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# Policy impact assessment in developing countries using Social Accounting Matrices: The Kenya SAM 2014

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## Abstract

This paper describes the structure and estimation of a Social Accounting Matrix (SAM) of Kenya for the year 2014. Among its specificities, this SAM includes a very high disaggregation of the agri-food sector and accounts for the double role of households as producers and consumers. Accounting for these characteristics is crucial to provide robust socioeconomic analysis in the context of developing countries. Indeed, this type of database is valuable to perform ex-ante evaluations of economic policies with various economic models and techniques. In this paper, we present an application with a linear multiplier analysis (backward linkages and value chain decomposition). The results show the capacity of the primary sector in Kenya to generate value added and employment, with this growth distributed more intensely in rural households whose main livelihood is semi-subsistence agriculture.

**KEYWORDS**

home production for home consumption, Kenyan economy, linear multisectoral models, Social Accounting Matrices

# 1 | INTRODUCTION

Agriculture is the principal sector of the Kenyan economy, contributing approximately 33% of the GDP in 2016 (Kenya National Bureau of Statistics, 2017) and employing around 80% of the national workforce. About 75% of Kenya's population lives in rural areas (World Bank, 2018) and derives its livelihood directly or indirectly from agriculture. As a majority of vulnerable groups, such as subsistence farmers (agricultural, livestock, or mixed), depend on agriculture as their main source of livelihood, the development of the agricultural sector is fundamental to any growth and poverty-reduction strategy.

In African countries (Kenya among them), peasants are producers and factor suppliers of economies, and therefore a large portion of the workforce (sometimes all of it) is dedicated to the production of self-consumed commodities. This results in substantial home production for home consumption (HPHC) that should be accounted for in any economic analysis. These economies include two types of "productive agents": households as producers of commodities partly for own consumption and partly for sale on the market and households that produce exclusively market-oriented commodities (Aragie, 2014). In addition, Kenya comprises households that produce cash crops (e.g., coffee and tea) exclusively for the market. As a result, a Social Accounting Matrix (SAM) for Kenya should include all three types of productive agricultural agents.

In Kenya, the self-consumption of commodities covers a significant proportion of food consumed, especially in rural areas and by households with lower chances of finding off-farm jobs. HPHC and the double role of households as producers and consumers must be properly considered. Failure to consider these characteristics and the difference in price formation between self-consumed commodities and marketed products lead to incorrect interpretations of the results of economic models aimed at assessing policy impacts, particularly in rural areas (Taylor & Adelman, 2003; Tiberti, 2011).

In June 2008, the Kenyan government launched Kenya Vision 2030 (Government of Kenya, 2008) as the new long-term strategic document for Kenya's economic and social development, identifying agriculture as one of the key sectors to deliver a 10% annual economic growth rate. In this framework, several agricultural policies have been formulated to increase agricultural productivity and income.[1] The development of these policies requires an exhaustive knowledge of the inter-sectoral links and transmission mechanisms of the possible shocks generated by economic policies on output, value added, and employment. This information must also be structured to reflect the specificities of the country. Thus, a database that enables this multisectoral analysis, based on an exhaustive description of the economic flows and allowing the application of informative models and tools, becomes a very relevant tool. This paper presents a 2014 Social Accounting Matrix (SAM) for Kenya, with a novel specific structure that includes HPHC with a high disaggregation of the agricultural sector and a regional disaggregation of agricultural sectors based on agro-ecological zones (AEZs). The SAM provides a detailed description of the Kenyan economic structure and serves as a database for linear multisectoral models and analysis tools. The estimation of linear multipliers and value chain analyses for output, value added, and employment for the disaggregated primary sector, distinguishing households as producers (for own consumption and market-oriented) from normal activities, provides significant information, defining the basic outline of potential results of the proposed policies.[2]

The rest of the paper is structured as follows. Section 2 introduces the concept of SAMs and develops the HPHC issue. Section 3 illustrates the estimation process of the Kenya SAM, and Section 4 shows the multiplier and value chain analyses. Section 5 concludes.

# 2 | HOME PRODUCTION FOR HOME CONSUMPTION SOCIAL ACCOUNTING MATRICES

## 2.1 | General issues behind SAMs

A SAM[3] is a comprehensive and economy-wide database, recording data on transactions among all economic agents within an economy in a given period. SAMs play a double role: they serve as a database to calibrate economic modeling and describe the complete circuit of economic relations in a simple but exhaustive way. The concept of the circular flow of income is the foundation of the SAMs (Mainar-Causapé, McDonald, & Ferrari, 2018). While input–output tables (IOTs) reflect only the productive part of the economy and not the relations between the income and expenditure of institutional agents, SAMs expand the explanatory capacity of I–O models, explicitly introducing income and its primary and secondary distribution, and the final consumption of institutional agents (households, government, etc.). SAMs are an extension of the IOT concept achieved in an integrated way and not through the addition of satellite accounts.

A SAM is ultimately a square matrix in which activities, commodities, factors, and institutional sectors are represented by specific rows and columns. Each cell records the payment by the account in column to the account in row. Thus, the income of each account is shown along its corresponding row while its expenditures are recorded in the corresponding column. Typically, a SAM contains six types of accounts: activities and/or commodities, factors, institutions (households and corporations/enterprises), government, capital accounts, and the rest of the world. The disaggregation of these six basic groups determines the size of a matrix. The basic structure of a standard SAM is shown in Figure 1.[4]

Several primary databases are used to populate the cells of a matrix. The main ones are the set of National Accounts systems, household budget, and/or labor market surveys (and others of a socioeconomic nature), as well as statistics related to the foreign sector and international trade.

| | Commodities | Activities | Factors | Households | Enterprises / Corporations | Government | Savings-Investment | Rest of the World | Total |
|---|---|---|---|---|---|---|---|---|---|
| **Commodities (C)** | | Intermediate (inputs) consumption | | Household consumption | | Government expenditure | Investment and stock changes | Exports | Demand |
| **Activities (A)** | Domestic production | | | | | | | | Gross output / Production (activity income) |
| **Factors (F)** | | Remuneration of factors / Factor income | | | | | | Factor income from RoW | Factor income |
| **Households (H)** | | | Factor income distribution to households | (Inter Households transfers) | Distribution of corporations income to households | Government transfers to households | | Transfers to Households from RoW | Household income |
| **Enterprises / Corporations (E)** | | | Factor income distribution to enterprises | | | Government transfers to enterprises | | Transfers to Enterprises from RoW | Enterprise income |
| **Government (G)** | Net taxes on products | Net taxes on production | Factor income to Government / Factor taxes | Direct Household taxes / Transfers to Government | Direct Enterprise taxes / Transfers to Government | | | Transfers to Government from RoW | Government income |
| **Savings-Investment (S-I)** | | | (Depreciation) | Household savings | Enterprise savings | Government savings | (Capital accounts transfers) | Capital transfers from RoW (Balance of Payments) | Savings |
| **Rest of the World (RoW)** | Imports | | Factor income distribution to RoW | Household transfers to RoW | Corporations income to Row | Government transfers to RoW | | | Payments to RoW |
| **Total** | Supply | Costs of production activities | Expenditure on factors | Household expenditure | Enterprise expenditure | Government expenditure | Investment | Incomes from RoW | |

**FIGURE 1** Standard structure of a SAM

*Source:* Own elaboration from Mainar-Causapé, McDonald, et al. (2018).

| | | Commodities | | Activities | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | HPHC Commodities (C_H) | Marketed Commodities (C_M) | Households as Activities (A_H) | Activities (A) | (F) | (H) | (E) | (G) | (S-I) | (RoW) | Total |
| Commodities | HPHC Commodities (C_H) | | | Intermediate (inputs) consumption | | | Household consumption | | | Stock changes | | Demand of HPHC commodities |
| | Marketed Commodities (C_M) | | | Intermediate (inputs) consumption | Intermediate (inputs) consumption | | Household consumption | | Government expenditure | Investment and stock changes | Exports | Demand of marketed commodities |
| Activities | Households as Activities (A_H) | Domestic production | Domestic production | | | | | | | | | Gross output / Production (Households activities) |
| | Activities (A) | | Domestic production | | | | | | | | | Gross output / Production (activity income) |
| | Factors (F) | | | Remuneration of factors / Factor income | Remuneration of factors / Factor income | | | | | | | |
| | Households (H) | | | | | | | | | | | |
| | Enterprises / Corporations (E) | | | | | | | | | | | |
| | Government (G) | | Net taxes on products | | Net taxes on production | | | | | | | |
| | Savings-Investment (S-I) | | | | | | | | | | | |
| | Rest of the World (RoW) | | Imports | | | | | | | | | |
| | Total | Supply of HPHC commodities | Supply of marketed commodities | Costs of production for Households as activities | Costs of production activities | | | | | | | |

**FIGURE 2** Split of activities and commodities in a HPHC SAM
*Source:* Own elaboration.

## 2.2 | Home production for home consumption

Introducing the relations between institutions and sectors depicting a semi-subsistence production system in a SAM and consequently accounts for HPHC implies the realization of adjustments to include new activities of households and commodities that are own-consumed or used in self-production.

The way in which HPHC is reflected in the SAM is described as follows. In a typical SAM, economic activities produce only market-oriented commodities and use only inputs acquired in the market. On the contrary, HPHC goods are produced by a category of producing households considered as activities.[5] These activities produce commodities that can be own-consumed or sold in the market. The cost structure (combination of inputs—own-produced and marketed—and value added) of producing households is shown by the column for these accounts; meanwhile, their row shows the destination of their production, that is own consumption or marketed commodities. Each producing household is associated with an institutional household. Own-consumption commodities are consumed only by the households producing them (as final consumption or as input), whereas market-oriented commodities are consumed by any household or used by any activity (household or classic) regardless of their origin.

The consumer price of market-oriented commodities includes trade and transportation margins and taxes. In the case of HPHC goods, basic and consumption prices are the same.

The Kenya SAM 2014 accounts for eight representative producing households, one for each of the six AEZs and the two metropolises. The rest of the activities and all marketed commodities are produced and sold on a national market.

An additional specificity of this SAM is the incorporation of three additional representative producing households (for three specific AEZs, High Rainfall, Semi-Arid North, and Semi-Arid South) that produce one or more of the six exported cash crops. This addition is necessary to reflect the production structure of products such as tea or coffee, which are also produced by small farms—households—but sold entirely to large processing and distribution companies that finally put them on the market. This approach implies the need to disaggregate agricultural commodities into marketed and HPHC ones, which requires the use of highly disaggregated data on household consumption, agricultural and livestock production, and the labor market. The split of activities and commodities is presented in Figure 2.

## 3 | STRUCTURE AND ESTIMATION OF A HPHC SAM FOR KENYA

A new SAM for Kenya for 2014 is estimated, following the steps described earlier, integrating the accounts to reflect HPHC. The basic structure of the Kenya SAM 2014 considers activities and commodities with peculiarities that deviate from the classical structure assumptions. The final more complex structure[6] allows the analysis of the HPHC issue in a regional context. Table A1 presents a reduced version of the SAM, showing its main structure (Mainar-Causapé, Boulanger, Dudu, Ferrari, & McDonald, 2018a).[7]

The estimation of this SAM requires data from different sources. The most relevant ones, provided by the Kenya National Bureau of Statistics (KNBS) are, Kenyan National Accounts from macroeconomic structure of the economy, Kenya Integrated Household Budget Survey (KIHBS) 2005/06 for consumption, income distribution, HPHC, Economic Survey (various years), Statistical Abstract (various years) and Economic Review of Agriculture (various years). Previous SAMs such as Kiringai, Thurlow, and Wanjala (2006), Mabiso, Pauw, and Benin (2012), and Thurlow and Benin (2008) serve to estimate specific values or check the final estimation of the current SAM. Other specific sources (industrial memorandums, from international organizations) are used for specific sectors or institutions. Additional agriculture-relevant databases (e.g., Government of Kenya, 2015) are necessary to estimate the primary sector accounts. The resulting estimation is consistent with the latest national statistics. In summary, the Kenya SAM 2014 contains 195 accounts: 53 activities (11 of them accounts of households as activities accounts[8]) producing 18 HPHC and 55 marketed commodities,[9] 27 labor accounts, 5 types of capital, 5 types of taxes, 23 types of households, 5 savings/investment accounts, and respective accounts for margins, enterprises, government, and rest of the world.

To describe country characteristics better, the agricultural sector is regionalized based on AEZs. This regional disaggregation allows specific issues with a regional dimension to be addressed: agricultural production, mobility of factors, migration, and so on. In the Kenya SAM 2014, six AEZs and the two major metropolises Nairobi and Mombasa have been considered (see Figure 3 and Table A3). This division into AEZs is based on previous studies (Kiringai et al., 2006; Mabiso et al., 2012; Thurlow & Benin, 2008) and distinguishes the cost structure of the agricultural and livestock sectors in different regions of the country. The eight regions/AEZs considered are (1) Nairobi, (2) Mombasa, (3) High Rainfall zone, (4) Semi-Arid North, (5) Semi-Arid South, (6) Coast, (7) Arid North, and (8) Arid South. The regional breakdown is applied to households as producing units and households as institutional units.

The SAM has eight agricultural household activities (one for each AEZ and metropolis considered) producing 35 commodities (18 of them subsistence commodities). The SAM includes three regional household activities (for the High Rainfall, Semi-Arid North, and Semi-Arid South regions) producing exported cash crops.

Households are grouped into Representative Household Groups (RHGs), according to the regional breakdown. In each region, RHGs are further disaggregated into rural and urban, depending on the area of residence. The households from the two metropolises, Nairobi and Mombasa, are disaggregated by income quintiles. The SAM sums 22 RHGs, allowing performing good analyses of income distribution.

The labor accounts are disaggregated to allow better socioeconomic analysis. The SAM contains three types of labor based on educational attainments: skilled, semi-skilled, and unskilled labor. Each labor factor is regionalized so that the SAM contains 27 types of labor.[10] The SAM includes five types of capital: agricultural, nonagricultural, livestock, irrigated land, and non-irrigated lands. Four types of investment goods (roads, irrigation, other infrastructures, and other investments) represent

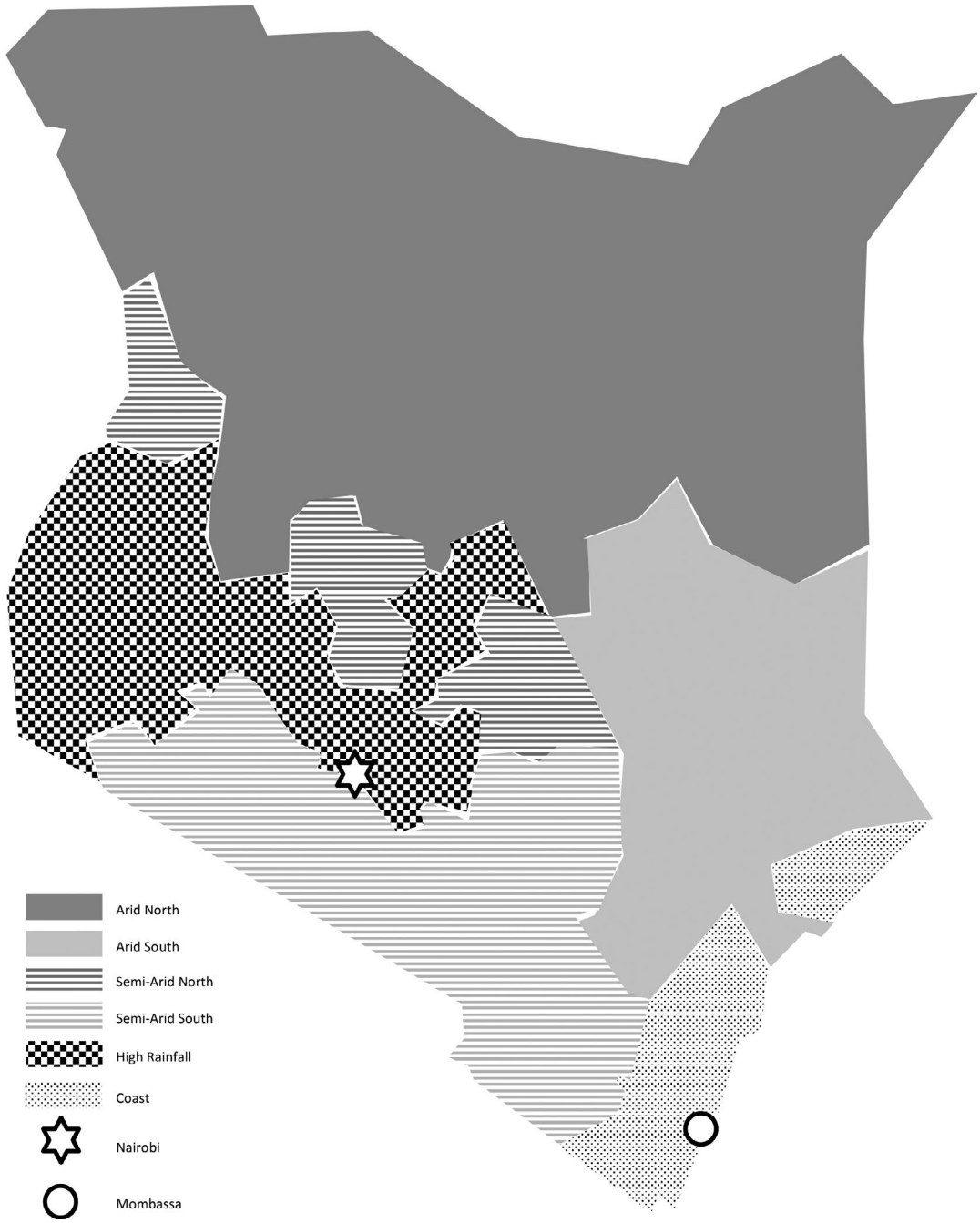


**FIGURE 3** Kenya SAM regional breakdown
*Source:* Own elaboration.

the savings/investment relationship. Different investment commodities, according to their characteristics, compose each account. To finance these investments, a single account collects savings from institutions (household, corporations, government, and rest of the world) and allocates them into those investment accounts.

Taxation is represented by five taxes, that is, direct, indirect, sales, factors, and import taxes.[11] Activity and commodity taxes have been estimated using KIHBS data (Kenya National Bureau of Statistics, 2007) as main data sources.

### 3.1 | Final adjustment, balancing, and residual estimation

Discrepancies derived from the use of different data sources and estimation methods result in an unbalanced SAM. These errors were corrected using well-established tools such as RAS and cross-entropy methods (McDougall, 1999; Robinson, Cattaneo, & El-Said, 2001). The use of these methods[12] ensures the smooth estimation of specific SAM cells without enough primary information, always under the premise of assumed known values for macroeconomic targets, accounts, cells, or submatrices for which credible statistical information is available.

## 4 | JOBS AND GROWTH GENERATION: MULTIPLIERS AND VALUE CHAINS

The agricultural and food industry sectors are key to fostering job creation and growth in the Kenyan economy. Understanding how an expansion of the production of these sectors generates income, value added, and jobs is crucial. SAM multipliers address this issue as shown in Arndt, Tarp Jensen, and Tarp (2000) and Subramanian and Sadoulet (1990). This paper applies multisectoral analytical tools such as linear multiplier analysis and value chain decomposition using the Kenya SAM 2014 described earlier[13] to quantify direct and indirect links among economic sectors, focusing on primary and food industry potential. These tools have clear advantages but also some disadvantages. On the positive side, they stand out for their simplicity to interpret and their capacity to explain clearly the effects produced by economic policies. However, this simplicity is due to very restrictive hypotheses, such as those of constant prices and fixed coefficient production function. These considerations imply that these findings can be used as a first reference in the analysis of economic policies and always with caution due to the aforementioned restrictions.

### 4.1 | Multipliers and backward linkage analysis

Assuming Leontief technologies (i.e., fixed prices and no substitution elasticities), multipliers (see Pyatt & Round, 1979, among many others) are based on the traditional input–output model extended to a SAM:

$$\mathbf{x} = \mathbf{A}\mathbf{x} + \mathbf{y} \Leftrightarrow \mathbf{x} = (\mathbf{I} - \mathbf{A})^{-1}\mathbf{y} = \mathbf{M}\mathbf{y}, \tag{1}$$

where $\mathbf{x}$ is the vector of gross output of endogenous accounts[14] and $\mathbf{y}$ is the corresponding vector of final demand. $\mathbf{A}$ is the matrix of coefficients in the SAM framework, where the representative element $a_{i,j}$ shows the participation that the payment of sector $j$ in another sector $i$ has on the payments of sector $j$ (elements of the SAM divided by their corresponding column total). $\mathbf{M}$ is the matrix of output multipliers, and its element $m_{i,j}$ depicts the increase in the output of account $i$ due the unitary increase in the exogenous account $j$. In the present analysis, we are interested in the submatrix of $\mathbf{M}$ formed by the rows of activities

and the columns of commodities, $\mathbf{M^a}$, collecting the multiplier effects of increases in the demand for those commodities in the output of the activities.

Using a diagonal matrix, **E**, populated with the ratio of the number of jobs per unit of output,[15] the employment multiplier matrix, $\mathbf{M^e}$, is obtained:

$$\mathbf{M^e}=\mathbf{EM^a}. \tag{2}$$

Each element $m^e_{i,j}$ in $\mathbf{M^e}$ shows the increment in the number of jobs in activity $i$ after a unitary exogenous injection in the final demand (exports, household consumption, or investment) in commodity $j$. Adding by columns in $\mathbf{M^a}$ and $\mathbf{M^e}$, the effect on output and employment, respectively, resulting from an exogenous increase in demand for commodity $j$, is obtained:

$$m^a_{i,\bullet}=\sum_{i=1}^{n} m^a_{i,j}, \tag{3}$$

$$m^e_{i,\bullet}=\sum_{i=1}^{n} m^e_{i,j}, \tag{4}$$

where $n$ is the number of endogenous accounts.

Output and employment multipliers include the "direct," "indirect," and "induced" effects.[16] An intuitive way of presenting multipliers is through the so-called backward linkages (BLs). BLs are obtained by adding multiplier (output and employment) and commodity columns and dividing by the average for all sectors:

$$\mathrm{BL}_i=\frac{\sum_{i=1}^{n} m_{i,j}}{\frac{1}{n}\sum_{j=1}^{n}\left(\sum_{i=1}^{n} m_{i,j}\right)}, \tag{5}$$

where $n$ is the number of endogenous accounts and $m_{i,j}$ is an element of a multiplier matrix (output or employment). BL provides a direct comparison among sectors in terms of potential capacity to create wealth and employment. Table 1 shows the multipliers by group of activities and commodity and the BL of the 2014 Kenya SAM.[17]

Primary sectors and food industry output multipliers are above the average of all sectors (BL > 1) with the only exception of oilseeds and non-tea cash crops. This indicates that the primary sectors and the agri-food industry are crucial for Kenyan economy, with an above-average capacity to boost growth.

Vegetables (3.17), fruits (3.12), livestock (3.12), and dairy (3.15) are the commodities with the highest output multipliers. Results show that agricultural commodities have a significant effect on producing households (the smaller subsistence farmers). Demand multipliers for producing households are especially high for vegetables (1.43), fruits (1.41), livestock (1.44), dairy (1.46), fishing (1.39), and other food crops (1.35) (on average, small farms receive 45% of the primary sector multipliers). The multiplier of the demand for these products on services output is also important, with values close to 1 in the case of vegetables, fruits, and other food crops. Multipliers of agricultural commodities on medium-large farms show lower values (vegetables [0.27], fruits [0.28], and other food crops [0.35]). Regarding the food industry, values are around

**TABLE 1** Output and employment multipliers and backward linkages of primary sector and food industry commodities

| | Cereals | Vegetables | Fruits | Oilseeds | Other food crops | Tea | Other cash crops | Livestock | Food | Dairy | Forestry | Fishing |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Output multipliers* | | | | | | | | | | | | |
| Small farms | 1.17 | 1.43 | 1.41 | 0.91 | 1.35 | 1.16 | 0.99 | 1.44 | 0.84 | 1.46 | 0.47 | 1.39 |
| Food crops (medium-large farms) | 0.22 | 0.27 | 0.28 | 0.19 | 0.35 | 0.08 | 0.05 | 0.09 | 0.09 | 0.09 | 0.07 | 0.08 |
| Cash crops (medium-large farms) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.41 | 0.21 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Livestock | 0.01 | 0.02 | 0.02 | 0.01 | 0.02 | 0.02 | 0.01 | 0.19 | 0.03 | 0.02 | 0.02 | 0.02 |
| Food industry | 0.19 | 0.23 | 0.23 | 0.15 | 0.24 | 0.23 | 0.16 | 0.23 | 0.74 | 0.42 | 1.00 | 0.39 |
| Manufactures | 0.17 | 0.21 | 0.21 | 0.14 | 0.21 | 0.20 | 0.15 | 0.21 | 0.18 | 0.20 | 0.20 | 0.21 |
| Utilities | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.01 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 |
| Construction | 0.01 | 0.01 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.01 | 0.01 |
| Services | 0.78 | 0.97 | 0.93 | 0.62 | 0.96 | 0.95 | 0.73 | 0.92 | 0.82 | 0.92 | 1.07 | 0.95 |
| Total output multiplier (average: 2.56) | 2.59 | 3.17 | 3.12 | 2.05 | 3.16 | 3.07 | 2.33 | 3.12 | 2.73 | 3.15 | 2.86 | 3.09 |
| BL | *1.01* | *1.24* | *1.22* | *0.80* | *1.24* | *1.20* | *0.91* | *1.22* | *1.07* | *1.23* | *1.12* | *1.21* |
| *Employment multipliers* | | | | | | | | | | | | |
| Small farms | 2.53 | 3.30 | 2.62 | 2.28 | 2.81 | 3.57 | 3.74 | 3.12 | 2.11 | 3.62 | 1.04 | 2.22 |
| Food crops (medium-large farms) | 3.29 | 4.08 | 4.17 | 2.81 | 4.26 | 1.14 | 0.81 | 1.31 | 1.29 | 1.35 | 1.04 | 1.25 |

(Continues)

**TABLE 1** (Continued)

| | Cereals | Vegetables | Fruits | Oilseeds | Other food crops | Tea | Other cash crops | Livestock | Food | Dairy | Forestry | Fishing |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cash crops (medium-large farms) | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 3.98 | 2.94 | 0.01 | 0.04 | 0.01 | 0.01 | 0.01 |
| Livestock | 0.69 | 0.84 | 0.84 | 0.55 | 0.85 | 0.85 | 0.61 | 8.99 | 1.46 | 0.84 | 0.82 | 0.82 |
| Food industry | 0.69 | 0.83 | 0.83 | 0.54 | 0.84 | 0.77 | 0.55 | 0.82 | 1.76 | 7.42 | 5.66 | 9.31 |
| Manufactures | 0.33 | 0.40 | 0.40 | 0.26 | 0.40 | 0.39 | 0.28 | 0.39 | 0.33 | 0.39 | 0.37 | 0.39 |
| Utilities | 0.01 | 0.02 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.01 | 0.02 |
| Construction | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.00 | 0.01 |
| Services | 2.19 | 2.76 | 2.52 | 1.70 | 2.64 | 2.43 | 2.05 | 2.54 | 2.83 | 2.47 | 3.46 | 2.71 |
| Total employment multiplier (average: 8.91) | 9.74 | 12.25 | 11.41 | 8.16 | 11.84 | 13.16 | 10.99 | 17.21 | 9.83 | 16.13 | 12.43 | 16.74 |
| BL | *1.09* | *1.37* | *1.28* | *0.92* | *1.33* | *1.48* | *1.23* | *1.93* | *1.10* | *1.81* | *1.39* | *1.88* |

*Source:* Own elaboration.

Significant: Backward Linkages (total multiplier/average) values are in italic.

0.2. For livestock, dairy, and fishing products, multipliers are similarly concentrated in small farms and services sectors, whereas food products distribute their multiplying capacity among the food industry (0.74), small farms (0.84), and services (0.82). One should highlight forestry products, with higher multiplying capacity in the food industry (1.00) and services (1.07) but only 0.47 among small farms.

Employment BLs of primary and agri-food commodities, all greater than 1 (except oilseeds), confirm the key role these sectors play within the Kenyan economy. Livestock products show the greatest capacity to generate employment with a multiplier of 17.21 (almost double the global average). Dairy products (16.13), tea (13.16), vegetables (12.25), and fishing (16.74) are commodities with a high employment multiplier. Regarding the distribution of their capacity to generate employment, livestock farming is concentrated in the corresponding livestock activities (almost nine new jobs are generated by 1 million Kshs of additional demand, 52% of its employment generation capacity), along with notable multipliers for small farms (3.12) and services (2.54). Dairy products mainly allocate their employment generation effects among the food industry (7.42), farms (3.62 in small ones, 1.35 in medium-large ones), and services (2.47). The highest values of forestry are in the food industry (5.66) and services sectors (3.46), whereas fishing is concentrated in the food industry (9.31, 55% of the employment multiplier capacity of these products).

It is necessary to interpret the results with care. Sectors with high or above-average multiplier (BL > 1) are sectors that have a higher capacity to increase production or create employment than the rest. These sectors should be considered when selecting policies to increase demanded commodities (through public spending or investment or export). Nevertheless, this capacity is not expressed in net terms because if the effort produced to increase the demand in these sectors implies a decrease in the demand in others, the potential effects could be noticeably reduced. Thus, the analysis of multipliers is an indicator that "selects" those sectors or commodities that, a priori, should be the target of demand-driven economic policies because of their high potential to contribute to the growth of the economy.

## 4.2 | Value chain analysis

The study of the value chain of a commodity reveals in which activities the value added or employment generated or induced by its demand is embodied. Any product or service requires (mostly) domestic inputs and factors to be produced, which supposes any exogenous increase in final demand is transformed in increase in production and increased demand for inputs and factors of production. The demand for new inputs expands their production and those of the inputs needed for the production. The initial demand shock generated an infinite cycle whose result is the creation of value added and employment embodied in many sectors of the economy. The analysis of the activities or sectors participating in each of these chains shows which demands need to be prioritized to generate more jobs and growth in the economy.

The values to estimate value chains are obtained by post-multiplying the value added[18] or employment multiplier matrices by the diagonal matrix with the exogenous values of each commodity:

$$\begin{pmatrix} z_{1,1} & \cdots & z_{1,c} \\ \vdots & \ddots & \vdots \\ z_{a,1} & \cdots & z_{a,c} \end{pmatrix} = \begin{pmatrix} m_{1,1} & \cdots & m_{1,c} \\ \vdots & \ddots & \vdots \\ m_{a,1} & \cdots & m_{a,c} \end{pmatrix} \begin{pmatrix} d_1 & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & d_c \end{pmatrix},$$

where $a$ is the number of activities, $c$ is the number of commodities, $m_{i,j}$ is an element of the multiplier matrix (value added or employment), and $d_i$ is the exogenous demand for commodity $i$.

The resulting matrices contain elements $z_{i,j}$ that indicate the value added or employment of activity $i$ generated by exogenous demand for commodity $j$ (as the sum of direct, indirect, and induced effects).

The percentages in the column total, $z_{i,j} / \sum_{i=1}^{a} z_{i,j}$, show the sectoral distribution of the demand of a commodity on value added or employment.

These distributions (representing the value chains) are presented in Table 2 and Figures 4 and 5. For Kenya, the primary sector is analyzed because of its relevance in the country. Starting with

**TABLE 2** Distribution (percentage) by groups of activities of value added and employment embodied in agricultural, livestock, and food industry commodities

| | Primary sector | | | | Agri-food | Other sectors | | | |
|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| *Value added* | | | | | | | | | |
| Cereals | 48.3 | 11.6 | 0.1 | 0.7 | 2.4 | 4.4 | 0.7 | 0.3 | 31.5 |
| Vegetables | 48.2 | 11.9 | 0.1 | 0.7 | 2.4 | 4.4 | 0.7 | 0.3 | 31.3 |
| Fruits | 48.6 | 12.3 | 0.1 | 0.7 | 2.4 | 4.4 | 0.7 | 0.3 | 30.5 |
| Oilseeds | 48.1 | 12.6 | 0.1 | 0.7 | 2.4 | 4.4 | 0.7 | 0.3 | 30.7 |
| Other food crops | 45.6 | 11.7 | 3.6 | 0.7 | 2.4 | 4.4 | 0.7 | 0.3 | 30.7 |
| Tea | 41.1 | 3.3 | 17.5 | 0.7 | 2.3 | 4.1 | 0.6 | 0.2 | 30.3 |
| Other cash crops | 47.4 | 3.2 | 8.7 | 0.7 | 2.2 | 4.2 | 0.6 | 0.2 | 32.9 |
| Livestock | 49.6 | 3.9 | 0.1 | 7.7 | 2.4 | 4.4 | 0.7 | 0.4 | 30.6 |
| Food (agroindustry) | 38.5 | 5.3 | 0.2 | 1.7 | 11.6 | 4.9 | 0.8 | 0.3 | 36.7 |
| Dairy | 50.6 | 4.0 | 0.1 | 0.7 | 8.8 | 4.4 | 0.7 | 0.3 | 30.4 |
| Forestry | 16.1 | 3.1 | 38.5 | 0.7 | 2.0 | 4.1 | 0.7 | 0.2 | 34.7 |
| Fishing | 48.5 | 3.7 | 0.1 | 0.7 | 2.4 | 12.0 | 0.7 | 0.3 | 31.5 |
| *Employment* | | | | | | | | | |
| Cereals | 25.9 | 33.0 | 0.2 | 7.0 | 5.9 | 4.4 | 0.1 | 0.1 | 23.3 |
| Vegetables | 27.0 | 33.3 | 0.2 | 6.8 | 5.7 | 4.3 | 0.1 | 0.1 | 22.6 |
| Fruits | 23.0 | 36.5 | 0.2 | 7.3 | 6.2 | 4.6 | 0.1 | 0.1 | 22.0 |
| Oilseeds | 27.9 | 34.4 | 0.2 | 6.7 | 5.6 | 4.2 | 0.1 | 0.1 | 20.8 |
| Other food crops | 23.6 | 33.6 | 2.6 | 7.2 | 5.9 | 4.5 | 0.1 | 0.1 | 22.4 |
| Tea | 27.1 | 8.7 | 30.3 | 6.5 | 4.9 | 3.9 | 0.1 | 0.0 | 18.5 |
| Other cash crops | 32.8 | 7.4 | 26.9 | 5.6 | 4.1 | 3.4 | 0.1 | 0.0 | 19.7 |
| Livestock | 18.1 | 7.6 | 0.1 | 52.2 | 4.0 | 3.0 | 0.1 | 0.1 | 14.8 |
| Food (agroindustry) | 19.9 | 11.6 | 0.6 | 14.2 | 15.0 | 7.2 | 0.3 | 0.1 | 31.2 |
| Dairy | 22.4 | 8.4 | 0.1 | 5.2 | 45.2 | 3.2 | 0.1 | 0.1 | 15.3 |
| Forestry | 8.4 | 8.4 | 39.9 | 6.6 | 4.7 | 4.1 | 0.1 | 0.0 | 27.8 |
| Fishing | 13.3 | 7.5 | 0.1 | 4.9 | 4.1 | 53.8 | 0.1 | 0.1 | 16.2 |

*Notes:* Groups of activities: (1) small farms, (2) food crops on medium-large farms, (3) cash crops on medium-large farms, (4) livestock, (5) food industry, (6) manufactures, (7) utilities, (8) construction, and (9) services.

*Source:* Own elaboration.

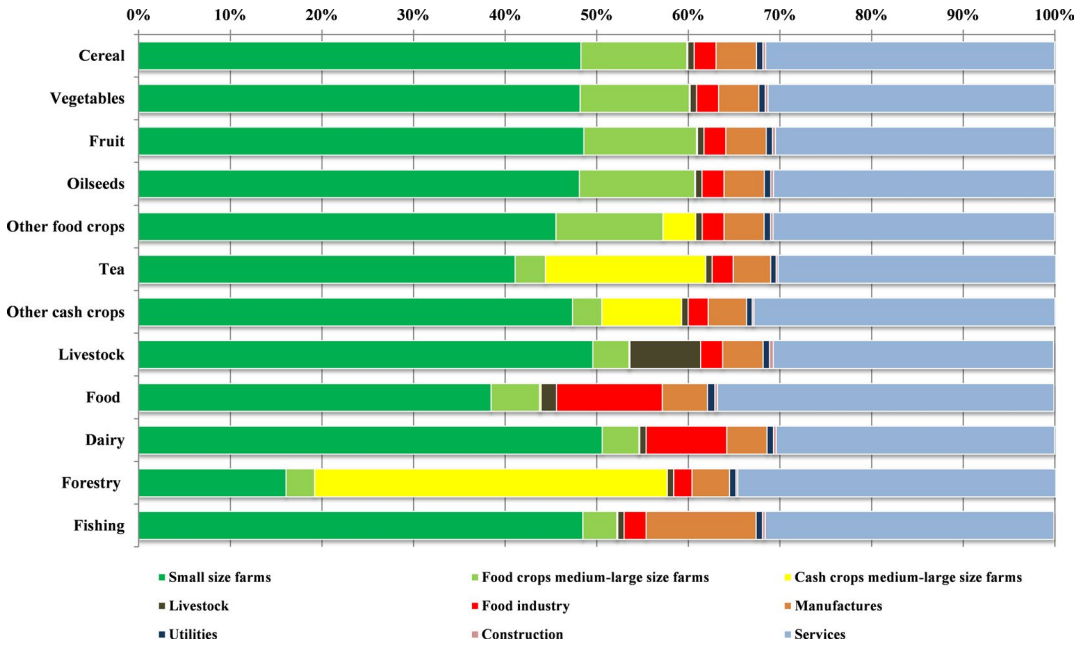


**FIGURE 4** Distribution by groups of activities of value added embodied in primary commodities
*Source:* Kenya Social Accounting Matrix 2014; own elaboration. [Colour figure can be viewed at wileyonlinelibrary.com]

agricultural products, the value added that they generate is of particular benefit to the primary sector (sum of columns [1] to [4]), which receives around 60%. It is also noteworthy that around 30% of the value added corresponds to service sectors. This may be due to the great importance of trade activities, intermediation, transportation, and distribution in these products, which makes them the recipients of an important part of the value added of the primary sector commodities. In cereals, vegetables, fruits, and other food crops, about 60% of the embodied value added is allocated to the primary sector, basically to small farmers (around 48%), whereas around 13% is allocated to livestock and medium-large-sized farms.

For tea, the percentage of value added generated for the primary sector (62.6%) is slightly higher than that for other agricultural sectors, and for other cash crops it is also around 60%. For tea, a greater share of value added is allocated to large agricultural farms (20.8%) to the detriment of smallholder farmers but this is not the case for other cash crops. Value chain analysis shows a substantial participation of small farms in the value added generated, not only for food crops but also for cash crops. This distribution responds to the specific Kenyan characteristics in the production of tea and coffee, the main cash crops. Indeed, small farmers produce a great share of these commodities and sell it directly to larger companies that finally process it for use in the agri-food industry.

It is also relevant that most of the embodied value added (nearly 50% for almost all commodities, except forestry and food) is allocated to small farms, while the share of commercial farms is between 4% and 5%. The value added share of the services sectors is always greater than 30%.

Regarding the agri-food commodities, around 45% of their embodied value added goes to the primary sector, especially to small agricultural activities (38.5%). Agri-food products allocate 11.6% of the value added generated to food industry, but 36.7% corresponds to services. For dairy products, small farms (50.6%) benefit the most from the embodied value added, whereas 8.8% is allocated to the agri-food industry and 1.7% is allocated to livestock. For forestry products, although the aggregate participation of the primary sector (58.5%) is near agricultural

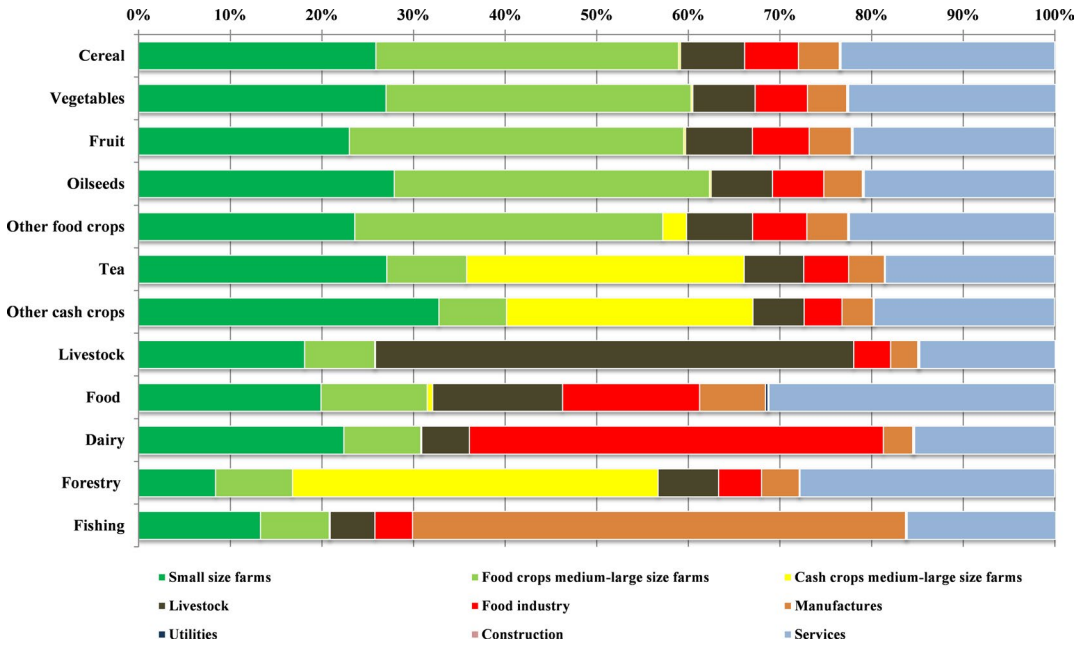


**FIGURE 5** Distribution by groups of activities of employment embodied in primary commodities
*Source:* Kenya Social Accounting Matrix 2014; own elaboration. [Colour figure can be viewed at wileyonlinelibrary.com]

commodities, it is mostly concentrated in cash crops on medium-large farms (38.5%) instead of small farms (16.1%).

The value chain analysis also estimates the number of jobs generated, directly and indirectly, by exogenous shocks. In this case, there are very significant differences compared to the value-added distribution. The participation of the primary sector in employment generated is greater than that observed for value added, but not for dairy and fishing products. In addition, large farmers own a stronger share in employment generation, especially for agricultural products, to the detriment of small farms. The participation of livestock farming in the employment embodied in the demand for primary commodities is more significant, especially in the livestock products (52.2%). On the contrary, the share allocated to the services sector is clearly smaller than the one observed in value added.

## 5 | CONCLUSIONS

The use of models, of varying degrees of complexity, for the analysis of the socioeconomic development of a country requires a database that adequately represents its economic structure. This paper presents a structured database to respond to the specific characteristics of Kenya: an agricultural economy with mostly primary production produced by semi-subsistence households, which are at the same time producers and consumers of what they produce. A brand-new SAM of Kenya has been estimated for 2014 and includes 195 accounts, with 53 activities (11 of them accounts of households as producers) producing 55 marketed and 18 HPHC commodities, and with a high disaggregation of the agricultural and food industry sectors. The SAM is an important contribution to the study of the Kenyan economy, and it introduces a novel structure that can be generalized for other developing countries or regions with similar characteristics.

Linear multisectoral models have been applied to this SAM. These models are simple but intuitive and provide results that are valid, comparable, and suitable for multisectoral qualitative analysis, although they need to be taken with caution due to the restrictive hypotheses associated with the models. The policy recommendations provided in the following should be taken lightly due to this restriction, but they are still useful for an initial impact analysis.The analysis shows that it is advisable to allocate resources to the agricultural sector because the effect on agricultural output is even more substantial (over 60% of the value added generated remains within these activities). Regarding food crops, fruits and vegetables are relevant and these commodities appeared as those with the highest job creation for rural households. For the cash crops analyzed, tea is seen as key, with a great effect on boosting output and employment.

In addition, policies that imply new investments in the livestock sector are recommended, as the analysis showed that, among the value chains analyzed, livestock and fishing products have the greatest impact on employment and value-added generation.

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## DATA AVAILABILITY STATEMENT

The data that support the findings of this study are openly available at https://datam.jrc.ec.europa.eu/datam/mashup/JRC_SAM/index.html?bookmark=KE_2014_V01

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## ENDNOTES

[1] Boulanger et al. (2018) provide a comprehensive analysis and assessment of policy options to support agriculture in Kenya.

[2] The multipliers and value chain analyses are different but are complementary approaches to the study of the relevance of the sectors and the effects of economic policies on them. Thus, while the multipliers analysis directly shows the capacity of a sector to generate new output, value added, or employment in a given sector and in the rest of the economy, the value chain analysis allows us to identify, for each sector considered, the sectors of the economy these magnitudes are generated.

[3] A common reference on the origin of SAMs is the work of Sir Richard Stone (see Stone, 1947). Pyatt and Round (1985) provide a fundamental explanation about the basic structure and potential utilities of SAMs.

[4] European Commission (2013), Eurostat (2008), Mainar et al. (2018), and Miller and Blair (2009) describe the characteristic of this structure, as well as specific issues of its definition and composition.

[5] These households are different from Representative Household Groups (RHGs) represented among institutional agents.

[6] It also includes a high disaggregation in the primary sector, labour factor, and RHGs.

[7] The complete Kenya SAM 2014 is available at https://datam.jrc.ec.europa.eu/datam/mashup/JRC_SAM/index.html?-bookmark=KE_2014_V01

[8] The eight household activities produce 35 commodities (18 of them "subsistence commodities," with production destined for own consumption and market-oriented).

[9] A summary of this breakdown of commodities and activities is shown in Table A2.

[10] For modelling purposes, the Kenya SAM 2014 also includes a virtual region called RoW (rest of the world) to collect payments for the foreign labor factor, also disaggregated into three types, like the Kenyan regions, so the labor factor is finally split into 27 accounts (8 [Kenyan] + 1 [RoW] regions by three types of labor).

[11] Tax accounts were not previously included as one of the six types of accounts of a typical SAM; indeed, taxes are not always specified as they are intermediate steps between payments from activities/commodities or institutions to the government. Their explicit inclusion allows for tax policy analysis. It is possible to build a SAM without tax accounts, attributing them directly to the government account.

[12] Both methods have been used, depending on the issue to be solved. The methods have the same theoretical basis. RAS could be considered a particular type of cross-entropy method (see McDougall, 1999).

[13] With the purpose of achieving greater clarity in the results presented, commodities and activities have been aggregated. Primary sector commodities have been grouped into cereal, vegetables, fruit, oilseeds, other food crops, tea, other cash crops, livestock, food, dairy, forestry, and fishing. Activities have been grouped into small farms (including households as activities/producers), food crops on medium-large farms (usual activity food crops), cash crops on medium-large farms (usual activity cash crops), livestock, food industry, manufactures, utilities, construction, and services.

[14] We considered the following exogenous in the estimation of **M**: public sector, savings and investment accounts, and the rest of the world.

[15] This vector of employment ratios is obtained from Kenya National Bureau of Statistics (2007, 2015a, 2015b). Employment data are recorded as full-time equivalent jobs.

[16] Direct effect is related to the output or employment increase in the activities that produce the shocked commodity, while the indirect effect results through production relationships (intermediate consumption). Induced effect is driven by changes in agents' income, which drives changes in consumption, generating the consequent loop effects.

[17] To clarify the meaning of multipliers, suppose that an increase of 1 million Kshs in the demand for cereal increases production by 2.59 million (1.17 million in small farms, 0.22 in food crops in medium-large farms). Employment increases by 9.74 new full-time equivalent jobs (2.53 in small farms, 3.29 in food crops in medium-large farms) per million Kshs of increase in the corresponding demand. Regarding BLs, 1.24 for vegetables indicates that the multiplier of this product (3.17) is 1.24 times the average multiplier of production.

[18] Value-added multipliers are obtained in the same way as employment multipliers, but using a vector of value-added ratios (obtained directly from the SAM) instead of the jobs or employment vector.

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# APPENDIX

**TABLE A1** Kenya SAM 2014 (abbreviated version) (Kshs thousand million)

| | ch | cm | m | ahf | ahc | a | flab | fland | flivst | fcp_ag | fcp_na | hh | enter | gov | dirtax | indtax | saltax | facttax | imptax | i-s | row | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HPHC commodities (ch) | | | | 151 | | | | | | | | 161 | | | | | | | | 1 | | 313 |
| Marketed commodities (cm) | | | 292 | 294 | 50 | 3,159 | | | | | | 4,162 | | 750 | | | | | | 1,144 | 954 | 10,806 |
| Margins (m) | | 292 | | | | | | | | | | | | | | | | | | | | 292 |
| Households as activities food (ahf) | 313 | 1,046 | | | | | | | | | | | | | | | | | | | | 1,358 |
| Households as activities cash crops (ahc) | | 198 | | | | | | | | | | | | | | | | | | | | 198 |
| Activities (a) | | 7,087 | | | | | | | | | | | | | | | | | | | | 7,087 |
| Labour factor (flab) | | | | 93 | 15 | 1,546 | | | | | | | | | | | | | | | 16 | 1,669 |
| Land factor (fland) | | | | 536 | 114 | 207 | | | | | | | | | | | | | | | | 857 |
| Livestock (flivst) | | | | 141 | | 34 | | | | | | | | | | | | | | | | 175 |
| Capital agricultural (fcp_ag) | | | | 99 | 19 | 77 | | | | | | | | | | | | | | | | 195 |
| Capital non-agricultural (fcp_na) | | | | 45 | | 1,912 | | | | | | | | | | | | | | | | 1,957 |

(Continues)

**TABLE A1** (Continued)

| | ch | cm | m | ahf | ahc | a | flab | fland | flivst | fcp_ag | fcp_na | hh | enter | gov | dirtax | indtax | saltax | facttax | imptax | i-s | row | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Households (hh) | | | | | | | 1,600 | 856 | 175 | 195 | 455 | | 1,048 | 42 | | | | | | | 324 | 4,696 |
| Enterprises (enter) | | | | | | | | 0 | | | 1,501 | | | 505 | | | | | | | | 2,007 |
| Government (gov) | | | | | | | | | | | | | | | 554 | 153 | 207 | 8 | 161 | | 26 | 1,108 |
| Direct taxes (dirtax) | | | | | | | | | | | | 312 | 242 | | | | | | | | | 554 |
| Indirect taxes (indtax) | | | | | | 153 | | | | | | | | | | | | | | | | 153 |
| Sales taxes (saltax) | | 207 | | | | | | | | | | | | | | | | | | | | 207 |
| Factor taxes (facttax) | | | | | | | 7 | 0 | 0 | 0 | 1 | | | | | | | | | | | 8 |
| Imports taxes (imptax) | | 161 | | | | | | | | | | | | | | | | | | | | 161 |
| Save/ investment (i-s) | | | | | | | | | | | | 51 | 716 | −214 | | | | | | | 592 | 1,145 |
| Rest of the world (RoW) | | 1,815 | | | | | 62 | | | | | 10 | | 25 | | | | | | | | 1,912 |
| Total | 313 | 10,806 | 292 | 1,358 | 198 | 7,087 | 1,669 | 857 | 175 | 195 | 1,957 | 4,696 | 2,007 | 1,108 | 554 | 153 | 207 | 8 | 161 | 1,145 | 1,912 | |

*Source:* Own elaboration.

**TABLE A2** Kenya SAM 2014 activities and commodities

| HPHC commodities | Marketed commodities | Representative household groups as activities | Activities |
|---|---|---|---|
| Maize | Maize | *Food* | Food crops |
| Wheat | Wheat | Nairobi | Cotton |
| Rice | Rice | Mombasa | Sugarcane |
| Other cereals | Other cereals | High Rainfall | Coffee |
| Roots and tubers | Roots and tubers | Semi-Arid North | Tea |
| Pulses and oil seeds | Pulses and oil seeds | Semi-Arid South | Tobacco |
| Fruits | Fruits | Coast | Others crops |
| Vegetables | Vegetables | Arid North | Livestock |
| Beef | Cotton | Arid South | Dairy |
| Dairy | Sugarcane | | Fishing |
| Poultry | Coffee | | Forestry |
| Sheep, goat… | Tea | *Cash crops* | Mining |
| Other livestock | Tobacco | High Rainfall | Meat and dairy |
| Fishing | Others crops | Semi-Arid North | Grain milling |
| Sugar and bakery… | Beef | Semi-Arid South | Sugar and bakery… |
| Beverages and tobacco | Dairy | | Beverages and tobacco |
| Other manufactured food | Poultry | | Other manufactured food |
| Water | Sheep, goat… | | Textile and clothing |
| | Other livestock | | Leather and footwear |
| | Fishing | | Wood and paper |
| | Forestry | | Printing and publishing |
| | Mining | | Petroleum |
| | Meat and dairy | | Chemicals |
| | Grain milling | | Fertilizers, nitrogen |
| | Sugar and bakery… | | Fertilizers, phosphorus |
| | Beverages and tobacco | | Fertilizers, potassium |
| | Other manufactured food | | Metals and machines |
| | Textile and clothing | | Non-metallic products |
| | Leather and footwear | | Other manufactures |
| | Wood and paper | | Water |
| | Printing and publishing | | Electricity |
| | Petroleum | | Construction |
| | Chemicals | | Trade |
| | Fertilizers, nitrogen | | Hotels |
| | Fertilizers, phosphorus | | Transport |
| | Fertilizers, potassium | | Communication |

(Continues)

**TABLE A2** (Continued)

| HPHC commodities | Marketed commodities | Representative household groups as activities | Activities |
|---|---|---|---|
| | Metals and machines | | Finance |
| | Non-metallic products | | Real estate |
| | Other manufactures | | Other services |
| | Water | | Administration |
| | Electricity | | Health |
| | Construction (roads) | | Education |
| | Construction (irrigation) | | |
| | Construction (other infrastructures) | | |
| | Construction (others) | | |
| | Trade | | |
| | Hotels | | |
| | Transport | | |
| | Communication | | |
| | Finance | | |
| | Real estate | | |
| | Other services | | |
| | Administration | | |
| | Health | | |
| | Education | | |

*Source:* Own elaboration.

**TABLE A3** Regions in Kenya SAM 2014

| Nairobi | Mombasa | High Rainfall | | Semi-Arid North | Semi-Arid South | Coast | Arid North | Arid South |
|---|---|---|---|---|---|---|---|---|
| Nairobi | Mombasa | Kiambu | Bondo | Nyeri | Taita Taveta | Kilifi | Isiolo | Tana River |
| | | Kirinyaga | Nyando | Mbeere | Kitui | Kwale | Marsabit | Garissa |
| | | Muranga | Bomet | Mwingi | Makueni | Lamu | Moyale | |
| | | Nyandarua | Keiyo | Nyambene | Kajiado | Malindi | Mandera | |
| | | Thika | Kericho | Tharaka | Narok | | Wajir | |
| | | Maragua | Koibatek | Laikipia | Trans Mara | | Baringo | |
| | | Embu | Marakwet | West Pokot | | | Samburu | |
| | | Machakos | Nakuru | | | | Turkana | |
| | | Meru Central | Nandi | | | | | |
| | | Meru South | Trans Nzoia | | | | | |
| | | Gucha | Uasin Gishu | | | | | |
| | | Homa Bay | Buret | | | | | |
| | | Kisii | Bungoma | | | | | |
| | | Kisumu | Busia | | | | | |
| | | Kuria | Mt. Elgon | | | | | |
| | | Migori | Kakamega | | | | | |
| | | Nyamira | Lugari | | | | | |
| | | Rachuonyo | Teso | | | | | |
| | | Siaya | Vihiga | | | | | |
| | | Suba | Butere/Mumias | | | | | |

*Source:* Own elaboration.