SOCIAL ACCOUNTING MATRIX AND APPLIED GENERAL EQUILIBRIUM MODELS: SOME POLICY EXPERIMENTS FOR CONGO

by

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ABSTRACT

This paper discusses the usefulness of social accounting matrix (SAM) and applied general equilibrium (AGE) modeling for policy designing, implementation, and evaluation. The paper applies both SAM and AGE modeling to the case study of Congo. We run two policy experiments related to trade policy and tax policy using simple trade model, Armington trade model, and the model with labor-leisure choice. This study offers the results which suggest that high tariffs rates impair production and misallocate scarce resources and it also shows that the excess burden of payroll and corporate taxes reduces the labor supply and then, welfare. The study concludes with a caution, as it raises the issue of data collection for building a consistent SAM, and begs for further empirical studies.

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1. Introduction

A social accounting matrix (SAM) is defined as "a square matrix that, for one year, accounts for the economy-wide circular flow of incomes and payments. This matrix maps the structure of an economy through its internal and external links, and the roles of different agents and sectors. To be specific, the SAM integrates national income, input-output, flow-of-funds, and international trade statistics into a comprehensive and consistent dataset. This framework has also nurtured the development of AGE modeling on its diversified applications. The AGE modeling has gained the attention of both academia and policy circles; it has also guided and shaped debate in various issues including trade, public finance, and structural adjustment programs.

Within the General Algebraic Modeling System (GAMS), the model consists of all equations declared before the model statement is entered (Lofgren et al. 2002). GAMS checks that the model is in fact the type the user thinks it is, and issues explanatory error messages if it discovers a mismatch. Once the model has been put together through the model statement, we can now attempt to solve it using the solve statement. GAMS itself does not solve our problem, but passes the problem definition to one of a number of separate solve problem (Rosenthal 2007).

This paper aims at conducting some policy experiments based on most models covered during this semester and the available data for the case of Congo. The recourse to this case study is a way to address a need for further research and data collection; and to show the relevance of this framework for policy designing and implementation in Congo. Indeed, the relevance of the study rests on the policy guidance and further exploration of impact of different policy scenarios and simulations on the welfare in the country. It is a

good time because this country has enacted many structural reforms. Moreover, Thomas and Bautista (1999) recognized the difficulty to construct a SAM in developing countries because of insufficient and fragmented data sources as well as the problems of data reliability. This paper reports the results of six policy experiments conducted with the Computable General Equilibrium (CGE) modeling that incorporates Simple trade, Armington, and labor and leisure choice models. We use GAMS to solve these models.

In this introduction, this paper defines the SAM and the AGE model in subsections 1.1 and 1.2, respectively. Section 2 explains the 1997 Congolese data and its extension to accommodate the different models under study; Section 3 provides the logic of the construction of different models and their distinct features; and Section 4 presents the results of policy counterfactuals. Finally, section 5 gives the concluding remarks.

1.1. Overview of Social Accounting Matrix

As stated earlier, a SAM is a comprehensive economy-wide data framework, but each cell shows payments from the account of its column to the account of its row. Therefore, the incomes of an account appear along its row and its expenditures along its column. The underlying principle of double entry accounting requires that for each account in this matrix the total revenue equals total expenditure (Thomas and Bautista 1999).

Quesnay (1759) launched a simple version of social account matrix (SAM) through his *Tableau Économique d'Ensemble* recording annual transactions of French economy. Later on, Kuznets (1937) and Leontief (1941) had remarkable influence on the social account matrix because of their work on national income accounts and input-output matrices, respectively. However, the actual format of SAM originated from the 1941

Meade and Stone's double-entry national income accounts. In effect, the current version, extensively used with the United Nations' system of national accounts, rests on the culmination Stone's work.

The SAM has also provided data base for constructing applied general equilibrium models. Since then, the use of data in this framework started with a simple model of two production sectors calibrated to US data from the 1950s to calculate the incidence of the US corporate tax income and Johansen calibrated the Norway 19 production sector model to identify the sources of growth during 1948-1953 (Kohoe, 1996).

The success in developing SAM relies on the development planning models utilizing these data. The first work was devoted to the implementation of Keynes's proposals for funding Britain's war effort during the Second World War (Kohoe, 1996). In this line of reasoning, the base data represent an equilibrium solution of the model which constitutes the basic assumption supporting the benchmark equilibrium and parameter estimation (Devarajan and Robinson, 2002).

1.2. Applied General Equilibrium Models

To begin with, a general equilibrium has various meanings depending on the fields it is actually applied. Markusen (2002) provides four defining features of a general equilibrium: multiple interacting agents; individual behavior based on optimization; most agent interactions are mediated by market and prices; equilibrium occurs when endogenous variables such prices adjust to the extent that the constraint they face cannot do better by altering their behavior.

From historical perspective, theoretical and applied researches were conducted separately until Scarf's work on economic equilibria of the multi-sectoral general equilibrium model. Yet, the static general equilibrium constitutes the initial focus of this field. This static general equilibrium allows the determination of the equilibrium of a single period. The main interests, though, remain the analysis of welfare impact of government tax policy and the evolution of capital stock with a strong assumption of myopic expectations. Indeed, the primary aim was to provide informed guidance to policy makers to undertake wisely more desirable policy actions. Hence, researchers compare the relevance of their results to the real world data.

The AGE model has become popular in academia and research institutions. It has also influenced policy formulation and provided guidance in debate on issues related to International trade, Public finance, Agriculture, Structural adjustment policies, and Income distribution (Devarajan and Robinson, 2002). In policy circles, this framework has proven to be useful in terms of policy relevance, transparency, validation and estimation, and diversity of approach. For one thing, policy relevance requires modelers to address issues of interest in the policy debate. This debate focuses on identifying the winners and losers from proposed policy changes because the compensation scheme should be tailored in order to generate ex post Pareto improvements and to understand the distributional tradeoffs and aggregate results. On the other hand, transparency matters because modelers should be able to describe in comprehensible manner the results and their implications. Timeliness also raises the question about the use of the results for the on going issue; thus the credibility of the model relies on up-date models and data to meet expectations.

2. The 1997 Aggregated Congolese SAM and its Extension

2.1. Description of Congolese SAM

Table 1 presents an aggregate SAM for Congo in 1987, which was adjusted in 1997 by RAS methods[1]. RAS is named for the linear algebra formulation below. It is a well-known technique to update input-output tables and the simpliest as well as most widely used. RAS stands for initial letters of matrix formulation to scale up a SAM for one period. In effect, R represents the vector of effect of substitution measuring the extent to which product *i* has been replaced by, or used as a substitute for, other products in industrial production. In addition, *A* is the symbol of the matrix of input-output coefficients, and *S* corresponds to the vector of the effect of fabrication, namely, measuring the extent to which industry *j* has come to absorb a greater or smaller ratio of intermediate to total inputs in its production. The substitution multiplies *r* operate along the rows and the fabrication multipliers operating along the columns. Each cell in the benchmark will face these two effects. Rigorously, RAS is given by:

$$A_1 = \hat{r} A_0 \hat{s} \quad (1)$$

$$F_1 = A_1 \hat{X}_1 \quad (2)$$

Where F_1 is the input-output flow matrix of the current year which is unknown; X_1 is the known output vector of the current year and $\hat{X}_1$ its diagonal matrix; A_1 is the new coefficient matrix to be estimated corresponding to F_1; and A_0 the benchmark matrix.

[1] Kankwanda.(2006). Functional and Structural Analysis of Economic Growth in Congo, Doctorate's thesis, Department of Economics, University of Kinshasa, Kinshasa DRC. But the official attempt to collect data was in 1993 with the assistance of USAID. The 1993 political instability and looting disrupted the implementation of this project. Nothing has been done thus far.

Stone (1961) proposes the basic rationale of this method which consists in finding a set of multipliers to adjust the rows of the existing matrix and a set of multipliers to adjust the columns so that the cells in the adjusted matrix will sum up to the required row and column totals relating to the later current year (United Nations 1999-ST/ESA/STAT/SER.F/74). This is due to the lack of planned survey and the tenure of national income products accounts with double-entry on official statistics.

From this reasoning, the actual SAM was updated by mimicking the past behavior of Congolese economy and captures the current national income product accounts to produce new coefficients for the actual SAM. The inter-industry transactions have been aggregated under three industrial sectors, namely, primaries, manufactures, and services. From fourteen sectors, we have merged them to six sectors, namely primaries, manufactures, services, consumption, investment and export. For one thing, primaries sector lumps together agriculture and extractive mining activities with low- embodied technology. On the other hand, manufactures sector groups industries, electricity and water production as well as distribution. Services also represent commerce, transportation and communication, banks and insurance Company, and other noncommercial services provided by the public administration and privation associations of mutual aid.

This SAM has a trade imbalance because the imports exceed the exports; the introduction of the foreign exchange balanced out the SAM. In fact, the foreign exchange is provided to the import sector as input and to consumer block as an endowment. All figures in table 1 are expressed in ten trillion Zaire. In 1997, the exchange rate was 1Nouveau Zaire worth 3 million Ancien Zaire. This change of denomination was due to hyperinflation and the 1994 decline of the economy by negative 13.4%. In spring 1997,

the currency became Congolese Democratic Franc (CDF) because of the new regime, with 1 CDF values at 100 thousand NZ. US dollar averaged about 1.31 CDF. For instance, 350 trillion of AZ of capital rents represents $US 8, 9 billion. The 1997 Congolese gross domestic product of 510 trillion Ancien Zaire reported on table 2 is equivalent to $US 12, 9 billion.

Table 1: The 1997 Congolese SAM (10 trillion Zaire for 1997)

	Primaries	Manufactures	Services	Consumption	Investment	Export(XP)	Total
Primaries	2	2	2	20	0	15	41
Manufactures	3	9	9	5	2	1	29
Services	4	2	15	24	0	1	46
Imports(MP)	3	12	4	0	0	0	19
PL(Wages)	1	2	9	0	0	0	12
PK(Rents)	28	2	5	0	0	0	35
Indirect Tax	0	0	2	0	0	0	2
Total	41	29	46	49	2	17	

Source: Author's calculations

2.2. Brief Explanation of different values of SAM

The column in a SAM indicates who made expenditure (expenses), and the row shows who received it (receipts). Reading down the first column of table 1, for instance, we see that in 1997 producers of primaries goods in Congo spent 20 billion Zaire for intermediate inputs from producers of primaries, 40 trillion Zaire for intermediate inputs from producers of services, likewise they paid 10 billion Zaire for labor inputs and 280 trillion Zaire for capital inputs. On the other hand, reading across the third row, producers of services purchased 40 trillion Zaire of primaries, 20 trillion Zaire of manufactures, and 10 trillion Zaire from exports. These transactions are organized in terms of producers' goods, consumer goods, and factors of production, institutions, capital account, and the foreign sector. These figures are consistent with the national income product accounts on table 3 recording the Congolese GDP in 1997 as being 510 trillion Zaire.

Table 2: National Income Product Accounts (10 trillion Zaire for 1997)

Expenditure		Income	
Private consumption	49	Wage	12
Private investment	2	Capital rent	35
Export	17	Indirect taxes	2
Import	-19	**Foreign Exchange**	**2**
Foreign exchange	**2**		
	51		51

Source: Author's calculations

To meet the requirement of the yardstick, the introduction of the foreign exchange will balance out the SAM.

2.3. Description of SAM used in Armington and Labor-Leisure choice models

2.3.1. Explanation of a SAM used for Armington Specification

The Armington specification involves a clear distinction of goods by industry and by country. It also allows for differing degrees of substitution among domestic and imported goods. In addition, imports are classified by sector that produces them, the sector of origin, and not by the sector that purchases them, the sector of destination. Table 3 below presents the detail relative to the case of Congo. The intersection between the column of manufactures, the imported manufactures, and the domestic manufactures suggests that producer of manufactures good spent 70 trillion Zaire to purchase imported manufactures and 90 trillion Zaire for manufactures domestic. In the end, for manufactures sector spent 120 trillion Zaire for imported commodities.

Table 3: SAM with Armington specification

	Primaries	Manufactures	Services	Consumption	Investment	Export	Total
Primaries	2	2	2	20	0	15	41
Manufactures	3	9	9	5	2	1	29
Services	4	2	15	24	0	1	46
Imported Primaries	1	2	0	0	0	0	3
Imported Manufactures	2	7	3	0	0	0	12
Imported services	0	3	1	0	0	0	4
PL(wages)	1	2	9	0	0	0	12
PK(capital rent)	28	2	5	0	0	0	35
Indirect Tax	0	0	2	0	0	0	2
Total(composite)	41	29	46	49	2	17	
Domestically produced commodities	38	17	42				
Imported commodities	3	12	4				

Source: Author's calculations

2.3.2. SAM used for Model with Labor and Leisure Choice

This SAM differs from the previous because we provide the consumer with additional resource of 50% of his or her initial endowment of 120 trillion. This endowment of 60 trillion will allow for purchasing leisure. It has also increased the total resource of this economy at 570 trillion Zaire: 60 trillion for leisure and 120 trillion affected to consumption of goods and service. The rest of the SAM remains the same except the consumption account which increases by the 60 trillion. However, Fox (2002) argues that the endowment should be dictated by a current level of leisure that is consistent with the output of the economy and the known characteristic of supply of labor. Finally, the responsiveness of change in tax policy depends on the initial endowment. For the case of Congo, we believe that the endowment may be realistic.

Table 4: the 1997 Congolese SAM with labor and leisure specification

	Primaries	Manufactures	Services	Consumption	Investment	Export(XP)	Total
Primaries	2	2	2	20	0	15	41
Manufactures	3	9	9	5	2	1	29
Services	4	2	15	24	0	1	46
Imports(MP)	3	12	4	0	0	0	19
PL	1	2	9	6	0	0	18
PK	28	2	5	0	0	0	35
Indirect Tax	0	0	2	0	0	0	2
Total	41	29	46	55	2	17	

Source: Author's calculations

3. Overview of AGE Model

3.1. Construction of AGE model

The logic driving the construction of an applied general equilibrium model constitutes the calibration of parameters of the model. It is a backward procedure in which the economic agents' transactions are modeled to reproduce the actual data in the SAM. To do so, it is required to build a highly simplified model with four consumers representing one or many types of household, the government, and the rest of the world through commercial relations, namely, import-export. Likewise, the number of goods may be limited in these core categories: primaries, manufactures, services, investment good, and import-export good. These goods are intermediate inputs to be considered in the whole set of production blocks including two factors of production, labor and capital; and import good. We distinguish goods by industry and country origin.

The planning problem consists of solving a utility maximization problem. This formulation consists of a set of markets for goods and factors of production. Consumers and firms optimize subject to the constraints they face such as technologies and budget

constraints. The equilibrium[2] is then obtained by finding a set of prices(r,w, p_1, p_2…p_6) without excess demands(X_{ij}, K_j, L_j, Y_j, C_i). Rigorously, we have:

$$\max u_i (C_1 \ldots C_6) = \prod_{i=1}^{6} C_i^{\gamma_i} \qquad (3)$$

$$\text{subject to } \sum_{j=1}^{6} p_j c_j^i \le I^i = (1-\tau_i)\left(w\bar{l}^{\,i} + r\bar{k}^{\,i} \right) + T^i \qquad (4)$$

In fact, in the utility function c_j^i represents the purchase of good *j* by consumer *i* , for example in table 3 , consumers spend 20 trillion Zaire to purchase primaries, 50 trillion Zaire for manufactured good, and 240 trillion Zaire for services. Similarly, the rest of the world purchases primaries good, manufactures, and services for 150 trillion, 10 trillion, and 10 trillion, respectively.

In addition, p_j is the price of good j and the income of consumer *I* is represented by I^i. The after tax income I^i is captured through the wage rate(w), the capital rental rate(r), the transfer payment T_i, the consumer's endowments of capital $\bar{l}^i$ and labor $\bar{k}^i$, and the indirect tax τ_I as above. In this model, the government collects taxes and bills to consumers and the investment is treated as a final demand for goods.

The model postulates for these goods a constant-returns production function that combines intermediate inputs in fixed proportions and the factors of production *l* and *k* with substitution possibilities driven by Cobb-Douglas functional form $\beta\kappa^{\alpha}\ell^{1-\alpha}$. The general form of the domestic production function is given by:

[2] Given prices, C_i solves the consumer's problem and transfers; X_{ij}, K_j, L_j, and Y_j solve the producer's problem. The market clears meaning that the production of sector j equals how many people eat and the demand for j from other sector as inputs. The market of labor and capital clear and the government's receipts equals direct taxes and indirect taxes.

$$Y_{jd}=\min (x_{1j}/a_{1j}... X_{6j},\ \beta_j k_j^{\alpha_j} l_j^{1-\alpha_j}) \qquad (5)$$

where X_{ij} represents the intermediate inputs of good *I* used in the production of good j; a_{ij} constitutes the amount of good *i* required to produce one unit of good *j*; and a_{ij}, β_j, and α_j are parameters to be calibrated. This model also assumes that producers never waste inputs; they minimize costs and earn zero after-tax profits because

$$Y_{jd}=x_{12}/a_{12}=x_{22}/a_{22}=\ldots= \beta_j k_j^{\alpha_j} l_j^{1-\alpha_j}. \qquad (6)$$

$$\left.\begin{array}{l}\min rk+wl \\ \text{st. } Y_j \leq \beta_j k_j^{\alpha_j} l_j^{1-\alpha_j}\end{array}\right\} \qquad (7)$$

3.2. Armington Aggregator Specification

Armington (1969) proposes a partial equilibrium framework that allows the use of composite commodities, namely, commodities produced abroad (M_i) and those produced domestically (D_i). His model has been used in numerous empirical literatures on estimating import demand functions. This model introduces more accurately trade model rather than the previous trade model. It is also an appropriate specification for building trade-oriented applied general equilibrium models for single countries. The aggregation format is given by:

$$Q_i= \gamma[\delta_i M_i^{-\rho}+ (1-\delta_i)D_i^{-\rho}]^{-1/\rho} \qquad (8)$$

Where Q_i is the total production; D_i denotes domestically produced goods, ρ is parameter governing substitution between domestic and imported goods, γ is Armington function shift parameter, δ_i is the share parameter, and M_i denotes imports.

The same rationale of cost-minimization is applied here. Given the specified prices for imported and domestic goods, the firm will choose a specified level of output at minimum cost. The solution to this problem is to find a ratio of imports to commodities produced domestically so that the marginal rate of substitution equals the ratio of the price of the domestically produced commodity to the price of the imported commodity. It is worth mentioning that the trade substitution elasticity determines the responsiveness of domestic demand to changes in the relative price of imported goods.

The use of Armington specification requires the classification of imported goods by sector that produced them, the country of origin, and the sector of destination. Table 3 above provides detailed information of the actual version of SAM with the implementation of Armington framework. However, in the simple trade model, there is an imperfect substitutability between imports and domestic output sold domestically. It is captured by a CES aggregation function in which the composite commodity that is supplied domestically is "produced" by domestic and imported commodities entering this function as inputs.

3.3. Model with labor-leisure choice

This model introduces the consumer's choice between leisure and labor. Fox (2002) suggests that the formulation of the consumer's utility using the linear expenditure system helps to model the behavior of household. The leisure is added at the top nest of the Constant Elasticity of Substitution function with composite consumption of primaries, manufactures, services, investment goods, and imported goods. The utility function allows the substitution between consumption and leisure. Thus, the consumer decides

between the weighted average leisure (L) and the composite good(X) with respect to available resources as follows.

$$U = \left[\theta \left(\frac{L}{Lo} \right)^{\rho} + (1-\theta) \left(\frac{X}{Xo} \right)^{\rho} \right]^{1/\rho}, \qquad (9)$$

$$such\ that\ M + W\bar{L} = WL + P_X X.$$

Where L_o and X_o represent the benchmark demands for leisure and consumption; the share parameter θ denotes the benchmark share of the budget devoted to leisure.
The budget constraint is composed of other non-wage income (M), wage rate (W), the endowment of time ($\bar{L}$), a composite consumption good(X), and the price of composite good (P_x).

The elasticity of substitution between labor and leisure will be here calculated from the elasticity of labor supply in section 4.3. The basic assumption is labor bears the most burden of the payroll and corporate tax in a small open economy, like Congo. In fact, the literature suggests that the relatively elastic demand for labor, coupled with the assumption of a highly inelastic supply of labor, means that labor bears most of the initial economic incidence of taxes on labor income. The reality on the ground in this country indicates that the payroll taxes on wages are borne entirely by labor. Therefore, it should be assumed that workers will respond to higher tax rates by taking more leisure, and the quantity of labor supplied would fall.

3.4. Contribution of Mathematical Programming System for General Equilibrium to Modeler's work

The software saves time and reduces input errors. For one thing, without this software modeler could be absorbed by tedious algebra to come up with a solution of the system of equations with complex functional forms. Actually, modelers have only to specify the nesting structure, substitution elasticity in each nest and the values of output and input in different block. The Mathematical Programming System for General Equilibrium (MPSGE) calibrates the model to match the benchmark data.

In addition, we try to introduce the valid labels of a function declaration ($PROD:) including:

```
$PROD:M s:1
        O:PM  Q:29
        I:PP  Q:2
        I:PM  Q:9 A:CONS T:TM
        I:PS  Q:2
        I:PMP Q:12
        I:PL  Q:2
        I:PK  Q:2
```

The manufacturing sector (M) is composed of the output (O) and the input (I). In addition, PM represents the total production of this sector with the quantity(Q) of 29, using as inputs 2 units of primaries (PP), 9 units of manufactures (PM), 2 units of services (PS), 12 units of imported goods, 2 units of labor primary factor (PL), and 2 units of capital primary factor(PK). A represents the statement that Assign to agent –the consumer's name (CONS) the revenue from tax rate TM (the Ad-valorem tax rate for Manufacturing sector inputs); and T also denotes the tax rate field identifier.

The calibration of the model constitutes the first step before running policy experiments. In effect, MPSGE chooses parameters such that given the functional forms summarizing the optimization problem; the solution reproduces transactions in table 1.

To be concrete, GAMS reports on the status of the solution process and loads solution values back into the GAMS database. The key piece of retrieve remains the solution of the benchmark because it is important to obtain the results in the benchmark with solver status as normal completion status and all relative prices and quantities are normalized to one. The solution values of the different counterfactual experiments will be interpreted from this benchmark as the values of the base year. The way to check the results is to look at points (dots) that appear on the marginal column. It means that the system is zero at the benchmark values. The following table presents the results of the benchmark as follows:

```
                      LOWER     LEVEL     UPPER    MARGINAL

---- VAR P              .        1.000     +INF       .
---- VAR M              .        1.000     +INF       .
---- VAR S              .        1.000     +INF       .
---- VAR MP             .        1.000     +INF       .
---- VAR I              .        1.000     +INF       .
---- VAR W              .        1.000     +INF       .
---- VAR PP             .        1.000     +INF       .
---- VAR PM             .        1.000     +INF       .
---- VAR PS             .        1.000     +INF       .
---- VAR PI             .        1.000     +INF       .
---- VAR PMP            .        1.000     +INF       .
---- VAR PFXX           .        1.000     +INF       .
---- VAR PL             .        1.000     +INF       .
---- VAR PK             .        1.000     +INF       .
---- VAR PW             .        1.000     +INF       .
---- VAR CONS           .       51.000     +INF       .
  P  Activity level for sector P
  M  Activity level for sector M
  S  Activity level for sector S
  MP  Activity level for sector MP
  I  Activity level for sector I
  W  Activity level for sector W (Hicksian welfare index)
  PP  Price index for commodity P
  PM  Price index for commodity M
  PS  Price index for commodity S
  PMP  Price index for commodity MP
  PI  Price index for commodity I
  PFXX  Price index for forex
  PL  Price index for primary factor L
  PK  Price index for primary factor K
  PW  Price index for welfare (expenditure function)
  CONS  Income level for consumer CONS
```

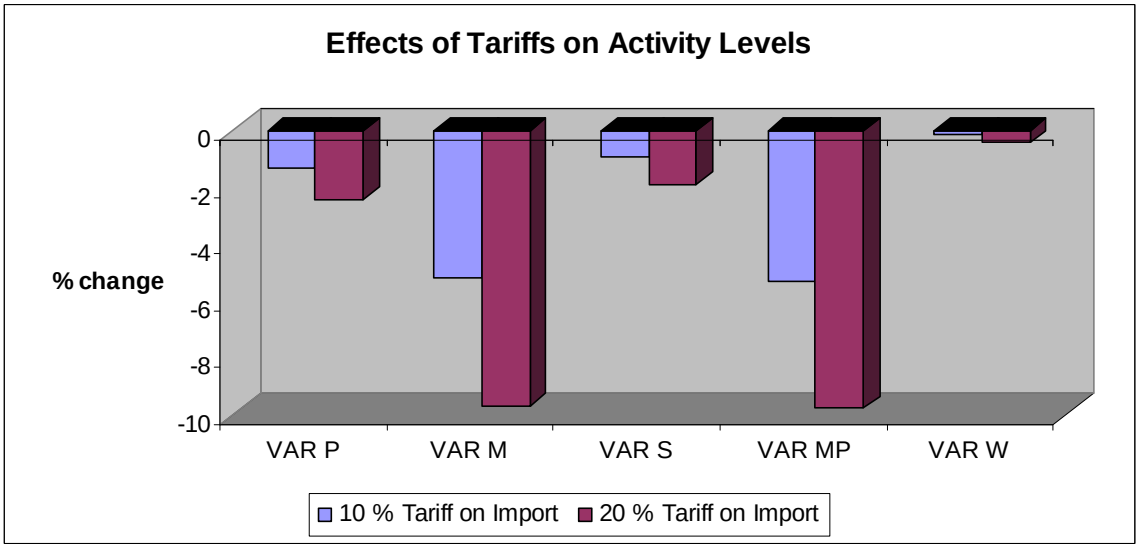
4. Results of Applied GE model of Congo

4.1. Simple Trade Model

In Congolese SAM, trade is not balanced. There are several closures of trade imbalance; but the easiest is to endow the consumer an initial amount of foreign exchange equal to the deficit. Thus, Import production block (MP) and the consumer's demand block (CONS) fix this imbalance as we input the foreign exchange. We treat all Imports as identical; Import sector that produces Import uses Export as inputs. There is no explicit rest of the world.

After obtaining the benchmark equilibrium, we run two counterfactual experiments, namely, the imposition of 10 % and 20% tariffs on imports as ad-valorem tax proportional to the value of the imports. These levels of tariff seem realistic because the average tariff in Congo is 15.6%[3] in 2003. We try to foresee the effects of decreasing and increasing this average to the different activities level to the extent that this country has been reforming including liberalization of the economy.

[3] The World Bank, The 2003 Country Report Congo, DR. In Africa, Nigeria has the highest tariff as high as 30% and in CEMAC and SADC group the simple average tax is 15%. The lost tariff is found in UEMOA including Burkina, Benin, Cote d'Ivoire ...) is 12%.



The first experiment shows a decline in all activity levels compared to the benchmark equilibrium. In fact, the 10% tariff has reduced the production of manufactures by -5.2 %. The Import as a regular sector has been contracted by -5.3% because this tariff was imposed on imported manufactures which is an input of the Import sector. In effect, manufactures sector has a large share (41.37%) as input in import sector and it is also an input for the manufactures sector (39%). At the same time, the production of primaries and service has respectively decreased by -1.3 % and -0.9 %. In the second experiment, as the tariff rate doubles there is an increasing change in terms of decline in all activity levels of -9.7 % in manufactures sector, -2.4 % in primaries, -1.9 % in services, and -9.8 % on Import.

This is the normal result of a tariff and of any trade policy that limits imports. When a small country like Congo imposed a tariff, when its share of the world market for manufactures is minor; the tariff raises the price of manufactures by the full amount of the tariff. The consumption of manufactures has fallen and then, the imports of

manufactures have declined. Finally in both counterfactuals, the welfare has declined by -0.1 % and -0.4% due to distortionary effect of tariffs. The welfare decreases at this level under this tariff regime because consumers have income from tariff which allows them to keep their welfare despite the increase in prices. It might also be the limits of the model to show the real effect on welfare and others may to some extent argue about the leak bucket.

The intuition behind these results is that first we use a simple model of trade; and second, all imports look like a regular sector. As the import has decreased because of tariff distortion, consumers buy more domestic goods. The notion of imperfect substitutability between imports and domestic output supports to the extent that domestic and imported commodities enter the production block as inputs; they look alike as stated above. In the next section, we are going to see the impact of the same tariff regime in Armington setting with more possibility of substitution between domestic and imported goods.

Table 5: Effects of Tariff on Trade Model

	10 % Tariff on Import	20 % Tariff on Import
VAR P	0.987	0.976
VAR M	0.948	0.903
VAR S	0.991	0.981
VAR MP	0.947	0.902
VAR W	0.999	0.996

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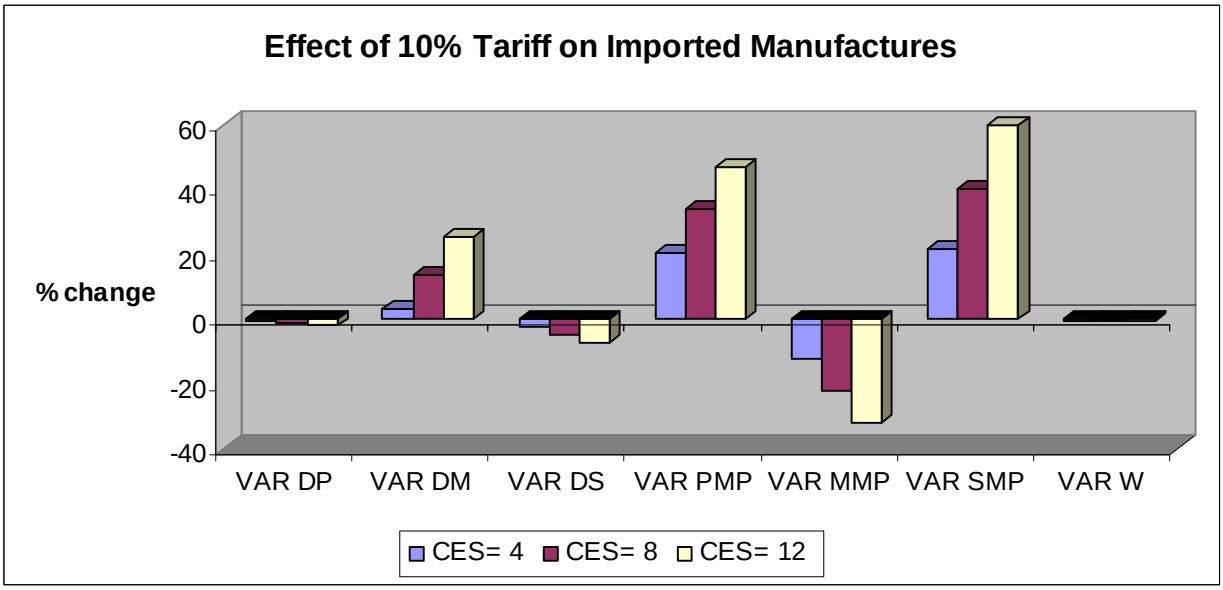
4.2. Armington specification

This model constitutes a more accurate trade model because it shows the reaction of domestic demand consecutive to changes in the relative prices of imported goods. Goods are classified in terms of domestically produced goods and imported goods.

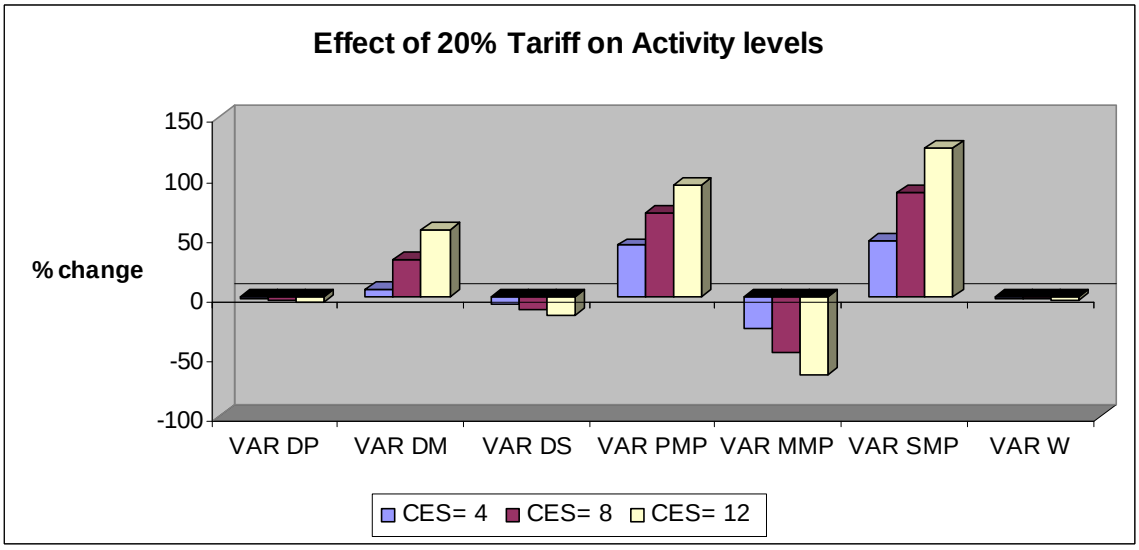
Indeed, imported goods are denoted by sector that produced them, country of origin, and the sector of destination.

The actual policy experiments use the same tariff rate of 10% and 20% tariff to compare the results of two models with the same trade policy. These experiments will allow for using the elasticity of substitution between domestic and imported states at 4, 8, and 12.

To begin with the first counterfactual experiment, the results on the graph below suggest two opposite patterns of changes in activity level of domestically produced and imported goods based on the increasing elasticity of substitution. To be specific, the change in the activity level of imported manufactures has been respectively -12.3%, -22 %, and -31.7%. This decline has been compensated by the rise en domestically produced manufactures at 3.1 %, 13.8 %, and 25.6 %. The distortionary effect of this tariff has negatively affected the domestically produced services; it has reduced the activity level by -2.5%, -4.8%, and -7.2%. In addition, this distortion has also contracted the domestically produced primaries by -0.8 %, -1.4 %, and -2 %; the reason is that imported manufactures represent one-thirds as input in primaries. Furthermore, imported primaries and services have risen due to the fact that these sectors have not been taxed. For instance, the change in activity level of imported primaries and manufactures may explain the reliance of this economy to the rest of the world with free trade.



By doubling the tariff rate, the situation worsens with the same trend in activity level of the different sector of production. The graph below is illustrative. In fact, the change in activity level of domestic service has more proportionally increased and the imported manufactures has fallen at the same pace. In fact, the domestically produced manufactures has increased by 7 %, 31.2 %, and 56.3 %. In addition, the imported manufactures has more than declined compared to the first experiment -26.3%, -46.5%, and -65 %, respectively. Primaries and services sectors have also seen their productions contracted with the same trend pattern. The production of imported primaries and services manufactures has risen due to the shift of resources in other sectors which have not be taxed with a decline in their relative prices.



The more substitution is allowed the more the domestic services production level increases implying a decline in imported manufactures. This result supports the assumption of substitution because the full effect occurs at the second counterfactual where the elasticity of substitution equals 8. Finally, the welfare decreases because of the distortionary effect of tariff. The lack of flexibility in simple trade model undermines the production of other sectors.

Table 6: Tariff impacts and Elasticity of Substitution between domestically produced goods and imported goods

	Elasticity of substitution between domestic and imported goods of 4		Elasticity of substitution between domestic and imported goods of 8		Elasticity of substitution between domestic and imported goods of 12	
	10 % Tariff on imported service	20 % Tariff on imported service	10 % Tariff on imported service	20 % Tariff on imported service	10 % Tariff on imported service	20 % Tariff on imported service
VAR DP	0.992	0.983	0.986	0.97	0.98	0.959
VAR DM	1.031	1.07	1.138	1.312	1.256	1.563
VAR DS	0.975	0.946	0.952	0.896	0.928	0.851
VAR PMP	1.203	1.429	1.342	1.706	1.47	1.936
VAR MMP	0.877	0.737	0.78	0.535	0.683	0.35
VAR SMP	1.218	1.468	1.404	1.864	1.6	2.249
VAR W	0.997	0.991	0.995	0.984	0.993	0.977

4.3. Model with Labor-Leisure choice

We calculate the elasticity of substitution between labor and leisure (σ) from labor supply elasticity (ρ) given by:

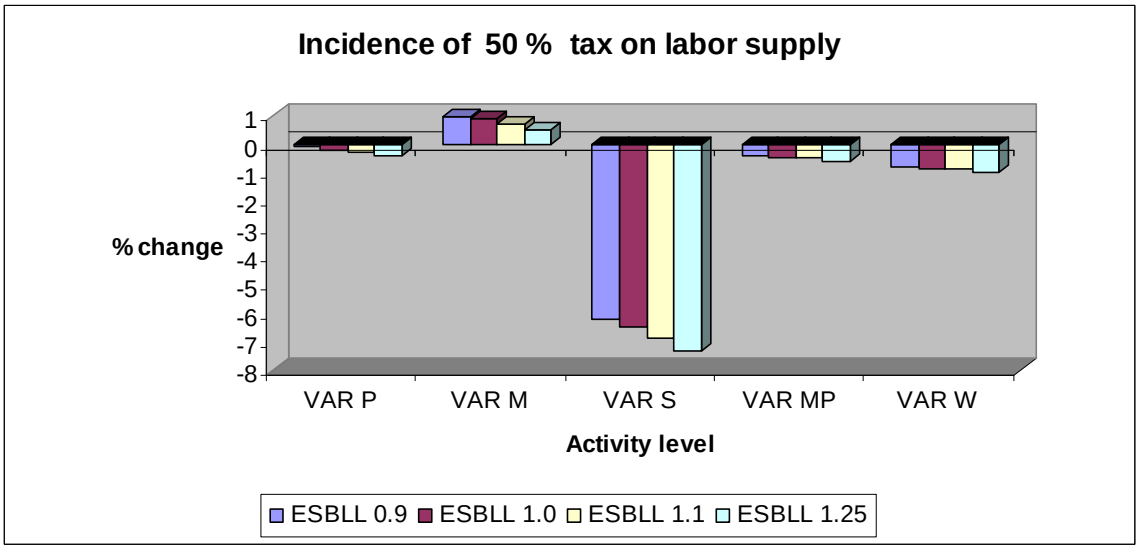
$$\sigma = 1/(1-\rho) \qquad (10)$$

It is important to note that when ρ equals to one, less than 1, and more than 1, it means the labor supply is completely inelastic, falling with an increase in the wage, and increasing with the increase in the wage, respectively.

In addition, the benchmark value of labor supply elasticity (ρ) is 0.5; thus the elasticity of substitution between labor and leisure is 2. For the remainder of this section, we use these different values of elasticity from labor supply elasticity such as 0.9 for -0.10; 1 for 0; 1.10 for 0.10, and 1.25 for 0.20.

We are discussing here the results of two main policy experiments: 50% of tax on service and 36% of tax labor for all elasticity of substitution between labor and leisure stated above. This model allows consumer to choose between leisure and labor supply because leisure enters into the workers utility function. In effect, Rutherford (1998) recommends that modelers specify an endowment of labor, something which is not in itself directly observable. In addition, the modeler should state an elasticity of substitution between labor and leisure, which will in turn imply an elasticity of labor supply. Yet, we proceed backward to this extent because we calculate the elasticity of substitution between labor and leisure from labor supply elasticity. The consumer's endowment of labor has been assigned to the welfare block and the consumer's demand block.

The results reported on the graphs below map the incidence of income and payroll taxes on labor. At the first experiment with 50% of tax burden, the change in services production shows a significant reduction in supply in this sector because labor bears the excess burden of this tax. Consequently, there is a decrease in welfare as a result the worker shifting to more leisure. On the other hand, the change in activity level of services ranges between -6.2% and -7.3%. Further, the welfare has been reduced from -0.8% to -1%. We believe that the contraction in import sector and primaries to some extent may explain the ultimate shift of this burden on the other sectors because investors could move abroad or reduce the amount of the capital.



The second experiment aims at exploring the responsiveness of labor to reduction of tax burden. The graph below indicates an improvement in welfare by 0.4% which shows an increase in consumption of goods and services rather than leisure. The same trend pattern is observed in different sector as an improvement with fewer burdens. For instance, with more substitutability between leisure and labor the change in primaries

activity level has been 100% of improvement. In addition, service sector production has increased by 1.9% compared to its value with 50% of tax as well as import sector by 0.2%.

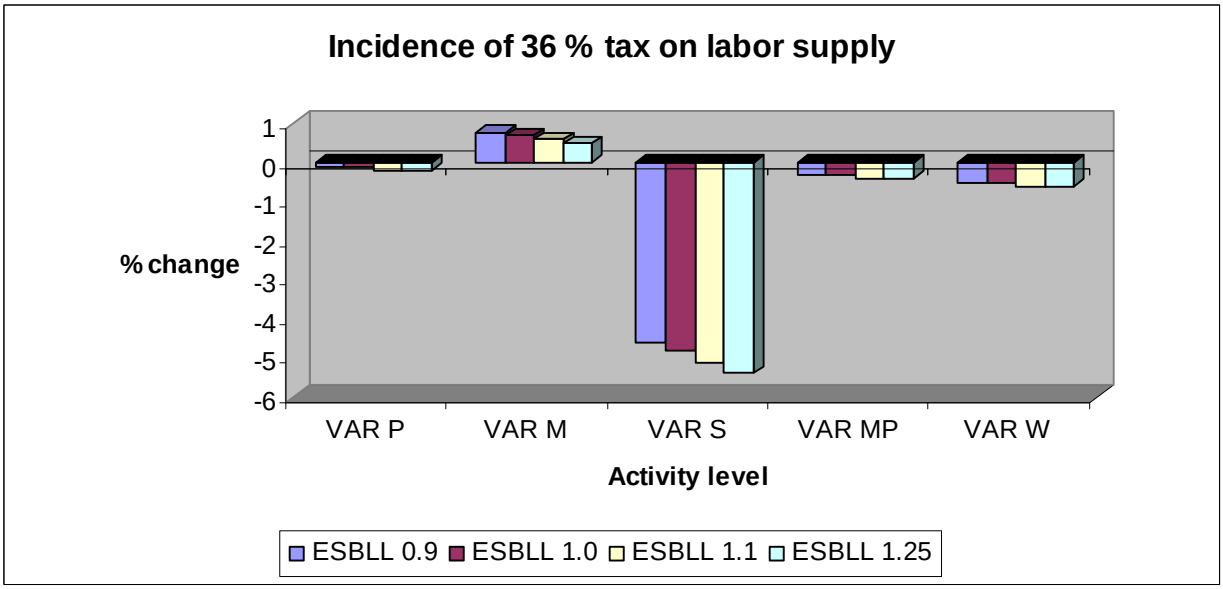


Table 10: Incidence of tax labor

	Elasticity of substitution between labor and leisure of 0.9		Elasticity of substitution between labor and leisure of 1		Elasticity of substitution between labor and leisure of 1.1		Elasticity of substitution between labor and leisure of 1.25	
	Tax on labor 50%	Tax on labor 36%	Tax on labor 50%	Tax on labor 36%	Tax on labor 50%	Tax on labor 36%	Tax on labor 50%	Tax on labor 36%
VAR P	0.999	0.999	0.998	0.999	0.997	0.998	0.996	0.998
VAR M	1.010	1.008	1.009	1.007	1.007	1.006	1.005	1.005
VAR S	0.938	0.954	0.935	0.952	0.931	0.949	0.927	0.946
VAR MP	0.996	0.997	0.995	0.997	0.995	0.996	0.994	0.996
VAR W	0.992	0.995	0.991	0.995	0.991	0.994	0.990	0.994

5. Concluding remarks

In summary, this paper conducts the policy experiments, namely trade policy and tax policy, to show the relevance of the computable General Equilibrium Model for policy designing and evaluation. At the same time, it addresses a critical need for further research and data collection for the usefulness of the CGE framework for policy analysis in Congo. The lack of guidance and debates before implementation of various policy issues may yield huge costs to both the economy and welfare in the country.

The paper has discussed the results and shown that Armington trade model has proven to be more accurate rather than the simple trade model because it maps out the distortionary effect of tariffs on imported service better than the impact in the Import and Manufactures sectors. Both models show that high tariff rate leads to misallocation of productive resources within a net-importing country like Congo.

In addition, the model with Labor-Leisure choice indicates that payroll tax at the rate of 50 percent and 36 percent leads to more leisure as the labor supply decreases and disrupts investment with its ultimate burden on the other economic immobile factors. Finally, all the three models discussed in the paper do work well; however there is need to improve and to build a SAM with more consistent data that addresses current policy issues. This paper paves the way for further research and policy experiments to guide policy makers with regard to the impact of trade and tax policies.

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