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Research Paper

Education and employment of women in the extractive industry in Côte d'Ivoire: A comparative approach of SAM multipliers and multilevel indicators

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Abstract. Economic and political crises of the last twenty years have undermined the performance of the Ivorian educational system. This paper aims to examine the link between public spending on education and the integration of women into the workforce in the extractive industry through the Social Accounting Matrix multipliers and the multilevel indicators (Garcia *et al*., 2008). The paper analyzes the nature of sectoral linkages, evaluates the capacity to propagate and the robustness of the economic system. An increase in public expenditure on education of 2.5%, leads to an additional increase of 2.06% in household income and 1.05% in female employment.

Keywords: Education, extractive industry, employment, social accounting matrix, network.

INTRODUCTION

Education is generally perceived as a vector for emancipation, assertiveness and personal employment. It is therefore recognized as affecting the productive structure of an economy. In this context, several studies have tried to address the issue of long-term relationships and the causal links between women's education and economic growth. Thus, theorists of endogenous growth (Lucas, 1988; Barro, 1990) and some empirical studies (Barro, 1991; Hanushek and Kimbo, 2000) found that the investment in education has a positive and significant relationship with economic growth. On the other hand, a positive and significant relationship between education and economic growth, is rarely found in the analysis of panel data (Barro and Lee, 1993; Benhabib and Spiegel, 1994; Islam, 1995). The question that arises is whether the educated woman is as productive as the man can be? Indeed, she is at the same time constrained to the domestic work, charged with marketing the family's food production or even commercial, mother, wife, employee, etc. These cases never cease to recall the impact that educated women can have on the productive structure, when they reach employment.

In general, the impact studies of education are based on models developed since the 1950s. These studies on the origin of growth have gained momentum with the work of (Romer, 1986) and (Lucas, 1988), in the framework of theories of endogenous growth, with emphasis on two modes. First, the direct link between education and economic growth, is characterized by an accumulation of education, outside the process of production "schooling" or "training" (Lucas, 1988). Second, an indirect link between education and economic growth, through an accumulation within the production process, translated by learning “on the job training” (Romer, 1986, 1990).

Lucas (1988) presents a model in which he considers education as a factor of production whose accumulation is beneficial for growth. Azariadis and Drazen (1990) reformulate Lucas model by introducing nested generations. In their model, they also proved the importance of investing in education. Romer (1990) examines the preponderance of research and development (R & D) in the growth process. He points out that the stockpile of knowledge favors the acceleration of the rate of wealth production, through labor and capital factors (Grossman and Helpman, 1991; Aghion and Howitt, 1992). Endogenous growth models introduce technical progress into the growth process, with a focus on the relationship between the education and productive sectors (Lucas, 1988). Indeed, in the Keynesian approach to economic growth, public spending is the starting point. While most studies in developed countries confirm a positive and significant impact of the education variable, depending on the chosen measure, these positions remain highly controversial in developing countries, given certain constraints.

In Côte d'Ivoire, the state contributes to financing education at more than 4% of Gross Domestic Product (GDP) on average, 4% in 1990 and more than 5% from 2012. The current average level of public expenditure on education in Côte d'Ivoire is 7.5%. Therefore, the objective pursued by this paper is to analyze the nature of sectoral relations and evaluate the capacity for propagation and the robustness of the Ivorian economic system, through a comparative analysis of Social Accounting Matrix and Network theory.

We hypothesize that a 2.5%[1] increase in public spending on education positively affects the extractive industry and women's employment.

The choice of this analysis approach lies in the fact that Input-Output models, as well as network theories, provide a favorable environment for measuring the economic impacts of decisions. Network theories have the additional advantage of showing the ability of a network to stimulate individual and/or collective decisions within a structure. These are based on the dynamism of "propagation" of phenomena in the relational composition between agents of the network (Garcia and Ramos, 2015).

Using multilevel indicators, the paper attempts to assess the weight and speed of influence of the education sector on the employment of women in the extractive industry in Côte d'Ivoire. The Employment Resources Tables (ERT) and the 2013 Integrated Economic Accounts Tables (IEAT) provided by the National Institute of Statistics (INS) were used as basic data for the construction of the Social Accounting Matrix (SAM, Appendix 1), multilevel indicators and simulations.

In the SAM[2], each cell in the matrix by convention, represents a financial flow from a column account to an online account. Resources are recorded in rows and expenses in columns. The cell is defined by Uij.

Equality between total expenditure and resources must be achieved, justifying the SAM internal consistency principle:

$$\underbrace{\sum_{j=1}^{n} Ukj}_{\text{Total expenses of the Account k}} \equiv \underbrace{\sum_{i=1}^{n} \mathrm{U}ik.}_{\text{Total resources of the Account k}}$$

Our methodology consists of six (6) steps up to the calculation of multilevel indicators. First distinguish the exogenous and endogenous accounts in the matrix (make all the exogenous accounts appear on the right). Then calculate the technical coefficients of expenditure. This is achieved by sequential division of each component in the endogenous accounts by the total of the corresponding column. Matrix A is obtained in the MCS process. Step 3 consists of generating the identity matrix (I). Its dimension is equal to the rows and columns of the matrix (A). It can be generated by the following formula: IF (LINE (A1) = COLUMN (A1); 1; 0). Then calculate the matrix (I-A). In step 5, invert the matrix (I-A). SAM multipliers or Leontief inverse are obtained. Step 6 is to standardize the matrix of technical coefficients (Friedkin, 1991) to obtain a new matrix of multilevel indicators.

THE MODEL

Intuitively, Input-Output and SAM tables are used to justify that, when direct and indirect effects are considered, each branch sells its goods and / or services to others and to itself. Also, buy from other sectors.

Thus, the study of relations favors the identification of sectors that have a great impact of relationship and affect the structure of supply and demand. However, taken as a network, some branches occupy a central position favorable to the economy and have more relations. These measures of centrality (Friedkin, 1991) make it possible to situate in a relationship network, the growth sectors from total effects, intermediate effects and immediate effects. Multilevel indicators have the advantage of comparing structures of different dimensions and offer an overall and relational image of hierarchical poles of influence. These indicators are equivalent to the SAM multipliers (Garcia and Ramos,

[1] Average investment rate CH_I.MUL = $\sum_{j=1}^{k} \mathrm{bij} / \mathrm{nj} = 5{,}03\%$, with bij growth in each branch. The current level of public spending on education in Côte d'Ivoire is 7.5%. Also, we have increased by 2.47% the level of I.MUL and simulated to 7.5%. Then, a 10% simulation made it possible to realize that a 2.5% increase impacts women's work in the mining sector.

[2] SAM aims to draw the circular flow of income between institutions, industries and the Rest of the World (ROW). It highlights the relationships that occur between production and income distribution structures, as well as capital flows, financial transactions and ROW, (Décaluwé *et al*., 2001).

2015). Supply is identified by domestic production (labor, capital depreciation and gross operating surplus) and imports, when final demand is measured by domestic consumption, domestic investment, public expenditure and gross exports.

The economic weight of a sector (education for example) is given by measuring the intensity of the links (backward and forward) it establishes with the other branches of activity. But in a network, this intensity varies with the type of connection (direct or indirect). Thus, this paper determines the total, intermediate and immediate effects of backward and forward linkages. The resources in the economy depend on the supply of goods of each branch Tj[3], and its value is equal to the value added and the sum of domestic intermediate consumption vij (by monetary value) from sector j to sector i.

From the input-output table, define the following equations:

$$T = At + Z \tag{1}$$

$$T' = t'B + Y' \tag{2}$$

With tij, intermediate deliveries from branch i to branch j, zj designate the final demand for the products of branch i, ti gives output in branch i, and yj gives the total use that is made of primary inputs in the branch j.

If we consider a matrix A whose coefficients aij are given by:

$$aij \equiv vij/t\text{j};\ A \equiv T\hat{t}^{-1} \tag{3}$$

Then the solution to equation (1) is given by:

$$T \equiv (I - A)^{-1}\, Z \equiv N.Z \tag{4}$$

Where $N \equiv (I - A)^{-1}$ is the inverse of Leontief. In Input-Output analysis, the basic assumption is that the input coefficients are the same for each sector and approximate the unit. Thus, when the final demand *ΔZ* increases, it also implies an increase in the production (supply) of *ΔT≡ N.ΔZ*. Element Nij indicates the unit variation in output in sector i required to satisfy one (additional) unit of final demand in sector j.

On the other hand, if we consider that an exogenous shock in a branch network manifests itself in a different effect on each sector, then the assumption of fixity deemed too restrictive to the IO framework is removed. Since the sectors of activity are differentiated by their degree of influence, we present the input coefficients with different effects for each sector.

Thus, any variation in final demand can be raised by a final or intermediate effect of demand, and induce an unequal influence in the production needs of each sector.

[3] The indices i and j refer respectively to the row products and to the branches.

Backward linkages

By releasing the fixity hypothesis, which differentiates the input coefficients between sectors, we identify the sensitivity of the branches to sectoral influences. In this context, Garcia and Ramos, (2015) proposed the following model:

$$T_i = \lambda_i^1\left(\tilde{v}_{ij}t_i + \cdots + \tilde{v}_{in}t_n\right) + Z_i \tag{5}$$

In matrix writing,

$$T = \hat{N}\tilde{A}T + Z$$

With $\hat{N} = \begin{bmatrix} \lambda_1^1 & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & \lambda_n^1 \end{bmatrix}$ the diagonal matrix (*n x n*) which reflects the influence of the coefficients for each sector;

$\tilde{A} = \{\tilde{v}_{ij}\}$ is the matrix (nxn) which represents the normalized input coefficients,

$X = \{x_i\}$ represents the production vector $(nx1)$ and $Z = \{z_i\}$ is the final demand vector $(nx1)$ of sector i.

The normalized technical coefficients are given by the $\tilde{v}_{ij}$ such that $\tilde{v}_{ij} = \frac{v_{ij}}{\sum_{j=1}^{n} v_{ij}}$, and the index of the sectoral influence is obtained from : $\lambda_i = \sum_{j=1}^{n} v_{ij}$.

Total effect

The solution to Equation 5 is given by:

$$t_i = \left(I - \lambda_i\tilde{v}_{ij}t_i\right)^{-1}(1 - \lambda_i)$$
$$= \left(I + \lambda_i\tilde{v}_{ij}t_i + \lambda_i{}^2\tilde{v}_{ij}{}^2t_i{}^2 + \lambda_i{}^3\tilde{v}_{ij}{}^3t_i{}^3 + \cdots\right)(1 - \lambda_i) \tag{6}$$

The total effect of one branch on another is related to the number of steps and the length of the steps, which unite them in the network. This is indicated by Equation 6.

Under these conditions, the total effect of a sector j is calculated as follows:

$$S_{et\,(D)} = \frac{\sum_{i=1}^{n} \lambda_i\tilde{v}_{ij}}{n} \tag{7}$$

The value of S_{et} gives the impact of the final demand of sector j on the entire economy. As S_{et} is large, the effect is enormous and an increase in total output of sector i, due to a rise in final demand in sector j, is described by:

$$\Delta t_i = N_{ij} = 1 + \lambda_i\tilde{v}_{ij} + \lambda_i{}^2\textstyle\sum_k \tilde{v}_{ik}\,\tilde{v}_{kj} + \lambda_i{}^3\sum_k\sum_n \tilde{v}_{ik}\,\tilde{v}_{kn}\,\tilde{v}_{nj} + \cdots \tag{8}$$

Equation 8, equivalent to structural complexity indicators (Rasmussen, 1956; Robinson and Markandya, 1973), specifies that $\lambda_i \tilde{v}_{ij}$ is the direct effect with a single stage, ${\lambda_i}^2 \sum_k \tilde{v}_{ik}\ \tilde{v}_{kj}$; is the two-step indirect effect that passes through k. In fact, any increase in final demand in sector j leads to an increase in output of sector k translated by $\tilde{v}_{kj}$. This varies the inputs and outputs of the industry i, same as ${\lambda_i}^3 \sum_k \sum_n \tilde{v}_{ik}\ \tilde{v}_{kn}\ \tilde{v}_{nj}$, realized in three stages and passing through k and n.

In sum, in IO models such as network theory, the influence index is a variable that aggregates intersectoral linkage measures (Friedkin, 2001). The influence potential of branch i (index of influence of branch i) is inseparable from its direct effects. Thus, a high technical coefficient means that sector j strongly depends on sector i and there is a high demand relation of branch j with respect to branch i.

Immediate effects

Two sectors in particular, education and mining, may have identical total effects, but the immediacy of their impacts may vary. Sectors whose effects are transmitted by several stages (long journey) have less immediate effects than sectors whose effects are transmitted in short sequences (short ride). Sectors with high immediacy are relatively less dependent on other sectors in the network.

The immediate effect S_{ei} is the inverse of the average length of the influence sequences of the sector j to the other sectors of the network:

$$S_{ei\ (D)} = \left(\frac{\sum_{i=1}^{n} \lambda_i m_{ij}}{n} \right)^{-1}, i \neq j \quad (9)$$

The measurement S_{ei} indicates the length and the inter-sequence force which connect the sectors. The higher the value of S_{ei}, the more the total effects of a given sector tend to have a rapid impact on other sectors of the network.

Intermediate effects

Intermediate effects indicate the extent to which any sector (ß) conveys the total effects of other sectors. Given the following equation:

$$\bar{h}_{(k)j} = \frac{\sum_{i=1}^{n} h_{(k)ij}}{n-1}, i \neq j \neq k \quad (10)$$

Reflecting the contribution of sector j in transmitting the effects of sector k, we determine the intermediate effect as follows:

$$S_{em(j)} = \frac{\sum_{k=1}^{n} \bar{h}_{(k)j}}{n-1}, j \neq k \quad (11)$$

Where $S_{em(j)}$ measures the contribution of sector j in transmitting the effects of all sectors of the network (Friedkin, 1991).

Forward linkages

Here, we consider the destination of goods produced. The forward linkages translate the dependence of the sales industry i to the purchasing industry j.

Let matrix B be the coefficients bij such that:

$$bij = uij/x\text{j}, B = \hat{x}^{-1}X \quad (12)$$

The output coefficients give the quantity of production of industry i sold to industry j. From Ghosh's input-output model (1958); Equation 2 supply-driven, we derive the following equation:

$$t_j = \beta_j^1 (\tilde{u}_{ij} t_j + \cdots + \tilde{u}_{jn} t_n) + y_j \quad (13)$$

The solution to Equation 12 is given by:

$$t'_j = (1 - \beta_j^1)' (I - \beta_j^1 \tilde{u}_{ij} t_i)^{-1} = M'G \quad (14)$$

Where $G = (I - \beta_j^1 \tilde{u}_{ij} t_i)^{-1}$ refers to the inverse of Ghosh, $\hat{B}$ is a diagonal matrix (*n x n*) which measures the influence coefficients specific to each sector: $\hat{B} = \begin{bmatrix} \beta_1^1 & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & \beta_n^1 \end{bmatrix}$; from where

$$\Delta t'_i = G_{ij} = 1 + \beta_i \tilde{u}_{ij} + {\beta_i}^2 \sum_k \tilde{u}_{ik}\ \tilde{u}_{kj} + {\beta_i}^3 \sum_k \sum_n \tilde{u}_{ik}\ \tilde{u}_{kn}\ \tilde{u}_{nj} + \cdots \quad (15)$$

This equation of structural complexity shows that following a price change $\Delta M'$, the output values change by $\Delta t'_i$. The latter takes into account an initial effect $\Delta M'$, a direct effect $(\beta_i \tilde{u}_{ij})\Delta M'$ in a first step and indirect effects in the following steps $({\beta_i}^2 \sum_k \tilde{u}_{ik}\ \tilde{u}_{kj} + {\beta_i}^3 \sum_k \sum_n \tilde{u}_{ik}\ \tilde{u}_{kn}\ \tilde{u}_{nj} + \cdots)\ \Delta M'$.

The $\tilde{u}_{ij}$ indicate the normalized technical coefficients as $\tilde{u}_{ij} = \frac{u_{ij}}{\sum_{j=1}^{n} u_{ij}}$. They describe the amount of industry production i going to industry j. The index of sectoral influence is given by: $\beta_i = \sum_{j=1}^{n} u_{ij}$.

As well as on the demand side, the total, immediate and intermediate effects can be calculated on the supply side from the normalized coefficients.

The total effects on the supply side are as follows:

$$S_{et\ (O)} = \frac{\sum_{j=1}^{n} \beta_i \tilde{u}_{ij}}{n} \quad (16)$$

The immediate effects are given by:

Table 1. Multilevel indicators and influence index 2013.

Sectors	Supply model				Demand model			
	Total effect	Immediate effect	Intermediate effect	Influence index	Total effect	Immediate effect	Intermediate effect	Influence Index
AAGRIC	6.139	0.005	0.409	1.269	2.931	0.005	0.195	0.886
ALIVES	4.443	0.003	0.296	0.912	2.993	0.005	0.200	0.995
AMININ	1.285	0.003	0.086	0.149	1.940	0.001	0.129	0.359
AFOOD	4.873	0.003	0.325	1.121	2.770	0.002	0.185	0.878
ACLOTH	1.213	0.002	0.081	0.160	3.646	0.002	0.243	1.000
AOTHM	2.890	0.002	0.193	0.453	3.255	0.003	0.217	1.000
AEQUIP	1.746	0.009	0.116	0.283	3.457	0.043	0.230	1.000
AUTILI	1.209	0.009	0.081	0.054	3.457	0.002	0.259	1.000
ACONST	4.253	0.022	0.284	0.991	3.878	0.025	0.243	1.000
ATRADE	2.314	0.002	0.154	1.000	3.638	0.002	0.248	1.000
AHOTEL	3.364	0.006	0.224	1.000	3.722	0.001	0.198	1.000
ATRANS	1.283	0.004	0.086	0.059	2.970	0.002	0.237	1.000
AESTAT	1.637	0.005	0.109	0.147	3.556	0.003	0.305	1.000
S.EDUC	1.332	0.504	0.089	0.159	4.569	0.504	0.286	1.000
APRIVS	1.559	0.009	0.104	0.142	4.292	0.003	0.265	1.000
Moyenne	5.359	0.039	0.176	0.527	3.405	0.040	0.229	0.941
T. quart	3.482	0.002	0.154	1.000	3.638	0.002	0.248	1.000
Minimum	1.911	0.002	0.081	0.054	1.940	0.001	0.129	0.359
Maximum	2.498	0.504	0.409	1.269	4.569	0.504	0.305	1.000

Source: 2013 multilevel indicators simulation results.

$$S_{ei\,(O)} = \left(\frac{\sum_{i=1}^{n} \beta_i m_{ij}}{n}\right)^{-1}, i \neq j \quad (17)$$

And the intermediate effects by the equation:

$$S_{em(i)} = \frac{\sum_{k=1}^{n} \bar{h}_{(k)i}}{n-1}, i \neq k \quad (18)$$

RESULTS AND DISCUSSION

The analysis of the key sectors of the Ivorian economy by multilevel indicators (Garcia *et al*., 2015) is based on the social accounting matrix (SAM) of Côte d'Ivoire in 2013, which was designed from the ERTs and IEAT 2013 provided by the National Institute of Statistics. The SAM of 43 activity sectors has been aggregated into 15 sectors on the model of SimSip SAM (Appendix 2). The results of the simulations in the Leontief and Ghosh approach in 2013 are given in Table 1, which presents the multilevel indicators and the 2013 influence indices. Multilevel indicators give details of the total, immediate and intermediate effects. In the Input-Output analysis, the total effects correspond to the backward and forward linkages.

Total effects

A sector is key when it generates higher-than-average input needs from other sectors and the output of which is widely used by other sectors. In 2013, Ivorian key sectors are related to the primary sector and related activities (AAGRIC, ALIVES and AFOOD), to the secondary sector with relatively medium technological intensity industries (ACONST and AHOTEL) and the education services sector (SEDUC). Two technology-intensive branches are key sectors (AOTHM, AMINES) as shown in Figure 1.

In 2013, the Ivorian economy has the same characteristics as the economy Greece in 2010. In fact, excluding the highly aggregated SAM (Appendix 2), the Greek key sectors in 2010 are related with the primary sector and associated activities, some low-medium high technological intensity industrial sectors (Garcia and Ramos, 2015), as same as Côte d'Ivoire. In both Côte d'Ivoire and Greece, only two technology-intensive sectors are key. In Greece, are computer and related activities and other business activities, when in Côte d'Ivoire, it refers to Extraction Industries, Oilseed Industries and Chemical Industries.

These results reflect the weight of the agricultural and low-technology industries in Côte d'Ivoire, with the education services sector being key (2.532%). The agricultural sector is divided into agriculture (food and industrial) and agribusiness. Linked to Education, Industrial Agriculture and its Related Activities (AAGRIC) indicate the highest total effect, reflecting strong demand for education service (6.139%). Similarly, that of subsistence agriculture has a high total effect (4.443 %).

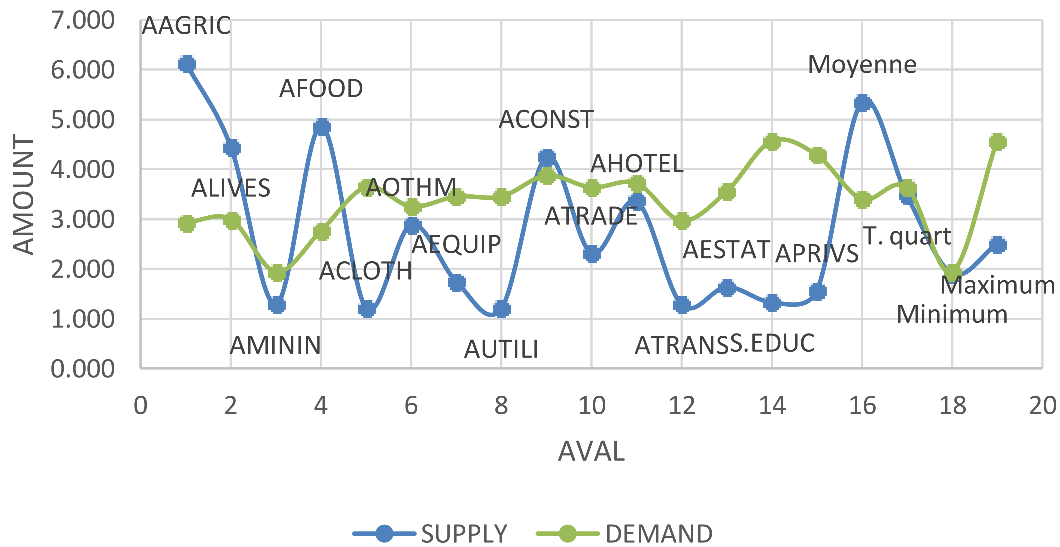

Figure 1. Total effect/key sectors 2013. Source: author' calculation from multilevel indicators.

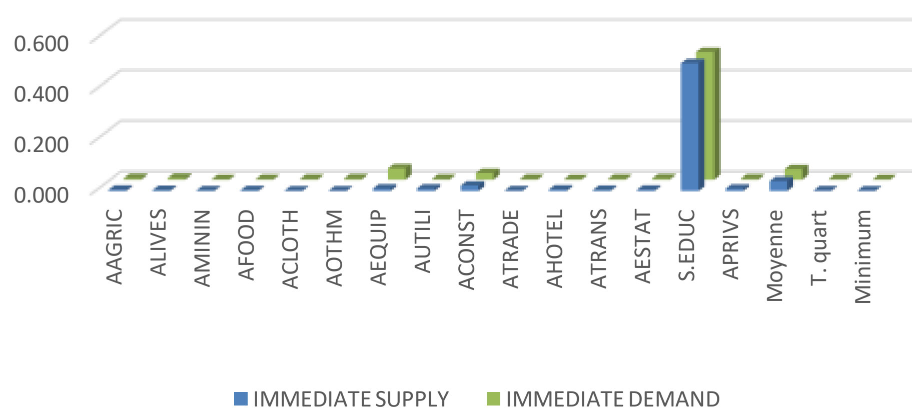

Figure 2. Immediate effect of 2013. Source: author's calculation from multilevel indicators.

It is the same for ACONST (4.253 %) and AHOTEL (3.364 %). In addition, the mining sector (AMINES) has an average demand of 3.285 %. This finding justifies the need to stimulate public spending on education in order to create momentum in the Ivorian productive structure, particularly in the extractive industry.

The assessment of the Ivorian productive structure from total effects should be associated with the study of sectoral transmission intensity (immediate effects) and the role of transmitter (intermediate effects).

Immediate and intermediate effects

In Côte d'Ivoire, out of eight (8) key sectors with the highest total effects, only education can quickly impact other economic sectors, with immediate effects being smaller than the average at 2.471 % (Figure 2). In addition, the technology-intensive sector (ACONST) has the advantage of going faster than the others, its immediate effect being 0.022%. However, the sectors of education (SEDUC), the extractive industry (AMINES) and real estate (ACONST) have the capacity to be central points around which other sectors of the Ivorian economy can gravitate so as to make it perform. Other key sectors include industrial agriculture and related activities (AAGRIC), food agriculture (ALIVES), dairy industry, beverage industry, tobacco industry (AFOOD), the tourism industry (AHOTEL), the oilseed industry and the chemical industry (AOTHM) which all have an important intermediate effect respectively (Table 1), despite the fact that they do not have a wide range of connections with all sectors of the economy. Thus, despite a high total effect, their impact is slowed by the quantity of intermediate relations (Figure 3).

In addition, other sectors related to the metal industry, equipment and audiovisual equipment (AEQUIP), wholesale and retail (ATRADE), make the Ivorian economy

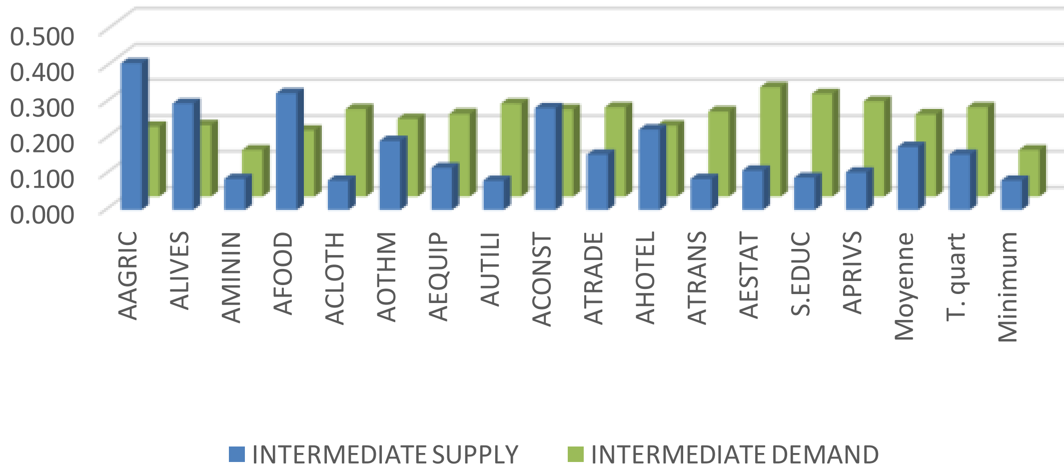

Figure 3. Intermediate effect 2013. Source: author's calculation from multilevel indicators.

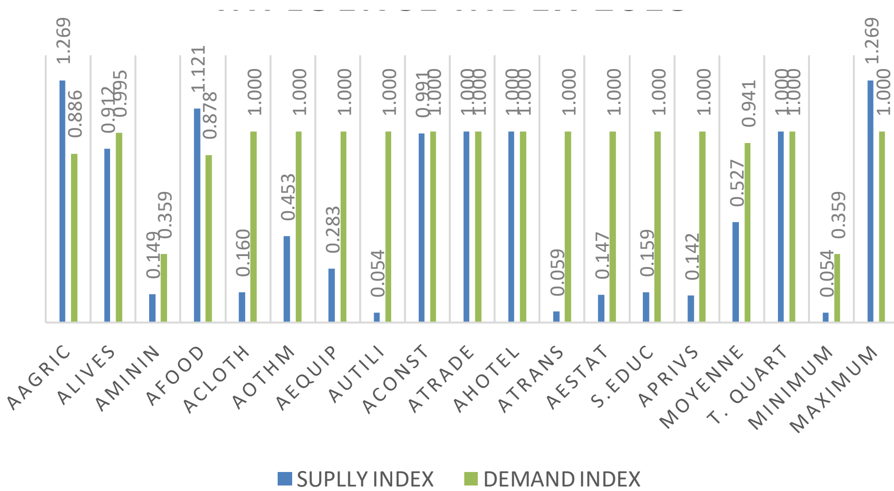

Figure 4. Influence index 2013. Source: author's calculation from multilevel indicators.

perform well, despite the fact that their total effects are low. In concrete terms, these activities do not have any significant backward and forward linkages that could drive the Ivorian economy towards growth, but their capacity to constitute a dissemination channel is considerable.

Influence index

The average influence index in 2013 in Leontief and Ghosh models are respectively 0.494 and 0.882%. In general, supply equals economic demand and susceptibility to influence is less. When a sector has a very large influence index above average, it shows signs of dependence on either the supply side or the demand side. The weaker he is, the less dependent he is. In 2013, only the extractive industry (AMINES) has the lowest index of influence on the demand side. This observation is suggestive and calls for a particular interest of the sector of the extractive industry (Figure 4).

By conducting a comparative study of multilevel indicators and SAM multipliers, we report changes in the percentage of income by household type and employment by sex in the extractive industries sector, when public expenditures increase by 2.5%.

Impact on household income

The policy of increasing educational expenditure affects the entire structure of the economy. Also, its impact differs according to the gender and the category of the household (Figures 5 and 6). In the SAM, the induced policy in the extractive sector, leads to an increase in income of urban poor households (URBPOOR) of 1.96%. First, they benefit from this increase of 2.5%. That of urban non-poor households (URBNPOOR) is 1.56%.

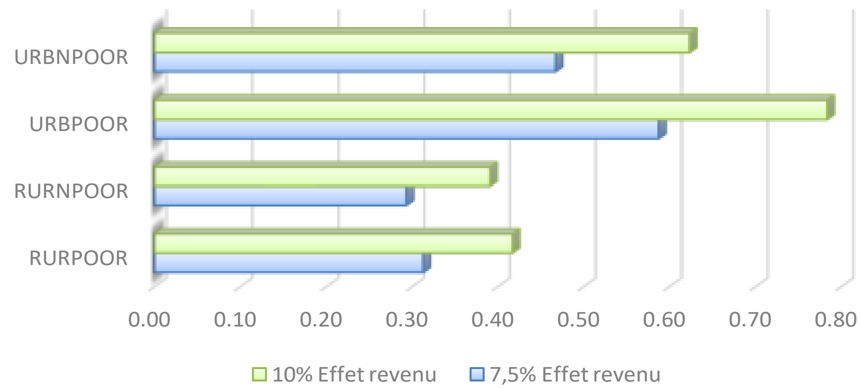

Figure 5. Impact on income of a 2.5% increase in public spending on education (Social Accounting Matrix). Source: results of the simulations of the author.

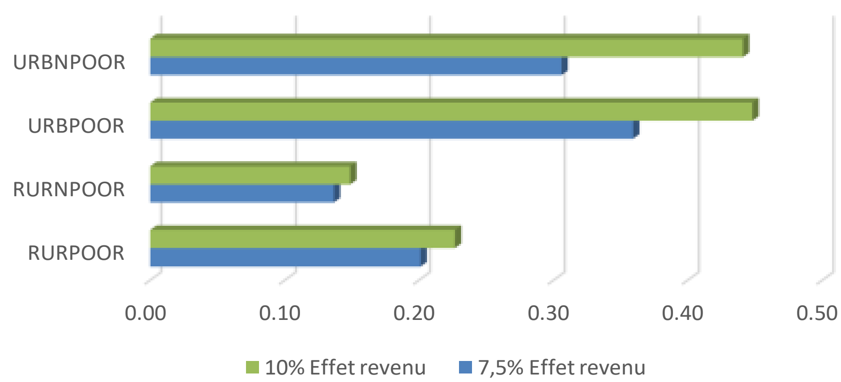

Figure 6. Impact on income of a 2.5% increase in public spending on education (network). Source: results of the simulations of the author.

Secondly, rural poor (RURPOOR) and rural non-poor (RURNPOOR) households respectively benefit from the increase at 1.04 and 0.98%, respectively. It can be seen that urban households benefit more from this policy, which is related to non-poor households in this sector.

But given that in the network, we relax the assumption of fixity, which differentiates the input coefficients between sectors, we identify the sensitivity of the branches as to sectoral influences, Garcia and Ramos, (2015). Thus, the normalization of the input coefficients in the network makes it possible to indicate that rural households benefit from the policy in approximately the same proportion as urban households: RURPOOR 0.26%, RURNPOOR 0.12%, URBPOOR 0.89% and URBNPOOR 1.35% (Appendix 3).

In addition, the companies in the sector are aware of an additional income increase of 3.5% according to the SAM, when the network shows 2.6%.

Impact on employment

In 2013, higher education spending benefited men and women differently. Figures 7 and 8 show the importance of the increase in employment by gender, whether in the SAM or in the network. The results are consistent with those of a previous study (Guédé, 2017), starting from the 2009 SAM. A 10% increase in public spending on education translates in a positive effect throughout the economy. Output, employment and household income increase.

The policy of increasing education expenditure by 2.5% leads to an increase in the possibilities of female employment creation of about 1.56% when that of men is 3.26% (SAM). The network indicates 1.05% for women and 1.77% for men. This differential in the two approaches is related to the normalization of the input coefficients in the network, which makes it possible to measure the individual and group-specific effects.

In addition, although there may be a gap in job creation by sex, this policy of increasing education spending is good for female employment. It would ultimately reduce the gap considerably.

There is child labor in the sector (LCHILD), but in a relatively insignificant proportion 0.01% in MCS and 4.10^{-2}% in the network. It is clear that female education signif-

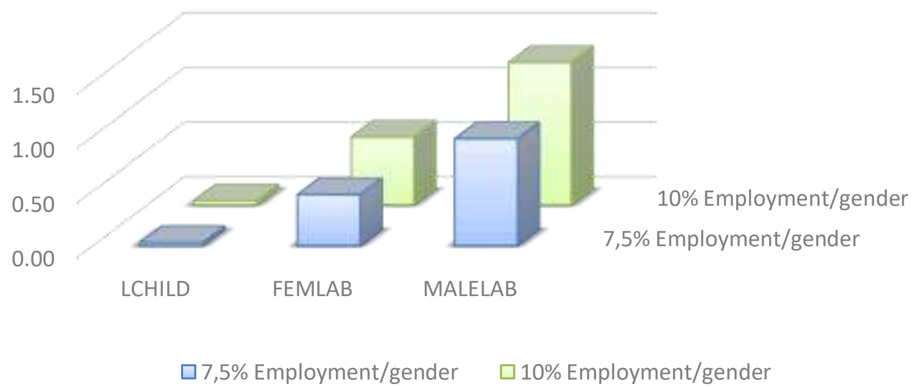

Figure 7. Impact on employment/gender in 2013 (SAM). Source: results of the simulations of the author.

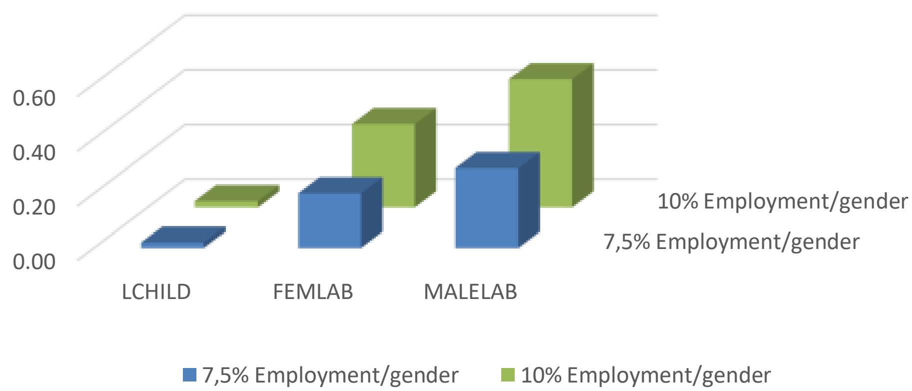

Figure 8. Impact on employment/gender in 2013 (network). Source: results of the simulations of the author.

cantly reduces the level of child labor. By considering the collective competence of individuals to meet and share information (Lucas, 1988), educated women in turn teach their offspring. In addition, this policy of increasing public education spending on girls increases their skills and opportunities to find work. In doing so, it reduces the level of child labor.

These results converge with the recent findings of the "School for All" with state investment at the national level to implement a policy, which allows gender mainstreaming in educational reform programs. Thus, the proportion of girls in the student population in lower secondary education increased from 36.5% in 2000 to 41.1% in 2014. However, the gap in job creation lies in the persistence of gender gaps enrollment illustrated by the gender parity index (*gender parity index of 0.70 for the first cycle and 0.63 for the second cycle in 2013/2014*).

CONCLUSION

The network analysis that has emerged in recent decades has opened up new paths for graph studies, centrality and regional development (Leitner *et al*., 2008). The relaxation of the fixity hypothesis allows the differentiation of input coefficients between sectors (Garcia and Ramos, 2015), which makes it possible to measure, for each branch, the sensitivity with regard to sectoral influences (total, immediate, intermediate effects and influence indices).

The incidence of recurrent crises in the past two decades taints the economy in terms of a system or network of relationships. The study of the impact of a public education expenditure policy on the extractive sector shows both in the SAM and in the network, a positive impact on the distribution of income by sex and by household category.

Several studies conducted with different approaches have analyzed the link between education and female employment in the mining industry. But to our knowledge, the consideration of a comparative approach SAM multipliers and multilevel indicators is innovative. In fact, unlike SAM multipliers, multilevel indicators (network theory) provide information on the process by which the structural relationship (centrality) affects the diffusion of flows and their robustness in the economic system.

Thus, the study of the centrality and the spread of the policy of public expenditure of education on the female employment in the sector of the extraction in Côte d'Ivoire reveals peculiarities. First child labor exists but is very low (4.10^{-2}%), female work is improved beyond one-third (1/3) of that of men (1.77%), or 1.05%. In addition, the distribution of income seems fair between the companies of the sector and the households, namely ENTR (2.6%), RURPOOR (0.26%), RURNPOOR (0.12%), URBPOOR (0.89%) and URBNPOOR (1.35%).

The same analysis from the SAM multipliers indicates 0.01% for child labor, 1.56% for female work against 3.26% for men, ENTR (3.47%), RURPOOR (1.04%), RURNPOOR (0.98%), URBPOOR (1.96%) and URBNPOOR (1.56%). That is a total differential of 5.8% between multilevel indicators and SAM multipliers. Both approaches therefore lead to some differences in the same conclusions (Appendix 3).

The study of the key sectors of the Ivorian economy by the multilevel indicators indicates that the key Ivorian sectors are related to the primary sector and related activities (AAGRIC, ALIVES and AFOOD), secondary sector to industry of average technological intensity (ACONST and AHOTEL), education services sector (SEDUC) and two technology-intensive sectors (AOTHM, AMINES). These results show that the Ivorian economy is highly dependent on low technology industries. However, while other sectors of the economy have a high demand for education services (AAGRIC 6,139, ALIVES 4,443, ACONST 4,253 and AHOTEL 3,364), the extractive sector (AMINES) has an average demand of 3,285. The labor force working in this sector is poorly educated, while this sector is a key sector as shown in the paper.

In 2013, the base of the Ivorian economy remains the agricultural sector. Its transition to the specific mining industry should be based on education, research and development that has an impact in the long term. In addition, there is a need for specific training for women, with very short periods opening up skills specific to specific jobs in the sector.

The whole analysis shows that the education policy of the state to increase its spending favors the employment of women in the extractive sector.

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Appendix 1: Basic Structure and content of the SAM.

Parameter	Factors		Institutions			Activities	Products	Accumulation	Row	Total
	Travail	Capital	Menages	Entreprise	ETAT					
Factors										
Labor	…	…	…	…	…	S	…	…	…	RT
Capital	…	…	…	…	…	RE	…	…	…	RC
Institution										
Household	S	…	TM	PDI	TAM	…	…	…	REX	RM
Companies	…	REE	…	…	…	…	..	…	TE	REN
State	…	…	ICS	I	TA	CSTA	TP	…	TE	RAP
Activities	…	…	….	…	SUB	…	PD	…	PDO	R
Products	…	…	CFM	…	CFAP	CI	…	ASI	X	D
Accumulation	…	…	EM	EE	EP	ACF	RS	…	DBP	ET
Row	RTE	…	T	T	T	…	M	SGP	…	PRDM
Total	PPT	PPC	DM	ERE	DAPU	PDO	O	IT	PRDM	

RT = revenu du travail
RE = revenu d'exploitation
RC = revenu du capital
S = salaire
TM = Transferts entre ménages
PDI = Profits distribués
TAM =Transferts aux ménages
REX = Revenu de l'extérieur
RM = Revenu des ménages
REE = Résultats d'exploitation
TE = Transfert de l'extérieur
REN = Ressources des entreprises
RAP = Ressources des Administrations Publiques
TP = Taxes sur les produits
CSTA = Charges sociales et taxes sur les activités
TA = Transferts aux Administrations
I = impôt
ICS = Impôts. cotisation sociales
O = offre
PDO = Production domestique
DAPU = Dépenses des APU
ERE = Emploi du RE
PPC = Paiement aux prestataires de capital
DM = Dépense des ménages
PPT = Paiement aux prestataires de travail
RTE = Rémunération du travail des étrangers
T = transferts
M = importation
SBP = Solde Global des paiements
DBP = Déficit de la balance des paiements
ASI = Augmentation des stocks et investissement
RS = Réduction des stocks
ACF= Amortissement du capital fixe
X = exports
EP = Epargne publique
EE = Epargne des entreprises
EM = Epargne des ménages
CFM = Consommation finale des ménages
CFAP = Consommation finale de A.P
CI = consommation intermédiaire
PD = Produit domestique
SUB = subventions
R : recettes
D = demande
ET = Epargne totale
PRDM = Paiement au RDM
IT = Investissement total

Appendix 2: Aggregation of activity sectors in the SAM.

Branches of activity	**Code**
Food agriculture Grain work	ALIVES
Industrial agriculture Breeding and hunting Appendices to agriculture and breeding Forestry Fishing and fish farming Meat and fish Cocoa and coffee processing	AAGRIC
Extraction Industries	AMININ
Oilseed industries Chemical Industries	AOTHM
Bakery. pastry… Dairy industries Beverage industries Tobacco industry	AFOOD
Textile and clothing industry Leather and shoes	ACLOTH
Woodworking industry Paper and cardboard	AUTILI
Refining industry Rubber and plastic industry	
Basic metal products Electrical machinery and appliances Audio-visual equipment and appliances	AEQUIP
Other non-metallic mineral products Furniture and products of various industries	AESTAT
Electricity. gas. water Repairs Construction work	ACONST
Real estate services Wholesale and retail	ATRADE
Hotel and restaurant services	AHOTEL
Transportation equipment manufacturing Transport and communication Post and Telecommunication Service	ATRANS

Appendix 2: Contd

Financial services	
Business services	APRIVS
Imputed revenue from banking services	
Education	S.EDUC

Appendix 3: Compared effect network and SAM due to 2.5% increase policy.

Parameter	SAM (10 - 7.5)	NETWORK (10 - 7.5)	Δ NETWORK-SAM
LCHILD	0.010	0.004	-0.006
FEMLAB	1.56	1.05	-0.51
MALELAB	3.26	1.77	-1.49
ENTR	3.47	2.61	-0.87
RURPOOR	1.04	0.26	-0.79
RURNPOOR	0.98	0.12	-0.86
URBPOOR	1.96	0.89	-1.07
URBNPOOR	1.56	1.35	-0.21
TOTAL	13.93	8.08	-5.85