNM} - \sum_{SNM=1} (PQ_{SNM} * CIJ_{MARJ,SNM})}{S}$$

$$F. 2.1.7 \quad CIJ_{MAR,J} = aij_{MAR,J} * CIT_J$$

F. 2.2 Households and firms' revenues and savings

$$F. 2.2.1 \quad YM_{H1} = S * \sum_{form=1} LD_{form} + \lambda_K * \sum_{FMM=1} (R_{FMM} * KD_{FMM}) + TGM + TEM + TWMBEN_{H1}$$

$$F. 2.2.2 \quad YM_{H2} = S * \sum_{inf o=1} LD_{inf o} + \sum_{inf o=1} (R_{inf o} * KD_{inf o}) + TWMBEN_{H2}$$

$$F. 2.2.3 \quad YDM_{H1} = YM_{H1} - TXYM_{H1} - TMEBEN - TMG - TMW$$

$$F.2.2.4 \quad YDM_{H2} = YM_{H2} - TXYM2 - TMN$$

$$F.2.2.5 \quad YE = \lambda_E * \sum_{FMM=1} (R_{FMM} * KD_{FMM}) + TWEBEN + TNBEN + TEE + TGE + \sum_{H=1} TMEBEN_H$$

$$F. 2.2.6 \quad EM_H = pme_H * YDM_H$$

$$F.2.2.7 \quad EE = YE - TEM - TXYE - TEW - TENIG - TEG - TEE$$

F.2.3 State's revenues and savings

$$F.2.3.1$$

$$YG = \sum_{FMM=1} TXS_{FMM} + \sum_{FMM=1} TXYM_{FMM} + \sum_{FORMEX=1} TXE_{FORMEX} + \sum_{FORMEX=1} TXE2_{FORMEX} \sum_{IMPOF=1} TXM_{IMPOF} + TXYE + TWSBEN + TNSBEN + TMG + TEG$$

$$F. 2.3.2 \quad EG = YG - CGT - TGM = TGE - TGNIG - TGW$$

F. 2.3.3

$$TXS_{FORMEX} = tx_{Formex} * (P_{formex} * XS_{formex} - (\frac{pwe_{formex} * e}{(1 + te_{formex}) * EX_{formex}}) - (\frac{PNIGE_{formex} * ENIG}{(1 + TE2_{formex}) * EXNIG_{formex}})) + tx * (1 + tm) * E * PWM_{formex} * M_{formex} + tx * (1 + tm2) * ENIG * PNIGM_{formex} * MNIG_{formex}$$

F. 2.3.4

$$TXS_{NEXPO} = tx_{NEXPO} * P_{NEXPO} * XS_{NEXPO} + (tx_{NEXPO} * (1 + tm_{NEXPO}) * E * PWM_{NEXPO} * M_{NEXPO}) + (tx_{NEXPO} * (1 + tm_{NEXPO}) * ENIG * PNIGM_{NEXPO} * MNIG_{NEXPO})$$

F. 2.3.5

$$TXM_{IMPOTX} = tm_{IMPOTX} * PWM_{IMPOTX} * E * M_{IMPOTX} + tm_{IMPOTX} * PNIGM_{IMPOTX} * ENIG * MNIG_{IMPOTX}$$

$$F. 2.3.6. \quad TXYM_H = tym_H * YM_H$$

$$F. 2.3.7 \quad TXYE = tye * YE$$

$$F.2.3.8 \quad TXE_{FORMEX} = te_{FORMEX} * PEWE_{FORMEX} * EX_{FORMEX}$$

F. 2.4 International trade

$$F. 2.4.11. \quad MM_{IMPOF} = \nabla_{IMPOF} * (Z_{IMPOF} * M_{IMPOF}^{-\phi_{IMPOF}} + (1 - Z_{IMPOF}) * MNIG_{IMPOF}^{-\phi_{IMPOF}})^{-1/\phi_{IMPOF}}$$

$$F. 2.4.2 \quad MM_{impof} = (\frac{PD_{impof}}{PM_{impof}})^{\Psi_{impof}} * (\frac{1 - \alpha_{impof}}{\alpha_{impof}})^{\Psi_{impof}} * D_{impof}$$

$$F.2.4.3 \quad M_{IMPOF} = (\frac{Z_{IMPOF}}{1 - Z_{IMPOF}})^{\nu_{IMPOF}} * (\frac{PMNIGM_{IMPOF}}{PMWM_{IMPOF}})^{\nu_{IMPOF}} * MNIGM_{IMPOF}$$

$$F.2.4.4. \quad Q_{IMPOF} = \kappa_{IMPOF} * (\alpha_{IMPOF} * MM_{IMPOF}^{-\sigma_{IMPOF}} + (1 - \alpha_{IMPOF}) * D_{IMPOF}^{-\sigma_{IMPOF}})^{-1/\sigma_{IMPOF}}$$

$$F.2.4.5. \quad XS_{FORMEX} = \beta_{FORMEX} * (\delta_{FORMEX} * EXX_{FORMEX}^{\ell_{FORMEX}} + (1 - \delta_{FORMEX}) * D_{FORMEX}^{1-\ell_{FORMEX}})^{1/\ell_{FORMEX}}$$

F.2.4.6.

$$EXX_{FORMEX} = \Theta_{FORMEX} * (\chi_{FORMEX} * EX_{FORMEX}^{\tau} + (1 - \chi_{FORMEX}) * EXNIG_{FORMEX}^{1-\tau_{FORMEX}})^{1/\tau_{FORMEX}}$$

F.2.4.7

$$EXX_{FORMEX} = (\frac{PE_{FORMEX}}{(PD_{FORMEX} / (1 + tx_{FORMEX}))})^{\phi_{FORMEX}} * ((1 - \delta_{FORMEX}) / \delta_{FORMEX})^{\phi_{FORMEX}} * D_{FORMEX}$$

F.2.4.8

$$EX_{FORMEX} = (PEWE_{FORMEX} / PENIGE_{FORMEX})^\mu * ((1 - \chi_{FORMEX}) / \chi_{FORMEX})^\mu * EXNIG_{FORMEX}$$

F. 2.4.9. $Q_{NIMPO} = D_{NIMPO}$

F. 2.4.10 $Q_{SNM} = D_{SNM}$

F. 2.4.11 $XS_{SNM} = D_{SNM}$

F. 2.4.12 $XS_{NEXPO} = D_{NEXPO}$

F.2.4.13

$$BACW = \sum_{IMPO=1} (PWM_{IMPO} * M_{IMPO}) + \sum_H (TMW_H * \frac{1}{E}) + TEW * \frac{1}{E} + \frac{1}{E} * TGW - \sum_{FORMEX=1} (PWE_{FORMEX} * EX_{FORMEX}) - TWSBEN * \frac{1}{E} - TWEBEN * \frac{1}{E} - \sum_{H=1} TWMBEN_H * \frac{1}{E} \quad E.$$

F. 2.5 Domestic demand

F. 2.5.1. $DINT_{FMM} = \sum_{j=1} a_{ij_{fmm,j}} * CIT_j$

F. 2.5.2 $C_I = CG + \sum_{H=1} CM_{H,I}$

F. 2.5.3 $CM_{H,I} = \frac{(\beta c_{H,I} * YDM_H)}{PQ_I}$

F. 2.5.4 $INV_{MAR} = \frac{(\beta i_{MAR} * IT)}{PQ_{MAR}}$

F. 2.5.5 $CG_I = \frac{(\beta g_I * CGT)}{PQ_I}$

F. 2.6 Prices

F. 2.6.1 $PM_{IMPOF} = PMWM_{IMPOF} * (\frac{M_{IMPOF}}{MM_{IMPOF}}) + (\frac{MNIG_{IMPOF}}{MM_{IMPOF}}) * PMNIGM_{IMPOF}$

F.2.6.2 $PMNIGM_{IMPOF} = (1 + tx_{IMPOF}) * (1 + tm2_{IMPOF}) * ENIG * PNIGM_{IMPOF}$

F.2.6.3 $PMWM_{IMPO} = PWM_{IMPO} * E * (1 + tx_{IMPO}) * (1 + tm_{IMPO})$

$$F. 2.6.4 \ PVA_{MAR} = \frac{(P_{MAR} * XS_{MAR} - \sum_{MARJ=1} PQ_{MARJ} * CIJ_{MARJ,MAR})}{VA_{MAR}}$$

$$F. 2.6.5 \ PVA_{SNM} = SA$$

$$F. 2.6.6 \ PE_{FORMEX} = \left(\frac{EX_{FORMEX}}{EXX_{FORMEX}}\right) * PEWE_{FORMEX} + \left(\frac{EXNIG_{FORMEX}}{EXX_{FORMEX}}\right) * PENIGE_{FORMEX}$$

$$F. 2.6.7 \ PENIGE_{FORMEX} = \frac{PNIGE_{FORMEX} * ENIG}{(1 + te2_{FORMEX})}$$

$$F. 2.6.8 \ PEWE_{FORMEX} = \frac{PWE_{FORMEX} * E}{(1 + te_{FORMEX})}$$

$$F. 2.6.9. \ PQ_{IMPOF} = \frac{PD_{IMPOF} * D_{IMPOF} + PM_{IMPOF} * MM_{IMPOF}}{Q_{IMPOF}}$$

$$F. 2.6.10 \ PQ_{SNM} = PD_{SNM}$$

$$F. 2.6.11. \ P_{NEXPO} = \frac{PD_{NEXPO}}{(1 + tx_{NEXPO})}$$

$$F. 2.6.12. \ P_{FORMEX} * XS_{FORMEX} = \frac{PD_{FORMEX} * D_{FORMEX}}{1 + tx_{FORMEX}} + PE_{FORMEX} * EXX_{FORMEX}$$

$$F. 2.6.12. \ P_{SNM} = PD_{SNM}$$

$$F. 2.6.13 \ PINDEX = \sum_{I=1} PVA_I * B_I$$

$$F. 2.6.14 \ R_{MAR} = \frac{(PVA_{MAR} * VA_{MAR} - S * LD_{MAR})}{KD_{MAR}} \quad I$$

F.2.7 Informal sector

$$F. 2.7.1 \ EXD_{info} = EXDO_{info} * \left(\frac{PCOMP_{info}}{PENIG_{info}}\right)^{\theta_{info}}$$

$$F. 2.7.2 \ EXD_{info} = EXNIG_{info}$$

$$F. 2.7.3 \ XS_{info} = EXNIG_{info}$$

$$F. 2.7.4 \quad PQ_{inf o} = PMWM_{inf o}$$

$$F. 2.7.5 \quad Q_{inf o} = M_{inf o}$$

$$F. 2.7.6 \quad PMWM_{inf o} = (1 + tm_{inf o}) * PWM_{inf o} * E$$

$$F. 2.7.7 \quad PENIG_{inf o} = \frac{P_{inf o}}{ENIG}$$

$$F. 2.7.8 \quad DINT_{inf o} = CIJ_{inf o, inf o}$$

$$F. 2.7.9 \quad Q_{inf o} = DINT_{inf o} + INV_{inf o}$$

F. 2.7.10

$$BACN = \sum^{mar} (PNIGM_{mar} * MNIGM_{mar}) + \left(\frac{1}{ENIG}\right) * TENIG + \left(\frac{1}{ENIG}\right) * TGNIG - \\ \sum^{mar} (EXNIG_{mar} * PNIGE_{mar}) - TNSBEN * \left(\frac{1}{ENIG}\right) - TNBEN * \left(\frac{1}{ENIG}\right)$$

F.2.8. Equilibrium conditions

$$F. 2.8.1. \quad Q_{FMM} = DINT_{FMM} + C_{FMM} + INV_{FMM}$$

$$F. 2.8.2. \quad Q_{SNM} = C_{SNM}$$

$$F. 2.8.3. \quad LS = \sum_{I=1} LD_I$$

$$F. 2.8.4. \quad IT = \sum_{H=1}^H EM_H + EE + EG + BACW * E + BACN * ENIG$$

F.3.1.8 Variables of the model

Endogenous variables

S= wage rate

XS= Sectorial production

VA_j= Value added

CIJ_{mar,j}= Intermediate consumption by the branch *mar* of sector *J*

CIT_j=Intermediate consumption of sector *J*

LD_j= Labour demand

PVA_j= Price of the value added

P_j= Production price

Pd_{form}= Domestic price

Pq_j= Composite price

Pm_{impof}= Non-discriminated price of the imported good

Pe_{formex}= Non-discriminated price of the exported good

Pewe_{formex}= Interior price of the good exported to the rest of the world

Pmwm_{impo}= Interior price of the good imported from the rest of the world

Penige_{exp}= Interior price of the good exported to Nigeria

$P_{mni}m_{impof}$ = Interior price of the good imported from Nigeria
 R_{fmm} = Remuneration of capital
 INV_{mar} = Investment
 IT = total investment
 YM_H = Household's income
 YDM_H = Household's disposable income
 Ye = Firms' revenue
 Yg = State's revenue
 EM_H = Household's savings
 EE = Firms' savings
 EG = State's saving
 $CM_{H,i}$ = Consumption of good i by household H
 C_i = Consumption of good i
 $Dint_{mar}$ = Intermediate demand
 TXS_{fmm} = Collected taxes on products
 TXM_{iimpo} = Collected duties on imports
 TXE_{formex} = Collected duties on exports to the rest of the world
 $TXE2_{formex}$ = Collected duties on exports to Nigeria
 $TXYM_H$ = Collected tax on households' income
 $TXYE$ = Collected tax on firms' income
 D_{form} = Demand of the domestic good
 Q_i = Composite demand of the domestic good and imports
 M_{impo} = imports from the rest of the world
 EX_{formex} = Exports to the rest of the world
 $Exnig_{exp}$ = Exports to Nigeria
 $BACW$ = Current account deficit with the rest of the world
 $BACN$ = Current account deficit with Nigeria
 Exd_{exp} = Export demand
 MM_{impof} = Aggregated imports from the rest of the world and Nigeria
 EXX_{formex} = Aggregated exports to the rest of the world and Nigeria
 CG_i = Government's consumption

Exogenous variables

R_{info} = Remuneration of capital in informal sectors
 $EXDD_{mar}$ = Nigeria's initial export demand for Beninese re-exportation goods
 LS = Labour supply
 KD_{mar} = Capital demand
 CGT = Government's total consumption
 Tew = Transfer from firms to the rest of the world
 Tem = Transfer from firms to households
 Tgm = Transfer from the State to households
 Tge = Transfer from the State to firms
 $Tmeben$ = Transfer from households to firms
 Tmg = Transfer from households to the government
 Tee = Transfer from firms to other firms
 $Tenig$ = Transfer from firms to Nigeria
 Teg = Transfer from firms to the government
 $Twmben$ = Transfer from the rest of the world to households
 $Tweben$ = Transfer from the rest of the world to firms
 $Twsben$ = Transfer from the rest of the world to the government
 $Tnsben$ = Transfer from Nigeria to the State
 $Tnben$ = Transfer from Nigeria to the firms
 Tmn = Transfer informal households to Nigeria

$Tgnig$ = Transfer from the State to Nigeria
 Tgw = Transfer from the State to the rest of the world
 Pwm_{mar} = World price of the imported good in foreign currency
 Pwe_{mar} = World price of the exported good in foreign currency
 $Pcomp_{mar}$ = Export composite price
 $Pnig_{mar}$ = Nigerian price of the exported good in foreign currency
 $Pnigm_{mar}$ = Prix nigérien du bien importé en devise étrangère
 E = Exchange rate with the rest of the world
 $Enig$ = Exchange rate with Nigeria
 $Pindex$ = Producer price index

F.3.1.10 Paramètres du modèle

A_{mar} = Scale coefficient of the Cobb-Douglas
 α_{mar} = Elasticity of the Cobb-Douglas
 iO_I = Coefficient of the Leontieff (CIT)
 vi_I = Coefficient of the Leontieff (value added)
 $aij_{MAR,J}$ = Coefficient input-output
 $\beta_{C_{H,I}}$ = Share of good i in household's H total consumption
 β_{g_i} = Share of good i in the government's total consumption
 pme_H = Marginal propensity to save
 $\beta_{i_{MAR}}$ = Share of good i in total investment
 λ_K = Share of the household's remuneration of capital
 λ_E = Share of the remuneration of capital that goes to firms
 Tx_{mar} = Collected tax rate on products
 Tym_H = Tax rate on households' income
 Tye = Tax rate on the firm's income
 Tm_{mar} = Import tariff (rate) with the rest of the world
 $Tm2_{mar}$ = tariff (rate) with Nigeria
 Te_{mar} = Export tariff with the rest of the world
 $Te2_{mar}$ = Export tariff with Nigeria
 β_{formex} = Scale parameter of the CET
 κ_{impof} = Scale parameter of the CES
 ℓ_{formex} = Transformation parameter of the CET
 δ_{impof} = Weight parameter of the CET
 ϕ_{formex} = Elasticity of transformation of the CET
 σ_{formes} = Substitution parameter of the CES
 α_{impof} = Weight parameter of the CES
 Ψ_{impof} = Elasticity of substitution of the CES
 Θ_{formex} = Scale parameter of the embedded CET
 χ_{formex} = Weight parameter of the embedded CET
 τ_{formex} = Transformation parameter of the embedded CET

μ_{formes} = Elasticity of transformation of the embedded CET

∇_{impof} = Scale parameter of the embedded CES

Z_{impof} = Weight parameter of the embedded CES

ρ_{impof} = Substitution parameter of the embedded CES

σ_{formes} = Substitution elasticity of the embedded CES

B_i = Production share of the branch i in total output

ϖ_{info} = Elasticity of the demand function for informal exports