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Exports and Labor Income by Gender: A Social Accounting Matrix Analysis for Senegal

Ismael Fofana, Juan Carlos Parra, and Quentin Wodon[†]

Raising the incomes of women can help reduce poverty in both the short run (by providing more resources to households) and the long run (by increasing investments in the human capital of children). Substantial research on gender disparities in labor incomes in developing countries has been conducted using microeconomic household survey data. These studies do not necessarily provide insights on how broad structural shifts in an economy can differentially affect opportunities for work and income generation for men and women, however.

This paper uses a recent Social Accounting Matrix (SAM) for Senegal to assess how growth in various sectors of the economy, especially exports from tourism, affects the incomes of women and men, both directly and indirectly through initial and multiplier effects. It finds that a tourism export boom could increase not only the level of income of Senegalese women but also their share of total labor income in the economy. The differential impact on labor income shares from growth in various sectors is not necessarily as large as one might expect, however. This suggests that broad policies to encourage the development of specific sectors may not be sufficient to fundamentally affect gender labor income shares.

Why should we be interested in gender disparities in labor income shares and more generally labor market conditions? In Sub-Saharan Africa such disparities have important implications for poverty reduction. At least three different aspects of poverty can be related to the decisions made by various household members in terms of their allocation of time and their prospects for labor income.

First, traditional consumption-based poverty is directly related to the earnings of household members as well as to household size. Both factors depend in part on who is working in the household and how much various household members earn.

Second, the issue of relative power within the households (for example, whether the household head or the spouse makes key decisions, either separately or jointly) also depends on the earnings of various household members. It can have important long-term effects on children. Typically, the less women are engaged in income-generating activities, the less influence they

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have on household decision making and the less the household invests in the human capital of children, which may in turn reduce the likelihood that their children will avoid poverty in the future (Hoddinott and Haddad 1995; for evidence on Senegal, see Bussolo, de Hoyos, and Wodon 2009).

Third, time poverty (working more hours than desirable) is an important welfare measure. It is the direct result of the decisions made within the household regarding the allocation of both domestic and productive work. For example, women tend to work much less in the labor market, but this is more than compensated by long hours spent on domestic work, so that they tend to be more time poor than men (that is, a larger share of women than men work long hours) (Blackden and Wodon 2006).

In a microeconomic setting, standard regression analysis techniques can be applied to household survey data to measure the likelihood of labor force participation as well as the time spent on various household activities by different household members. The same techniques can be used to see how expected levels of earnings for women compare with the expected values for men. Differences between men and women can then be analyzed using alternative decomposition methods to assess what drives differences in earnings and what remains unexplained.[1] Access to basic infrastructure services, such as electricity and water, is important, because such access has a direct impact on the time allocation of household members, especially in Africa, as well as on the productivity of labor.

While standard microeconomic techniques can help shed light on gender disparities, they do not typically provide insights on how broad structural shifts in the economy affect opportunities for work for men and women differently. This paper uses a recent Social Accounting Matrix (SAM) for Senegal to assess how demand shocks in various sectors of the economy are likely to affect the incomes of women and men differently.

Since the 1994 devaluation of the CFA franc, the performance of the Senegalese economy has been good, both in comparison with other countries in the subregion and from an historical perspective. As a result, poverty reduction has been substantial. According to estimates by Ndoye and others (2008), the share of the population living in poverty decreased from 67.9 percent in 1994/95 to 50.8 percent in 2005/06, the latest year for which household survey data are available[2]. Despite the decline, concerns remain that the poor may not have benefited as much from growth as they could have. The real average growth rate reached almost 5 percent over this period, and fiscal and external balances were maintained. Growth slowed after 2006, however, and has been uneven in various sectors of the economy. Growth has been achieved

1. Despite consensus on the existence of gender disparities in African labor markets, assessing their nature and extent remains a challenge. Databases provide incomplete and limited information on the relative situations of men and women, use very diverse methodologies and definitions of employment and earnings, and focus mostly on urban areas (see, for instance Appleton, Hoddinott, and Krishnan 1999; Brilleau, Roubaud, and Torelli 2004). Drawing on a meta-analysis of studies on the gender pay gap, Weichselbaumer and Winter-Ebmer (2005) find that only about 3 percent of empirical studies conducted on the topic since the 1960s draw on African data.

2 In 2005-2006, the poverty line computed following the cost of basic needs method was CFAF 924 per person per day in Dakar, CFAF 662 in other urban areas, and CFAF 561 in rural areas (CFAF = Communauté Financière Africaine franc).

mainly in trade, telecommunications, agriculture (with ups and downs), construction, and real estate activities.

One of the sectors that has traditionally been important for exports in Senegal is tourism, which has grown in recent years. Given the high labor intensity of this sector and the fact that it employs many women, one might expect that growth of the sector would contribute to a larger income share for women over time. However, beyond the direct impact of tourism on female income shares is the indirect impact of growth in the tourism sector on labor income through the multiplier effect tourism has on the rest of the economy. Analysis of this type can easily be conducted using a SAM approach.

The rest of this paper is organized as follows. The next section provides a brief description of the structure of a standard SAM, as well as some details on the construction of the 2004 Senegal SAM used for the analysis, with a focus on the steps that were taken to disaggregate the labor shares of different sectors in the SAM by gender. The following section presents the results of the simulations. The last section summarizes the paper's main conclusions.

Basic Structure of a Social Accounting Matrix

Social accounting matrices (SAMs) have been used fairly extensively to model the impact of shocks on an economy. A brief literature review on SAMs is provided in Nganou, Parra, and Wodon (2009).

Intuitively, the SAM model is a static comprehensive model that assumes that all agents and accounts in the SAM behave according to their expenditure propensities (what one agent or account in the economy buys from another agent or account), and that these propensities are unaffected by shocks simulated in the model (that is, there are no behavioral responses or changes following a shock). The general equilibrium nature of the SAM model comes from the fact that the model takes into account multiplier effects. If production in one account or sector is increased, that sector must buy inputs from other accounts, which in turn must purchased additional inputs, and so on. All these spillover effects from an initial shock are taken into account in the SAM model, which gives us the overall impact on the economy of a shock after the economy has reached a new equilibrium following the shock.[3]

The core of the SAM model is the technical coefficients matrix containing the expenditure propensities for every account in the matrix. The equilibrium character of the model is given by the fact that, at a solution, there are no forces suggesting additional changes. In the simplest form of the model, no resource constraint is specified because it is assumed that any additional production required is feasible, so that all resources (factors) required to undertake additional production are available (this assumption can be relaxed).

The simplicity of the SAM model is both its main weakness and strength. This simplicity is a weakness because no behavioral response is taken into account, and the model cannot be

3. Thorbecke and Jung (1996) suggest that an important limitation of the "traditional" SAM model is the assumption that the average expenditure propensities (technical coefficients) hold for exogenous demand shocks, implying income elasticities equal to one. A more realistic alternative, mentioned in Lewis and Thorbecke (1992), is to use marginal expenditure propensities, if available, as we do here for consumers.

used to simulate at the same time price and quantity shocks (when a price shock is simulated, quantities are held constant, and when a quantity shock is simulated, prices are held constant). But simplicity is also a strength, because the model is easy to understand and its results can be easily replicated. More complicated models, such as computable general equilibrium (CGE) models, can take into account behavioral responses, but their results depend on many assumptions which are not always easy to assess for the external reader. Obviously, strong assumptions are implicit in the SAM model, but they are transparent and easier to comprehend. SAM models are probably especially helpful in low income countries where data are limited.

Another potentially important advantage of the SAM model is the possibility of analyzing the structure of the economy and to quantify the strength of the linkages between the different accounts. The final effect of any shock can be easily decomposed in several ways to shed light on the economic links between accounts and their intensity. This type of decomposition analysis is much more difficult to do with a CGE given the more complex nature of such models.

In technical terms, SAMs are numerical arrays representing the circular flow of income in an economy between sectors or activities, as well as between sectors, the government, households, and the rest of the world. Each cell in a SAM, denoted by SAM_{ij}, reflects payments from an account *j* to another account *i*. When using a SAM for simulations, some accounts have to be set as endogenous (which means that they can react to a shock in the economy) and the rest of the accounts are set as exogenous (no change in the account following a shock). It is customary to set the government, capital, and rest of the world accounts as exogenous, but this choice depends on the nature of the analysis. Mathematically, the structure of simulations can be presented using a simple representation of a SAM (table 1).

Table 1. Schematic Social Accounting Matrix

Income/expenditure	Endogenous accounts	Exogenous accounts	Total
Endogenous accounts	T	X	Y
Exogenous accounts	L	T	Y_x
Total	Y	Y_x	

Source: Adapted from Defourney and Thorbecke 1984.

The core of the SAM analysis is the multiplier model. Assume there are *n* endogenous accounts. Let $\mathbf{A_{nxn}}$ denote the matrix of technical coefficients, that is, the matrix resulting from dividing every cell T_{ij} in $\mathbf{T_{nxn}}$ by the respective column sum Y_j. Let $\mathbf{Y_{nx1}}$, $\mathbf{N_{nx1}}$, and $\mathbf{X_{nx1}}$ denote column vectors with the sums of total expenditures for the endogenous accounts, the endogenous component of those expenditures, and the exogenous component, respectively. Then by construction, the following two equations hold: $Y = N + X$ and $N = AY$. Combining these equations yields

$$Y = AY + X \qquad (1)$$

which can be rewritten as

$$Y = \left(I - A\right)^{-1} X = MX \qquad (2)$$

where **I** is the *n* x *n* identity matrix. The matrix $M = \left(I - A\right)^{-1}$ is known as the accounting multiplier matrix, the Leontief inverse matrix, or simply the inverse matrix. Each cell m_{ij} of M quantifies the change in total income of account *i* as a result of a unitary increase in the exogenous component of account *j*. This change takes into account all the interactions in the economy that follow from an initial shock, so that SAMs are general equilibrium models.

As already mentioned, when using SAMs for simulations of standard demand shocks (for example, an increase in the demand of tourism from the rest of the world), it is important to realize that a number of assumptions are implicit in the framework. The two main assumptions are that all prices remain fixed, as do all expenditure propensities, whether one considers productive activities or commodities purchased by households. Thus a SAM is essentially a picture at one point in time of the economy and of the relations between different sectors as well as institutions or groups of agents. When using the SAM for simulations, we assume that the structural relations observed in the economy do not change, which is to say that there are no behavioral adjustments by agents following a shock. This is a strong assumption, which implies that the analysis obtained from a SAM is often tentative and indicative only, and may lead to an overestimation of the impact of a shock.

Characteristics of the 2004 Senegal SAM

This section provides a basic description of key features of the Senegal SAM. It begins with the activities identified in the SAM and then focuses on how the SAM labor accounts have been disaggregated by gender, which is the feature of the SAM then used to assess the impact of various shocks on labor income by gender.

Activities

The Senegal SAM used here is based on an input-output table for 2004. The SAM includes 35 activities and commodities and 8 production factors, including 6 labor income accounts disaggregated by urban versus rural location, gender, and education (literate versus illiterate workers in urban areas). There are two capital accounts, one for households and the self-employed and one for firms and government. Households are defined according to their geographic location (Dakar, other urban households, and rural households).

Commerce is by far the largest contributor to value added, accounting for almost 17 percent of the total (table 2). This sector is followed by public administration with almost 7 percent and by a group of industries, including real estate, financial services, telecommunications, and agriculture, with contributions of about 5–6 percent of total value added. Other industries such as construction, transport, livestock and hunting, and meat and fish processing each account for about 4–5 percent.

Table 2. Sectoral Analysis for the 2004 Senegal SAM

Sector	*Production (Q)*		*Value added at factor costs*		*Imports (M)*		*Exports (X)*		*M/Q*	*X/XS*	*Import taxes*	*Local taxes*
	Millions of dollars	*Percent of total*	*Millions of dollars*	*Percent of total*	*Millions of dollars*	*Percent of total*	*Millions of dollars*	*Percent of total*				
Commerce	1,979	15.2	1,292	16.9	0	0.0	0	0.0	0.00	0.00		1.4
Public administration	727	5.6	529	6.9	0	0.0	0	0.0	0.00	0.00		0.1
Real state	476	3.7	442	5.8	0	0.0	0	0.0	0.00	0.00		7.1
Financial services	817	6.3	417	5.5	121	4.0	118	5.8	0.15	0.14	12.8	6.1
Agriculture	441	3.4	382	5.0	135	4.5	8	0.4	0.24	0.02	23.4	-24.3
Telecommunications	573	4.4	363	4.8	26	0.9	96	4.7	0.05	0.17	4.2	6.6
Construction	1,253	9.6	327	4.3	0	0.0	0	0.0	0.00	0.00		0.2
Livestock and hunting	362	2.8	297	3.9	1	0.0	3	0.1	0.00	0.01	17.3	8.9
Transport	608	4.7	298	3.9	52	1.7	91	4.4	0.09	0.15	15.6	6.4
Education	293	2.3	259	3.4	6	0.2	0	0.0	0.02	0.00	32.2	7.2
Meat and fish processing	478	3.7	243	3.2	32	1.1	154	7.5	0.09	0.32	25.9	5
Industrial agriculture	251	1.9	192	2.5	22	0.7	8	0.4	0.08	0.03	16	78.9
Utilities	377	2.9	167	2.2	0	0.0	0	0.0	0.00	0.00		7.7
Chemical products	404	3.1	151	2.0	322	10.6	302	14.8	0.76	0.75	17.9	-73.7
Other private services	217	1.7	144	1.9	0	0.0	56	2.8	0.00	0.26	32.2	5.7
Fishing	258	2.0	141	1.8	12	0.4	91	4.5	0.06	0.35	1.8	3.5
Textiles	261	2.0	107	1.4	75	2.5	32	1.6	0.25	0.12	21.1	6.7
Health	153	1.2	105	1.4	0	0.0	0	0.0	0.00	0.00	32.2	7.2
Mining	168	1.3	88	1.2	386	12.7	105	5.1	0.72	0.26	2.3	35.4
Food	469	3.6	92	1.2	288	9.5	75	3.7	0.42	0.16	29.8	4.8
Other manufacturing	153	1.2	89	1.2	31	1.0	8	0.4	0.18	0.05	25.5	8.1
Grains and cereals	541	4.2	83	1.1	224	7.4	6	0.3	0.29	0.01	28.8	5.9
Tourism	330	2.5	74	1.0	0	0.0	249	12.2	0.00	0.75		2.5
Forestry	92	0.7	59	0.8	9	0.3	2	0.1	0.10	0.02	14.4	43.9
Glass and pottery	199	1.5	64	0.8	65	2.1	32	1.6	0.28	0.16	18	34.7
Metallic products	137	1.1	57	0.7	194	6.4	42	2.1	0.67	0.31	15.8	-45.9
Wood products	94	0.7	43	0.6	63	2.1	51	2.5	0.15	0.04	4.7	5.2

Paper products	129	1.0	44	0.6	72	2.4	15	0.8	0.31	0.00	14.4	8.7
Beverages	73	0.6	29	0.4	19	0.6	2	0.1	0.21	0.02	30.1	6.9
Petroleum	453	3.5	34	0.4	265	8.7	459	22.5	0.03	0.44	1.1	13.9
Rubber products	90	0.7	30	0.4	54	1.8	21	1.0	0.44	0.23	19.1	6.3
Tobacco	64	0.5	12	0.2	0	0.0	12	0.6	0.01	0.18	27	6.2
Leather products	27	0.2	15	0.2	13	0.4	3	0.2	0.35	0.13	31.9	6.3
Machinery and equipment	34	0.3	8	0.1	385	12.7	0	0.0	0.92	0.00	17	3.2
Transport materials	13	0.1	4	0.1	162	5.3	0	0.0	0.93	0.00	20.3	0.3
Total	12,992	100.0	7,634	100.0	3,037	100.0	2 039	100.0	0.19	0.13	16.1	3.3

Source: Authors using SimSIP SAM**.**

Note: M/Q is the import share within sector production; X/XS is the export share of production.

Senegal's main imports are machinery and equipment, metallic products, transport materials, mining, food, and petroleum, which together accounted for 82 percent of cif imports in 2004. The country relies on imports for 90 percent of its demand for machinery and equipment and transport materials; 70–80 percent of its demand for chemical products, mining, and metallic products; and 30–40 percent of its demand for rubber products, food (excluding cereals, meat, and fish), leather products, and paper products. Petroleum represents 23 percent of total fob exports. Chemical products and tourism ("hotels and restaurants" in the national accounts) are also important commodities sold to nonresidents, with chemical products representing 15 percent and tourism 12 percent of total exports. Meat and fish processing, mining, fishery, financial services, telecommunications, and transport are also important export sectors. Tourism and chemical products are the most export-oriented industries, exporting three-quarters of their production. Petroleum, fishing, meat and fish processing, and metallic products are also export oriented.

Gender Disaggregation for Labor Income

Gender-disaggregated SAM accounts are needed to analyze the impact of exogenous shocks on labor income shares by gender. This section explains how the labor income component of the Senegal SAM was disaggregated for each activity by using data from the 1994/1995 and 2001/02 nationally representative household surveys (Enquête Sénégalaise Auprès des Ménages [ESAM]) and establishing a correspondence between the SAM activities and the sectors of occupation listed by household members in the surveys. Both surveys identify the sector of activity of workers; data on earnings are available only in the first survey. It was therefore necessary to impute earnings in the second survey. Both the levels of earnings and the share of workers in different sectors by gender were then used to estimate the labor income shares accruing to women in each sector of the SAM.

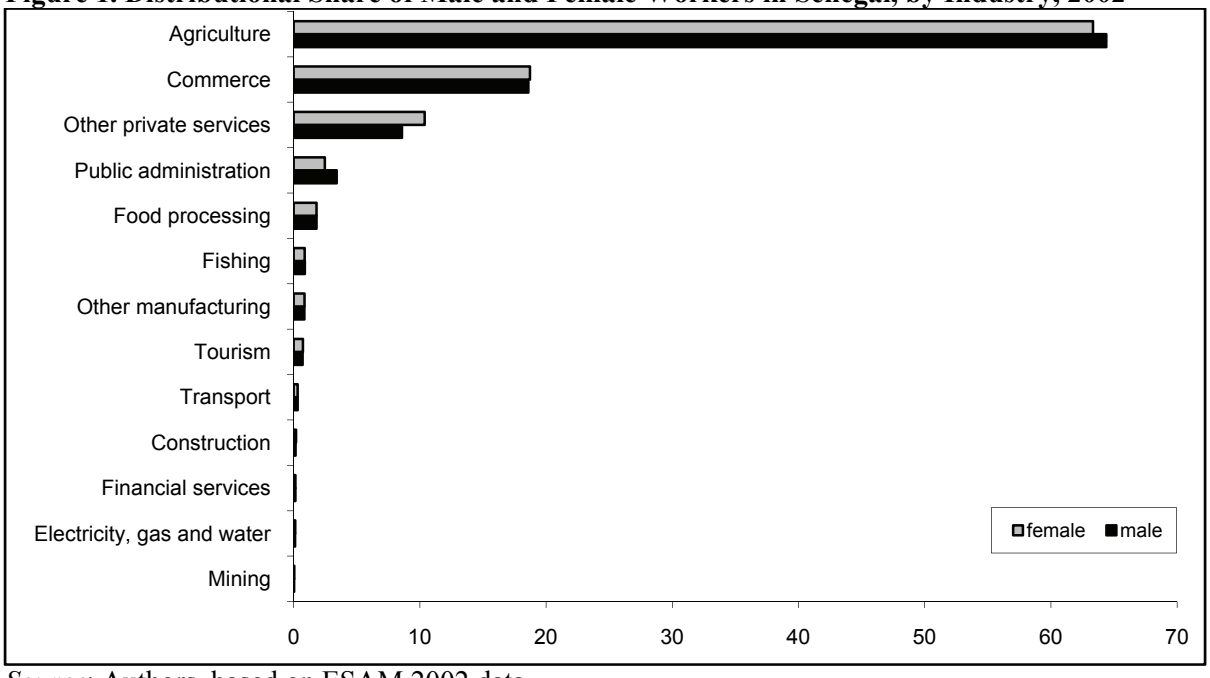
The estimates of the earnings by gender in the SAM are based on two sources of data. The first is the distribution of employment by gender and sector in the ESAM II survey. According to that survey, there were 1.57 million women and 1.92 million men working in Senegal in 2002. Agriculture was the principal activity for both men (64 percent of all male workers) and women (63 percent of all female workers) (table 3 and figures 1 and 2). It was followed by commerce, with 19 percent of male and female workers. The shares of workers in these two sectors increased between 1995 and 2002, at the expense of activities such as construction, transport, other manufacturing, fishing, and (somewhat surprisingly) public administration. In absolute terms all sectors except public administration (where female employment fell 26 percent) witnessed an increase in male and female employment. Male employment increased at a rapid annual rate in construction (10 percent) and other manufacturing (9 percent). Female employment witnessed a significant increase in activities that have not traditionally been female intensive, such as construction (29 percent) and mining (25 percent). (The ratio of female to male employment in these industries nevertheless remains small.) Female employment in other private services rose by 24 percent over the period. This sector is the most female intensive after tourism and commerce. Overall, the ratio of female to male employment remained at roughly 0.8 between 1995 and 2002. Activities with a large share of female workers include private and social services (tourism, as well as commerce and other private services); food-processing activities; and agriculture. Manufacturing industries (including construction, transport, and mining) are less female intensive.

Table 3. Female and Male Employment in Senegal, by Sector

Sector	*Number of workers*		*Share of total (percent)*		*Female/male*
	Female	*Male*	*Female*	*Male*	*intensity*
Agriculture	996,856	1,077,828	63.3	64.4	0.9
Commerce	294,681	181,482	18.7	18.6	1.6
Other private services	163,404	135,110	10.4	8.6	1.2
Public administration	38,944	102,833	2.5	3.4	0.4
Food processing	28,521	31,631	1.8	1.8	0.9
Fishing	13,816	56,826	0.9	0.9	0.2
Other manufacturing	13,506	79,460	0.9	0.8	0.2
Tourism	11,531	6,517	0.7	0.7	1.8
Transport	5,027	94,391	0.3	0.3	0.1
Construction	3,049	122,149	0.2	0.2	0.0
Financial services	2,137	4,112	0.1	0.1	0.5
Electricity, gas, and water	1,905	15,638	0.1	0.1	0.1
Mining	725	9,616	0.0	0.0	0.1
All	1,574,101	1,917,593	100.0	100.0	0.8

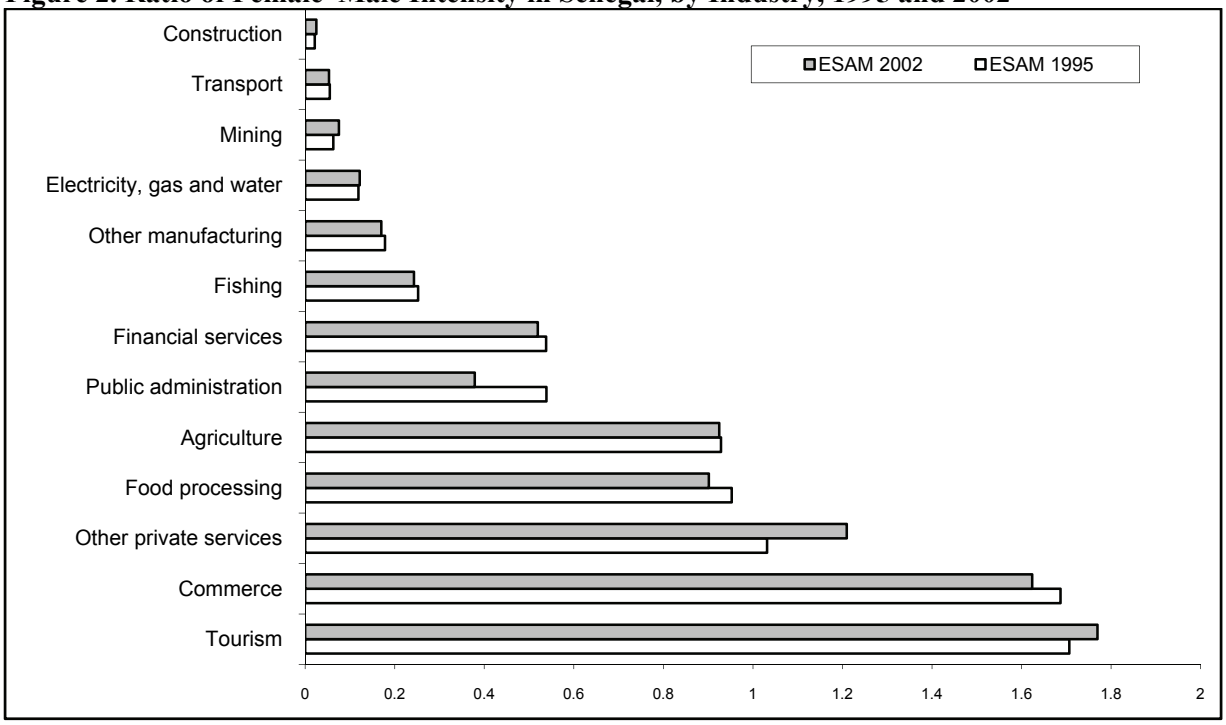
Source: Authors' compilation, based on data from ESAM 1995 and ESAM 2002.

Figure 1. Distributional Share of Male and Female Workers in Senegal, by Industry, 2002



Source: Authors, based on ESAM 2002 data.

Figure 2. Ratio of Female–Male Intensity in Senegal, by Industry, 1995 and 2002



Source: Authors, based on ESAM 1995 and 2002 data.

To compute labor income shares by gender, we also need data on earnings. Gender differences in earnings in Africa are large, as the data from the 1995 ESAM survey indicate (table 4). Because the 2002 ESAM II survey did not include wage or income data, we used the wage data from the ESAM I survey (indexed by inflation between 1995 and 2002) combined with the labor employment shares of the ESAM II survey to construct labor earnings in the SAM. This information was then used to estimate male and female income shares for the SAM.

Table 4. Average Monthly Earnings by Females and Males in Senegal, 1995 (CFAF)

Item	*Female*	*Male*	*Female/male ratio*
Sector			
Transport	193,548	137,617	1.41
Commerce	70,441	83,511	0.84
Electricity, gas, and water	173,288	224,461	0.77
Fishing	85,575	122,900	0.70
Other manufacturing	56,889	96,613	0.59
Financial services	135,404	231,140	0.59
Food processing	56,753	110,513	0.51
Public administration	130,883	269,087	0.49
Construction	23,000	63,094	0.36
Other private services	85,173	267,473	0.32
Tourism	25,906	88,579	0.29
Agriculture	7,964	32,483	0.25
Mining	0	140,387	0.00
Type of employment			
Self-employed workers	5,591	10,809	0.52
Salary and wage workers	44,306	124,151	0.36
Family helpers	3,574	17,602	0.20
Individuals in training	28,777	30,702	0.94
All	86,690	166,892	0.52

Source: Authors' compilation, based on data from ESAM 1995.

Nationally, only one-third of total labor income accrues to female workers. This share is larger in the primary sector (43 percent) and much smaller in the secondary sector (12 percent) (table 5). In urban areas men and women are involved primarily in services, and differences in total labor incomes by gender are smaller than they are in rural areas. In rural areas agriculture is the main activity, and differences in labor incomes are larger. The largest share of labor income accrues to men in mining, construction, other manufacturing, and transport and telecommunications.

Table 5. Female and Male Labor Income Shares in Senegal, by Sector, 2002 (percent)

	Share			*Intensity*	
Sector	*Female*	*Male*	*All*	*Female*	*Male*
Senegal	100.0	100.0	100.0	32.2	67.8
Primary sector	31.3	20.1	23.7	42.5	57.5
Secondary sector	6.4	22.7	17.5	11.7	88.3
Tertiary sector	62.4	57.2	58.9	34.1	65.9
Urban areas	100.0	100.0	100.0	41.9	58.1
Primary sector	84.0	62.7	71.7	49.2	50.8
Secondary sector	0.8	9.8	6.1	5.7	94.3
Tertiary sector	15.2	27.4	22.3	28.6	71.4
Rural areas	100.0	100.0	100.0	28.6	71.4
Primary sector	3.1	7.4	6.2	14.2	85.8
Secondary sector	9.4	26.5	21.6	12.4	87.6
Tertiary sector	87.6	66.0	72.2	34.7	65.3
Sector of activity	100.0	100.0	100.0	32.2	67.8
Agriculture	29.8	14.6	19.5	49.2	50.8
Fishing and hunting	1.5	4.2	3.3	14.4	85.6
Mining	0.0	1.3	0.9	0.0	100.0
Food industry	2.7	7.7	6.1	14.1	85.9
Other industries	3.3	8.5	6.8	15.7	84.3
Electricity, gas and water	0.3	1.2	0.9	9.4	90.6
Construction	0.1	5.3	3.6	1.0	99.0
Commerce	29.3	12.5	17.9	52.7	47.3
Tourism	1.9	0.7	1.1	55.9	44.1
Transport and telecommunications	1.1	11.6	8.3	4.4	95.6
Financial services	13.6	9.6	10.9	40.2	59.8
Public administration	6.9	10.1	9.0	24.4	75.6
Other private services	9.6	12.7	11.7	26.3	73.7

Source: Authors' compilation, based on ESAM 1995 and ESAM 2002 data.

The next step in computing gender-disaggregated labor income data for the SAM consists of mapping the industrial sectors observed in the ESAM surveys with the sectors as defined in the SAM (table 6). Overall, tourism is the most female-intensive labor activity, with 55.9 percent of total payments to labor going to female workers. Shares of labor income for women are 52.7 percent in commerce and 49.2 percent in agriculture. Petroleum is the most important export product, representing 22.5 percent of total exports, followed by chemical products (14.8 percent) and hotels and restaurants (12.2 percent). These three sectors also exhibit high export propensities (55.7 percent for petroleum, 51.4 percent for chemical products, and 19.9 percent for hotels and restaurants). One might expect that tourism would have the largest potential among export sectors for increasing the share of total income earned by women. In fact, the effect also depends on multiplier effects, as shown in the next section.

Table 6. Female Labor Income Share and Labor Intensity in Senegal SAM, 2004

Sector	*Female labor income share (percent)*	*Labor intensity (percent)*
Tourism	55.9	10.7
Commerce	52.7	28.9
Agriculture	49.2	63.7
Industrial agriculture	49.2	49.7
Livestock and hunting	49.2	51.3
Forestry	49.2	36.0
Financial services	40.2	24.1
Real state	40.2	31.8
Health	28.6	43.9
Other private services	28.6	44.9
Public administration	24.4	39.8
Education	24.4	72.0
Textiles	15.7	29.6
Leather products	15.7	19.8
Wood products	15.7	20.2
Paper products	15.7	8.8
Petroleum	15.7	1.7
Chemical products	15.7	9.8
Rubber products	15.7	4.0
Glass and pottery	15.7	5.2
Metallic products	15.7	6.2
Machinery and equipment	15.7	7.3
Transport materials	15.7	12.1
Other manufacturing	15.7	20.5
Fishing	14.4	40.9
Meat and fish processing	14.1	20.3
Grains and cereals	14.1	7.7
Food	14.1	10.0
Beverages	14.1	8.4
Tobacco	14.1	5.8
Electricity, gas, and water	9.4	7.6
Transport	4.4	18.2
Telecommunications	4.4	26.7
Construction	1.0	9.3
Mining	0.0	16.8

Source: Authors' compilation, based on ESAM 1995 and ESAM 2002 data.

Sectoral Growth and Impact on Labor Income Shares by Gender

All of the computations in this section were performed using SimSIP SAM, a powerful and easy to use Microsoft® Excel–based application with MATLAB® running in the background that can be used to conduct policy analysis under a SAM framework. The tool, developed by Parra and Wodon (2010), is distributed free of charge, together with the necessary MATLAB components.

The accompanying user's manual describes its use and the theory behind the computations. The application can be used to perform various types of analysis and decompositions and to obtain detailed and graphical results for experiments.

We start by providing the labor income multipliers[1] (multiplied by 1,000 to make the table easier to read) by gender, location and other subgroups following a unitary exogenous demand shock for some specific sectors in the economy (table 7). The same table shows, below the multipliers, the corresponding percentage changes in labor incomes. So, for example, in the top left corner one reads that the multiplier of the rural male income due to an increase of CFAF1,000 million in tourism is equal to CFAF171 million; and that this corresponds to 0.63% of the initial level of the rural male income.

Because male workers as a group earn so much more than women, due to both a higher number of male workers and a higher average wage for male workers, the multiplier impacts are larger for male workers than for female workers. For example, after multiplier effects are taken into account, an additional CFAF1,000 million of exports in tourism, generates an increase of CFAF654.6 million in male labor income and CFAF367.7 million in female labor. Other private services exports have the greatest impact on labor income among the four export sectors with CFAF1,313 millions of additional labor income per CFAF1,000 millions of additional exports. Agriculture experiences the largest increase in labor income for female workers as a ratio of the corresponding increase for male workers, with a figure of 1.6 times what the male workers receive. The increase in labor income primarily favors illiterate male workers. The impact is also greater among urban than rural workers.

Table 7. Effect on Labor of Exogenous Demand Shock of CFAF1,000 Million in Senegal, by Sector and Population Segment, 2004 (in CFAF millions)

Population segment	*Tourism*	*Petroleum*	*Agriculture*	*Financial services*	*Other private services*	*Transport*	*Construction*
Rural							
Male	171.0	62.3	296.8	128.5	187.2	142.8	129.8
	(0.63)	(0.23)	(1.09)	(0.47)	(0.69)	(0.52)	(0.48)
Female	139.9	45.4	261.6	93.4	120.6	91.1	83.0
	(0.71)	(0.23)	(1.32)	(0.47)	(0.61)	(0.46)	(0.42)
Total	310.9	107.7	558.4	221.9	307.9	233.9	212.8
	(0.66)	(0.23)	(1.19)	(0.47)	(0.65)	(0.50)	(0.45)
Urban							
Male illiterate	360.8	167.8	283.0	444.3	568.1	374.4	343.5
	(0.53)	(0.24)	(0.41)	(0.65)	(0.83)	(0.55)	(0.50)
Female illiterate	147.3	58.1	104.3	206.3	221.3	122.5	117.2
	(0.61)	(0.24)	(0.43)	(0.85)	(0.91)	(0.50)	(0.48)
Male literate	122.8	57.3	100.2	105.6	133.8	153.6	130.2
	(0.52)	(0.24)	(0.42)	(0.45)	(0.57)	(0.65)	(0.55)
Female literate	80.6	33.8	64.5	63.0	81.9	64.7	55.7
	(0.64)	(0.27)	(0.51)	(0.50)	(0.65)	(0.51)	(0.44)
Total	711.4	317.0	551.9	819.1	1,005.0	715.1	646.7
	(0.55)	(0.25)	(0.43)	(0.63)	(0.78)	(0.55)	(0.50)
Gender							
Male	654.6	287.4	680.0	678.3	889.1	670.7	603.5
	(0.55)	(0.24)	(0.57)	(0.57)	(0.74)	(0.56)	(0.50)
Female	367.7	137.3	430.3	362.7	423.8	278.3	255.9
	(0.65)	(0.24)	(0.76)	(0.64)	(0.75)	(0.49)	(0.45)

Source: Authors, using SimSIP SAM.
Note: Figures in parentheses are percentage changes.

Although the share of labor income initially obtained by female workers exceeds 50 percent for tourism (see Table 6), the final effect of an exogenous demand shock in that sector is much greater for male than female workers. This is because of the higher indirect effects for male workers, which account for 73.1 percent of the total effect for male workers versus 63.9 percent of total effects for female workers (see Table 8; indirect effects are defined here as closed-loop effects divided by total effects; see the annex on multiplier decompositions for details). The indirect effects are greater for female than male workers in all sectors but agriculture and financial services, mainly because of smaller labor income shares for females in those sectors than in tourism. Rural workers appear to benefit more from the indirect effects in the other export sectors than urban workers do, a result that can be explained mainly by the smaller labor income share for rural workers in those sectors.

Table 8. Share of Total Multiplier Effect Caused by Indirect Effects in Senegal, by Sector and Population Segment, 2004 (percent)

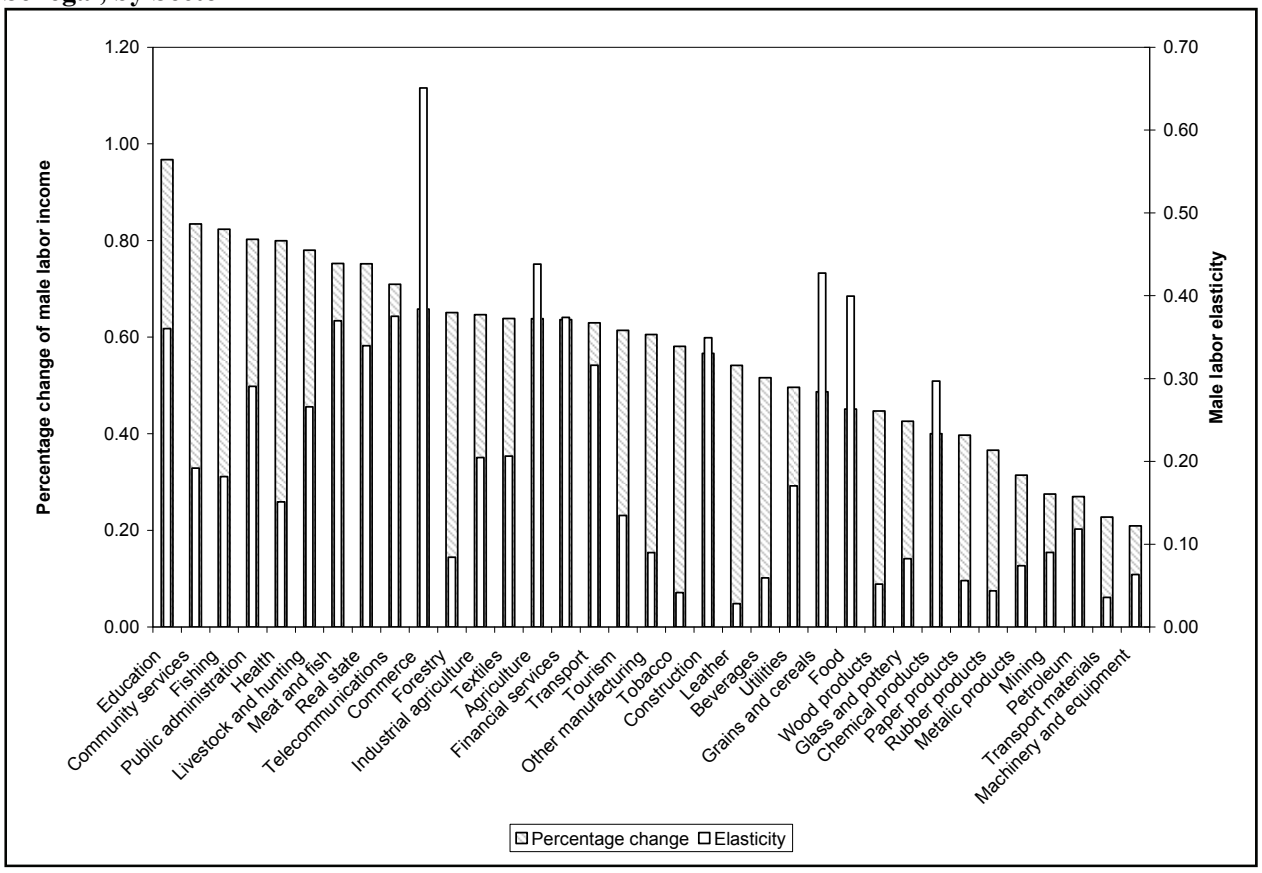
Population segment	*Tourism*	*Petroleum*	*Agriculture*	*Financial services*	*Other private services*	*Transport*	*Construction*
Rural							
Male	70.2	91.6	45.0	94.0	73.7	80.8	82.2
Female	64.2	94.5	39.4	96.2	85.2	94.4	96.1
Urban							
Male illiterate	74.4	76.4	93.3	62.0	55.2	70.5	70.4
Female illiterate	64.8	78.5	89.5	47.7	50.4	76.7	73.5
Male literate	73.1	74.3	90.4	87.0	78.2	57.1	61.9
Female literate	61.6	69.4	79.4	80.3	70.6	74.7	79.5
Gender							
Male	73.1	79.3	71.8	72.0	62.5	69.6	71.1
Female	63.9	81.6	57.5	65.9	64.2	82.0	82.1

Source: Authors, using SimSIP SAM.

While the increase in labor income is larger for male workers than for female workers in all seven sectors, the proportion of total labor income that goes to female workers increases, after an exogenous shock, in five of the seven sectors (transport and construction are the exceptions). This means that expressing the changes in labor income caused by an increase in exports in percentage terms rather than values, paints a different picture (See number in parenthesis, Table 7). The increase in labor income in rural areas is larger for female than male workers in the first four sectors (tourism, petroleum, agriculture, and financial services), and the gain is larger among literate workers in urban areas in the first five sectors (adding other private services to the four sectors above). Transport and construction benefit male workers more than female workers, regardless of location and education.

In order to compare the percentage increases in labor income by gender in the seven sectors in Tables 7 and 8 with other sectors, we simulate an increase in the demand for each of the sectors in the SAM equal to 1 percent of aggregate exports (CFAF11,217 million) and estimate the resulting increase in labor income in percentage terms (Figure 3). The size of this shock is, again, arbitrary and was chosen as a percentage of aggregate exports to give an idea of importance relative to macroeconomic aggregates. Education generates the greatest growth in male labor income, with an increase in total male income of 1.0 percent. Manufacturing activities for machinery and equipment generate, on average, the smallest percentage growth in male labor income (close to 0.2 percent and partially explained by their low labor intensities). The effect on labor income is related in part to the labor intensity of different activities, as well as the gender shares of labor income in the various sectors, but the multiplier effects of the various sectors also play a role. Commerce exhibits the highest elasticity on labor income (0.7). Agriculture, grains and cereals, and food also have high elasticities (greater than 0.4).

Figure 3. Impact on Male Labor and Labor Elasticity of 1 Percent Change in Aggregate Exports in Senegal, by Sector

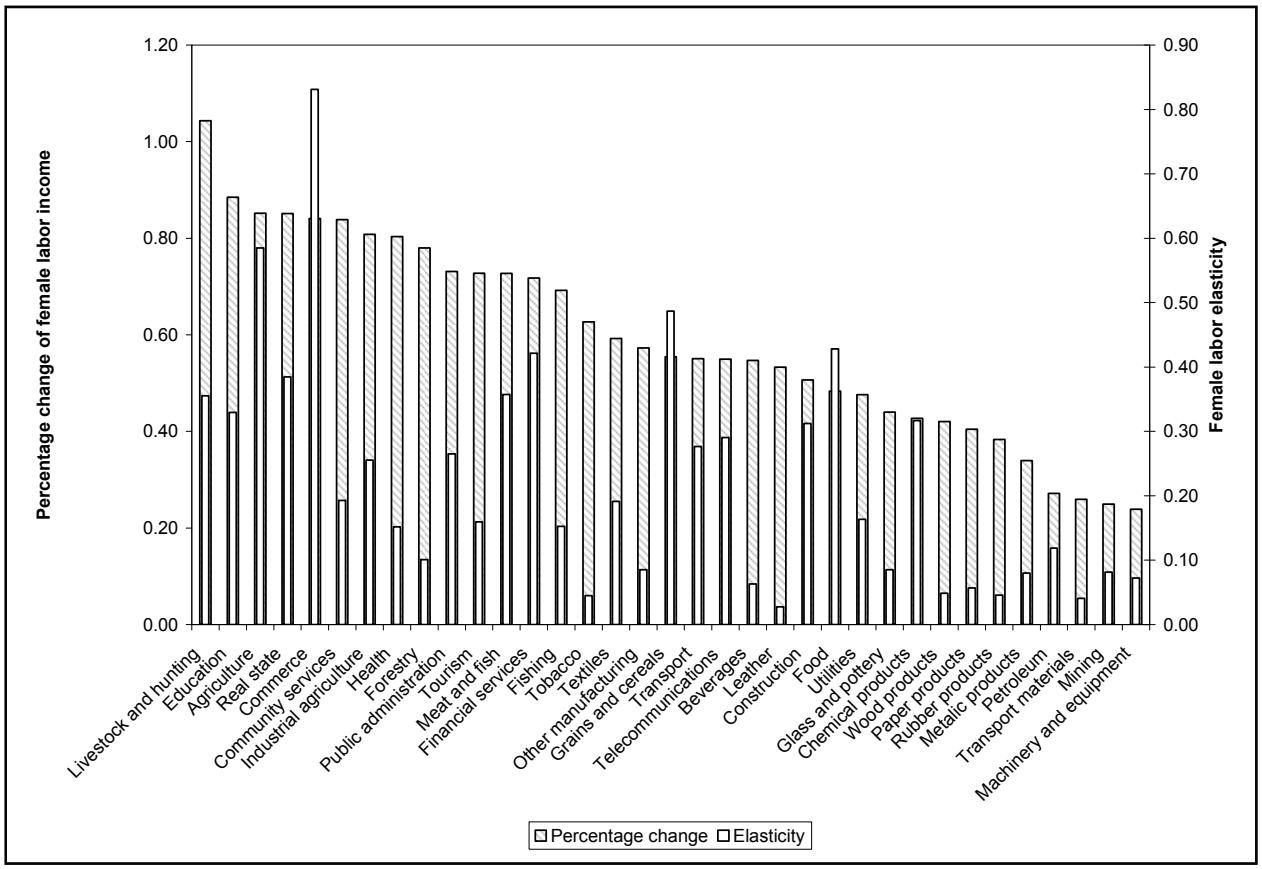


Source: Authors, using SimSIP SAM.

The same procedure described above is used to look at the impact of shocks on female labor income (Figure 4). The livestock and hunting sector experiences the strongest growth in female labor income (1.0 percent) when all sectors face the same shock equal to 1 percent of aggregate exports. As it does for male labor income, commerce has by far the highest elasticity on female labor income (0.8).

Both male and female labor incomes exhibit a very high elasticity to demand shocks in commerce, with a moderate impact on labor income. On the other hand, labor income for both genders exhibit very low elasticity to demand shocks in forestry, tobacco, and leather, again, and these sectors would cause a moderate growth on labor income. This corrects for the 'size bias' that is present in simulations when using the exact same shock for all sectors; the shock might be too big for some sectors and too small for others. In this case, commerce is the biggest sector in the Senegalese economy, and forestry, tobacco, and leather are among the smallest.

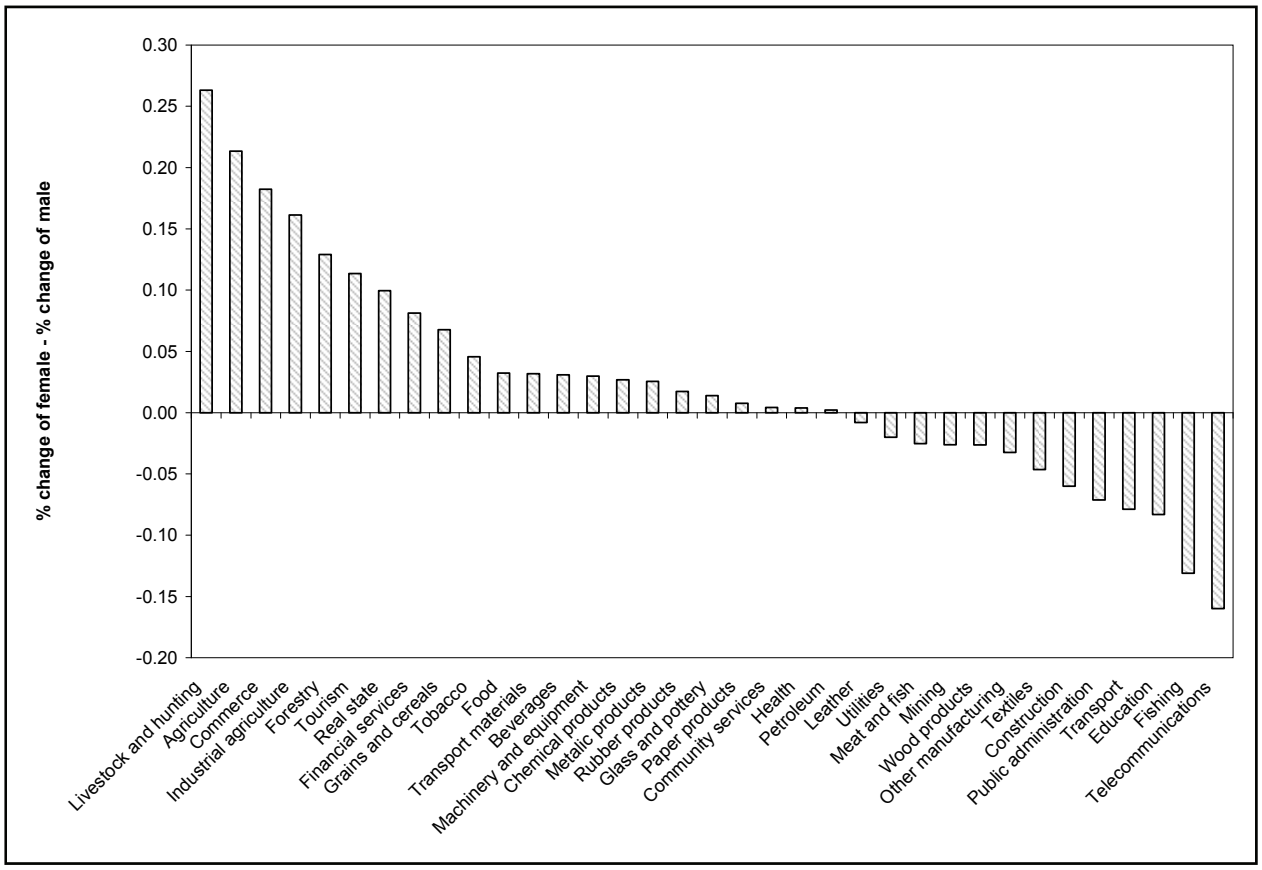
Figure 4. Impact on Female Labor and Labor Elasticity of 1 Percent Change in Aggregate Exports in Senegal, by Sector



Source: Authors, using SimSIP SAM.

Figure 5 presents the differences between the percentage change in labor income for female and male workers presented in Figures 3 and 4. Sectors with bars above the horizontal line benefit female workers more than male workers in percentage terms. Tourism ranks only fifth among the sectors that benefit female workers after livestock and hunting, agriculture, commerce, industrial agriculture, and forestry. Many different factors contribute to these rankings and to the overall impact on labor income. One factor is the labor intensity of the sector. Another is the labor income shares by gender for each sector. A third is the multiplier effects, which depend in large part on the backward and forward linkages of the various sectors with the rest of the economy. Even if indirect effects matter, however, the original labor income shares in each sector (direct effect) apparently play an important role, because the sectors that have the largest pro-female labor impacts tend to be those with the largest income shares going to women (primary and service-oriented sectors).

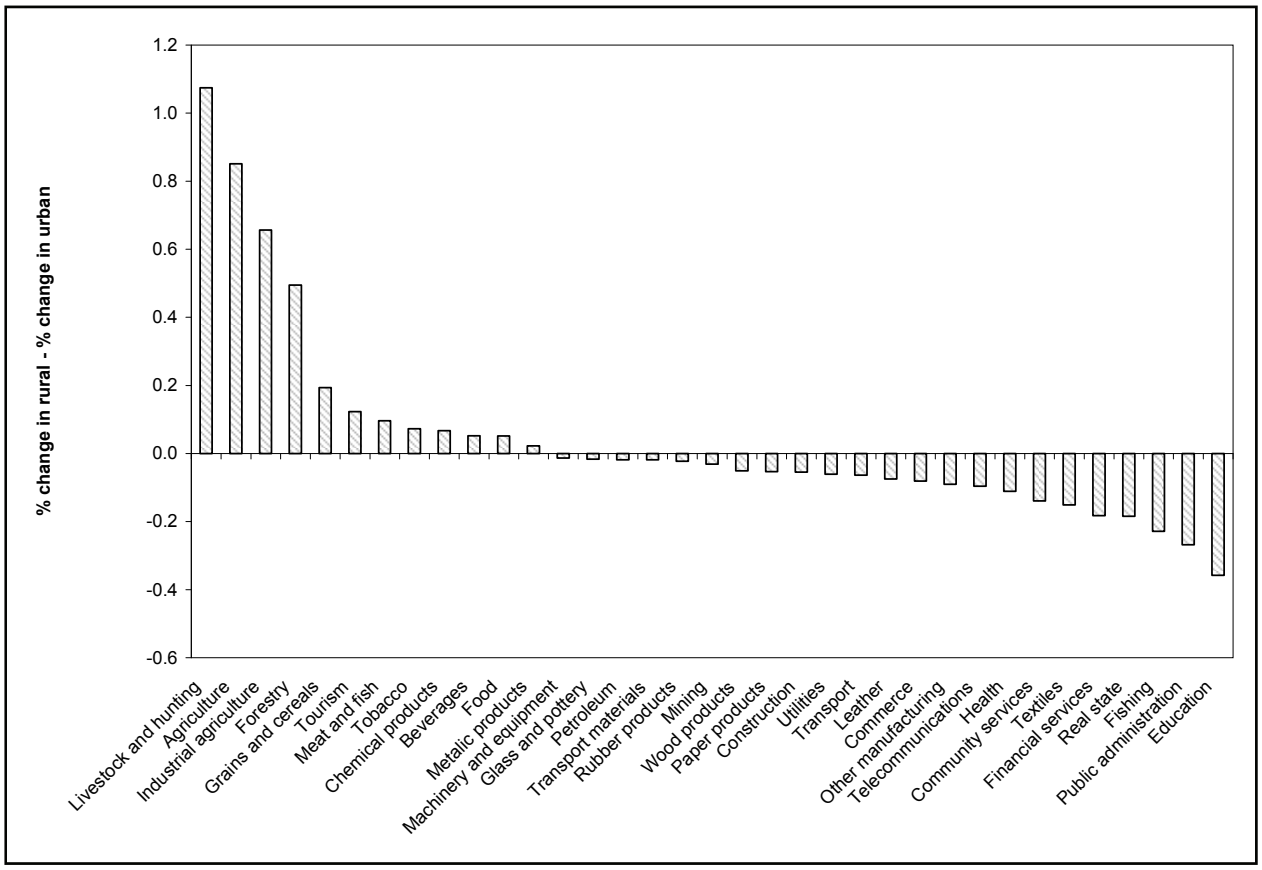
Figure 5. Difference in Sectoral Impact on Female and Male Labor Income as Result of 1 Percent Change in Aggregate Exports in Senegal



Source: Authors, using SimSIP SAM.

The same differences that are presented in Figure 5 were computed for rural and urban workers and are presented in Figure 6. In this case, sectors with bars above the horizontal line benefit rural workers more than urban workers. Tourism ranks fifth again, after livestock and hunting, agriculture, industrial agriculture, forestry, and grains and cereals.

Figure 6. Difference in Sectoral Impact on Rural and Urban Labor Income of 1 Percent Change in Aggregate Exports in Senegal



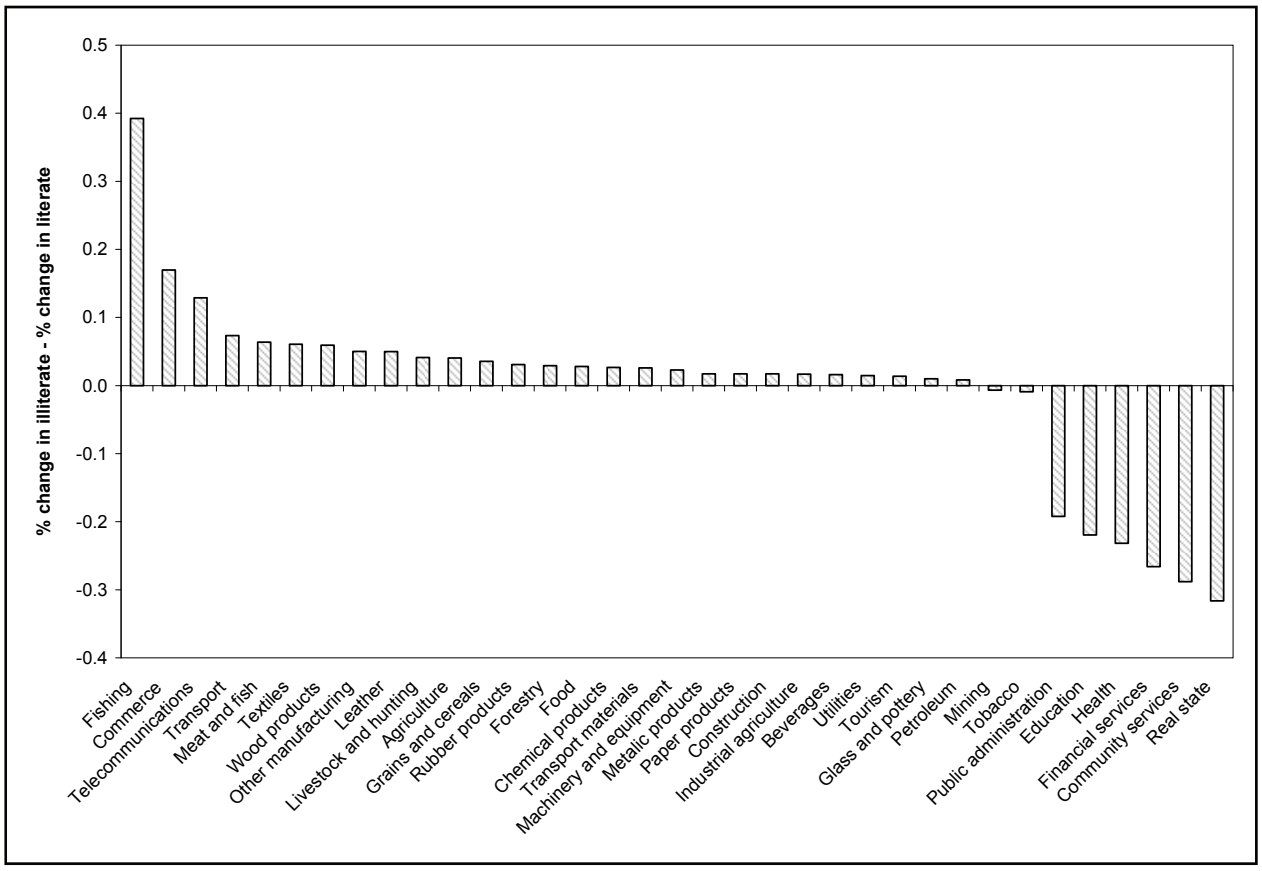
Source: Authors, using SimSIP SAM.

Figure 6 presents the differences in the percentage increases in labor income for illiterate and literate workers in urban areas resulting from an across-the-board 1 percent increase in total exports (same exercise as for female-male and rural-urban). Sector with bars above the horizontal line benefit illiterate workers more than literate workers. Fishing is by far the sector with the largest difference (largest benefit to illiterate workers compared to the benefit to the literate workers): an exogenous increase in demand equal to 1 percent of aggregate exports would increase labor income for illiterate workers by 0.4 percent more than the increase in labor income for literate workers. Public administration, education, health, financial services, other private services, and real estate would contribute relatively more to the increase of literate workers' labor income. In all of these sectors, small shares of labor income are going to illiterate workers.

Some of the sectors benefit more, at the same time, female workers (compared to male workers), workers in rural areas (compared to urban areas), and illiterate workers (compared to literate). These sectors are livestock and hunting, agriculture, industrial agriculture, forestry, tourism, grains and cereals, food, beverages, chemical products, and metallic products. Public

administration and education benefit more, at the same time, male workers, workers in urban areas, and literate workers.

Figure 7. Difference in Sectoral Impact on Illiterate and Literate Workers' Labor Income as a Result of 1 Percent Change in Aggregate Exports in Senegal



Source: Authors, using SimSIP SAM.

Conclusion

Increasing labor income for women and reducing gender disparities in labor income can reduce poverty. In addition to the direct impact from higher household income, research shows that a larger labor income share for women tends to shift consumption choices toward human capital for children.

This paper uses simple macro-micro simulation techniques to assess how changes in the production of various exports affect labor income shares. It finds that an expansion in tourism would lead to a larger income share for women over time, from 32.2 to 32.4 percent after an increase in its exports equal to 1 percent or aggregate exports. The impact on female labor income of an expansion in tourism is smaller than that of some other sectors, such as agriculture and financial services. But among export-oriented sectors, tourism is the sector in which women

stand to gain the most from a demand shock. The direct impact of tourism expansion on female labor incomes is important, because this sector has a large share of female workers; the indirect impact through multiplier effects is also important, with almost two-thirds of the labor income gains being caused by indirect effects. At the same time, the differential impact on labor income shares from demand shocks in various sectors with high initial labor shares is not necessarily as large as one might expect, because multiplier effects typically reduce initial direct effects observed within sectors. This suggests that broad policies to encourage the development of specific sectors of the economy may not be sufficient to fundamentally affect gender labor income shares and thereby gender differences in income.

Annex 1

Block Decomposition of the Multiplier Matrix

Cell m_{ji} of the multiplier matrix M quantifies the change in total income of account *i* as a result of a unitary increase in the exogenous component of sector *j*. In order to decompose the matrix M [4], for any matrix nxn nonsingular matrix, we can rewrite equation (2) as

$$Y = \left(A - \tilde{A}\right)Y + \tilde{A}Y + X \tag{3}$$

$$Y = A^{*}Y + \left(I - \tilde{A}\right)^{-1} X \tag{4}$$

where

$$A^{*} = \left(I - \tilde{A}\right)^{-1}\left(A - \tilde{A}\right). \tag{5}$$

Multiplying through by A^{*} yields

$$A^{*}Y = A^{*^2}Y + A^{*}\left(I - \tilde{A}\right)^{-1} X. \tag{6}$$

From equation (2) we have an expression for $A^{*}Y$. Replacing it on the left-hand side yields

$$Y = A^{*^2}Y + \left(I + A^{*}\right)\left(I - \tilde{A}\right)^{-1} X. \tag{7}$$

Multiplying equation (2) through by A^{*^2} and replacing the expression for $A^{*^2}Y$ from equation (6) yields

$$Y = \left(I - A^{*^3}\right)^{-1}\left(I + A^{*} + A^{*^2}\right)\left(I - \tilde{A}\right)^{-1} X. \tag{8}$$

Notice that we just decomposed multiplicatively the multiplier matrix M from equation (2) into three different matrices. Define

$$M_1 = \left(I - \tilde{A}\right)^{-1},\ M_2 = \left(I + A^{*} + A^{*^2}\right), \text{ and } M_3 = \left(I - A^{*^3}\right)^{-1}. \tag{9}$$

Then $M = M_3 M_2 M_1$. It is also possible to present the decomposition in an additive way:

$$M = I + \underbrace{\left(M_1 - I\right)}_{TR} + \underbrace{\left(M_2 - I\right)M_1}_{OL} + \underbrace{\left(M_3 - I\right)M_2 M_1}_{CL} \tag{10}$$

4. Fore more details about computation, see Pyatt and Round (1979).

where the first term (the identity matrix) is the initial unitary injection, matrix M_1 captures the net effect of a group of accounts on itself through direct transfers, matrix M_2 captures all net effects between partitions, and matrix M_3 captures the net effect of circular income multipliers among endogenous accounts. The terms in the additive decomposition (labeled *TR* for transfer effects, *OL* for open-loop effects, and *CL* for closed-loop effects), have broadly the same interpretation as the corresponding multiplicative effects (the matrices M_i).

The *nxn* matrix $\tilde{A}$ (partition of A) was chosen as follows, considering that the first row (and column) corresponds to the activities/commodities group, the second to the production factors, and the third to enterprises/households:

$$\tilde{A} = \begin{pmatrix} A_{11} & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & A_{33} \end{pmatrix}.$$

Using the definition of A^* from equation (5) yields

$$A^* = \left(I - \tilde{A}\right)^{-1}\left(A - \tilde{A}\right) = \begin{pmatrix} \left(I - A_{11}\right)^{-1} & 0 & 0 \\ 0 & I & 0 \\ 0 & 0 & \left(I - A_{33}\right)^{-1} \end{pmatrix}\begin{pmatrix} 0 & 0 & A_{13} \\ A_{21} & 0 & 0 \\ 0 & A_{32} & 0 \end{pmatrix}$$

$$= \begin{pmatrix} 0 & 0 & A_{13}^* \\ A_{21}^* & 0 & 0 \\ 0 & A_{32}^* & 0 \end{pmatrix}, \quad \begin{cases} A_{13}^* = \left(I - A_{11}\right)^{-1} A_{13} \\ A_{21}^* = A_{21} \\ A_{32}^* = \left(I - A_{33}\right)^{-1} A_{32} \end{cases}. \tag{11}$$

Using the expression for A^* and the definitions in equation (9) yields

$$M_1 = \begin{pmatrix} \left(I - A_{11}\right)^{-1} & 0 & 0 \\ 0 & I & 0 \\ 0 & 0 & \left(I - A_{33}\right)^{-1} \end{pmatrix} \tag{12}$$

$$M_2 = \begin{pmatrix} I & A_{13}^* A_{32}^* & A_{13}^* \\ A_{21}^* & I & A_{21}^* A_{13}^* \\ A_{32}^* A_{21}^* & A_{32}^* & I \end{pmatrix} \tag{13}$$

$$M_3 = \begin{pmatrix} \left(I - A_{13}^* A_{32}^* A_{21}^*\right)^{-1} & 0 & 0 \\ 0 & \left(I - A_{21}^* A_{13}^* A_{32}^*\right)^{-1} & 0 \\ 0 & 0 & \left(I - A_{32}^* A_{21}^* A_{13}^*\right) \end{pmatrix}. \tag{14}$$

We can provide expressions for the matrices TR, OL, and CL defined in equation (10):

$$TR = \begin{pmatrix} \left(I - A_{11}\right)^{-1} - I & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & \left(I - A_{33}\right)^{-1} - I \end{pmatrix} \tag{15}$$

$$OL = \begin{pmatrix} 0 & A_{13}^* A_{32}^* & A_{13}^* \left(I - A_{33}\right)^{-1} \\ A_{21}^* \left(I - A_{11}\right)^{-1} & 0 & A_{21}^* A_{13}^* \left(I - A_{33}\right)^{-1} \\ A_{32}^* A_{21}^* \left(I - A_{11}\right)^{-1} & A_{32}^* & 0 \end{pmatrix} \tag{16}$$

$$CL = \begin{pmatrix} C_{132} \left(I - A_{11}\right)^{-1} & C_{132} A_{13}^* A_{32}^* & C_{132} A_{13}^* \left(I - A_{33}\right)^{-1} \\ C_{213} A_{21}^* \left(I - A_{11}\right)^{-1} & C_{213} & C_{213} A_{21}^* A_{13}^* \left(I - A_{33}\right)^{-1} \\ C_{321} A_{32}^* A_{21}^* \left(I - A_{11}\right)^{-1} & C_{321} A_{32}^* & C_{321} \left(I - A_{33}\right)^{-1} \end{pmatrix} \tag{17}$$

where $C_{132} = \left(I - A_{13}^* A_{32}^* A_{21}^*\right)^{-1} - I$, $C_{213} = \left(I - A_{21}^* A_{13}^* A_{32}^*\right)^{-1} - I$, and $C_{321} = \left(I - A_{32}^* A_{21}^* A_{13}^*\right)^{-1} - I$.

We now interpret and describe some features of the matrices TR, OL, and CL defined in equation (10). TR, which quantifies the net effect (net with respect to the initial unitary effect of a shock to an account on itself) of groups of accounts into themselves (intra), is a block diagonal matrix with a zero block in the second block on the diagonal, a consequence of the absence of transfers among production factors. OL, which captures the net direct effect (net with respect to the matrix M_1) between (inter) accounts, has zeros along the diagonal. CL, the matrix that captures the net closed-loop effects (net with respect to the product $M_2 M_1$), has no special structure.

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