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Institute for Advance Development Studies



02/2015

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by:

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An agriculture-focused, regionally disaggregated SAM for Mexico 2008[⊗]

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January 2015

Abstract

This paper describes the construction of a Social Accounting Matrix (SAM) for the Mexican economy for year 2008. It presents the methodology and data sources used, assumptions made, criteria adopted to disaggregate the SAM's accounts and the main results obtained. The Mexico SAM was built as the main data base for the calibration of a Computable General Equilibrium (CGE) Model, used to investigate the quantitative effects of climate change on the Mexican economy, with emphasis on analyzing its distributional impacts. Since the effects of climate change are mainly transmitted to the economy through the agricultural sector and since impacts on agriculture differ across regions, the Mexico SAM presents a significant disaggregation in the accounts referred to the agricultural activities and to income distribution, redistribution and income spending across households and regions. The final disaggregated SAM is quite large and is included in the accompanying spreadsheet file.

Keywords: Social Accounting Matrix, Mexico

JEL classification code: E16

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1. Introduction

This paper describes the construction of a regionally disaggregated Social Accounting Matrix (SAM) for the Mexican economy in 2008, which is the latest year for which an input-output table was available.

The 2008 Mexico SAM was built as part of the activities carried-out within the project on *Global and Local Impacts of Climate Change in Brazil, Mexico and Peru* commissioned by the Office of Evaluation and Oversight (OVE) at the Inter-American Development Bank (IDB). The project's main objective was to analyze the economic and distributional impacts that climate change would have in these three countries over the period 2010-2050. Since the effects of climate change are mainly transmitted to the economy through the agricultural sector, the Mexico SAM presents a significant disaggregation in the accounts referred to the agricultural activities and to income distribution, redistribution and income spending across regions and households.

The Mexico SAM was built as the main data base for the calibration of a Dynamic Computable General Equilibrium (DCGE) Model, which in turn was used to carry-out simulation exercises aimed at assessing the economic and socio-economic impacts of climate change.

The paper is organized in 7 sections.

Section 2 presents and analyses the main structure of the Mexican SAM. It describes the structure, explaining the accounts included and the main linkages existing among them. This section also presents the aggregated numeric Macro SAM, .

Section 3 explains the main features of the SAM framework adopted: first, in displaying existing macroeconomic data according to conventional accounting procedures, and second in extending conventional accounts, embracing classifications which are capable of tracing the essential interconnections throughout the economic system and of detailing those areas of particular concern to policy makers in planning to meet their development objectives.

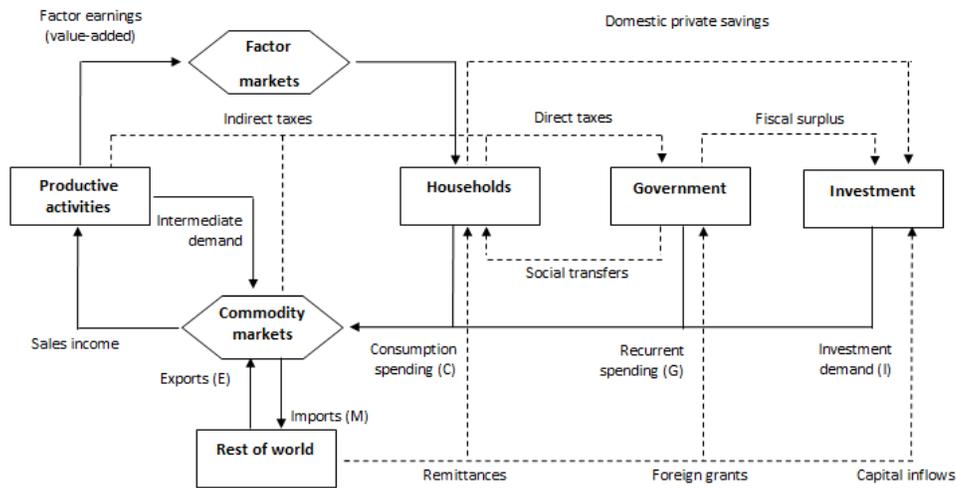
Section 4 presents in detail the process followed in the construction of the full-fledged SAM for Mexico. It describes the methodology adopted, data sources used, assumptions made, criteria chosen to disaggregate the SAM's accounts and the main results obtained from this process. A standard methodology was used in the construction of the Mexico 2008 SAM. The statistical information available in Mexico was quite complete, detailed and updated, and thus, all required data bases were available, including national accounts, input-output tables, institutional accounts, household surveys, gross output values for individual crops and livestock.

Section 5 outlines the balancing procedure and section 6 describes the imputation of labor incomes. Finally, section 7 presents the main conclusions.

2. The main structure of the Mexican SAM

A simple way of depicting an economy is the circular flow diagram shown in Figure 1, which captures all transfers and real transactions between sectors and institutions. Production activities purchase land, labor and capital inputs from the factor markets, and intermediate inputs from commodity markets, and use these to produce goods and services. These are supplemented by imports (M) and then sold through commodity markets to households (C), the government (G), investors (I) and foreigners (E). In the circular flow diagram, each institution's expenditure becomes another institution's income. For example, household and government purchases of commodities provide the revenues producers need to continue the production process. Additional inter-institutional transfers, such as taxes and savings, ensure that the circular flow of incomes is closed. In other words, all income and expenditure flows are accounted for and there are no leakages from the system.

Figure 1: Circular flow diagram of the economy



Source: Breisinger, Thomas and Thurlow (2009).

A SAM is a detailed particular numerical representation of the transactions and financial flows described in Figure 1. It presents macroeconomic and microeconomic data in a matrix form, where accounts are arranged along the rows and columns of the matrix. A cell entry in the matrix represents a particular transaction or transfer within the economy. By convention, receipts (incomings) are presented along the rows, while payments (outgoings) are shown along the columns (Pyatt G. and Round J. 1985).

Table 1 presents the overall structure of the 2008 Mexican SAM. The SAM framework represents the circular macroeconomic flow, which goes from production of output to the distribution of

value added or factor income to factors of production, to the distribution of factor income to institutions based on their factor endowments, to secondary redistribution of income among institutions, to commodity demands.

The SAM comprises nine account categories, namely: activities, commodities, factors of production, households, enterprises, taxes, government, saving-investment and rest of the world. Annex Table A1 presents a detailed list of all the categories in which each of the accounts were disaggregated.

Rows and columns 1 relate to separate accounts for production activities and the commodities they produce. Column 1 presents the cost structure for the production of output. It comprises intermediate consumption (row 2), income or value added distribution to factors, i.e. labor, capital and land (row 3), and net indirect tax payments of activities (row 6). Thus, the total of column 1 comprises the total output of domestic production valued at market prices.

Column 2 shows the structure of total supply of commodities. It comprises the domestically produced output (row 1), which is supplied by domestic activities, plus imports (row 9), supplied by the rest of the world, plus net tariffs and other net taxes on commodities paid (row 4). Commodity demand is shown along the commodity row (row 2). This includes intermediate demand by activities for further production of commodities (column 1), households' consumption demand (column 4), government current consumption (column 7), gross investment demand (column 8), including stock changes, and exports (column 9).

Column 3 outlines how factor income is distributed to institutions, i.e. households and enterprises, based on the institutions' factor endowments. Row 4 of column 3 comprises the part of income which is received by households, i.e. incomes that compensate labor (wages and salaries) plus the mixed income of self-employed workers. The latter includes those incomes which cannot be clearly separated into the part which remunerates capital from that which remunerates labor. Row 5 of column 3 includes factor income, which remunerates capital and is received by enterprises.

Row 4 contains all current incomes received by households, namely: factor incomes (column 3), transfers from enterprises, e.g. distributed profits (column 5), transfers from government, e.g. pension payments (column 7), and transfers from the rest of the world, e.g. remittances (column 9). Column 4 on the other hand shows the way households allocate their total incomes, including: consumption of goods and services (row 2), income tax payments (row 6), and transfers to the rest of the world (row 9). The difference between households' total incomes and total current expenditures represents households' savings, which are compiled in row 8 of column 4.

Likewise, row 5 contains enterprises' current incomes, including profits (column 3), transfers from government (column 7), and transfers from the rest of the world (column 9). Column 5 records the way enterprises allocate their incomes, comprising: transfers to households, e.g. distributed profits (row 4), tax payments on corporate profits (row 6), transfers to the rest of the world, e.g. remittances of corporate profits (row 9). The difference between enterprises' total incomes and

total current expenditures represents enterprises' savings, which are compiled in row 8 of column 5.

Row 6 collects all tax payments, including indirect taxes on activities (column 1), import tariffs and indirect taxes on commodities (column 2), income taxes paid by households (column 4) and by enterprises (column 5). Column 6 transfers all these tax payments to the government (row 7).

Row 7 outlines all government's current revenues. They comprise all tax payments (column 6) and transfers from the rest of the world, e.g. official grants (column 9). Column 7 outlines how government allocates its total incomes, including: government's current consumption of goods and services (row 2), transfers made to households (row 4), to enterprises (row 5) and to the rest of the world, e.g. interest payments due to the government's external debt (row 9). The difference between government's total incomes and total current expenditures represents the recurrent fiscal balance (savings or dissavings), which are compiled in row 8 of column 7.

Row and column 8 portray the economy's saving-investment balance. Savings are compiled along row 8, including households' savings (column 4), firms' savings (column 5), government's savings (column 7), and foreign savings (column 9). Total savings are allocated to total investment in column 8, which is a component of total demand for commodities (row 2).

Finally, row 9 and column 9 outline the external balance. Payments to the rest of the world are recorded along the row, comprising import payments (column 2), transfers by households (column 4), transfers by enterprises (column 5), and transfers by the government (column 7). Payments from the rest of the world are recorded along column 9, comprising: export payments, which is also part of the aggregate demand for commodities (row 2), transfers from abroad to households (row 4), transfers to enterprises (row 5), and to the government (row 7). The difference between total payments to and total receipts from the rest of the world represents foreign savings or the balance-of-payments current account deficit or surplus and is recorded in row 8 of column 9.

Table1 – Mexico’s SAM Structure

		1	2	3	4	5	6	7	8	9	10
		Activities	Commodities	Factors of Production	Households	Enterprises	Taxes	Government	Saving-Investment	Rest of the World	Total
1	Activities		Domestic supply								Total revenue
2	Commodities	Intermediate demand			Household consumption			Government consumption	Investment	Exports	Total demand
3	Factors of Production	Value added									Factor income
4	Households			Wages		Transfers		Transfers		Transfers	Household income
5	Enterprises			Profits				Transfers		Transfers	Firms' incomes
6	Taxes		Import tariffs & indirect taxes		Direct taxes	Direct taxes					Tax payments
7	Government						Tax receipts			Transfers	Government revenues
8	Saving-Investment				Household savings	Firms' savings		Government savings		Foreign savings	Total savings
9	Rest of the World		Imports		Transfers	Transfers		Transfers			Payments to RoW
10	Total	Total cost	Total supply	Factor income	Households' outlays	Firms' outlays	Total taxes	Government's outlays	Total investment	Payments from RoW	

Table2 – Aggregate Numeric SAM for Mexico (Billions of Mexican pesos)

	Activities	Commodities	Factors of Production	Households	Enterprises	Taxes	Government	Saving-Investment	Rest of the World	Total
Activities		20,772.4								20,772.4
Commodities	8,901.0			8,243.2			1,342.1	2,996.1	3,274.9	24,757.2
Factors of Production	11,871.5									11,871.5
Households			5,660.8		3,289.2		854.8		264.8	10,069.6
Enterprises			6,210.7				222.4		33.1	6,466.2
Taxes		385.6		182.6	2,383.7					2,951.9
Government						2,951.9			131.9	3,083.8
Saving-Investment				1,612.7	567.0		595.6		220.9	2,996.1
Rest of the World		3,599.2		31.1	226.4		69.0			3,925.6
Total	20,772.4	24,757.2	11,871.5	10,069.6	6,466.2	2,951.9	3,083.8	2,996.1	3,925.6	

Table 2 presents the aggregated numeric SAM for Mexico, corresponding to the SAM structure shown in Table 1. The figures presented in the numeric SAM fully match the national account figures available at the National Bureau of Statistics and Geography of Mexico (INEGI) website <http://www.inegi.org.mx/>. INEGI publishes a complete set of national accounts, comprising a detailed input-output table, a complete set of institutional accounts, and detailed supply-demand tables. The figures presented in the aggregate numeric SAM were preserved when the more detailed version of the SAM was constructed.

3. Main features of the SAM

According to Pyatt and Round (1985), the classification and arrangement of accounts within a SAM framework ought to serve a dual purpose: “In the first place, the SAM should be in a form which is adequate to display existing macroeconomic data according to conventional accounting procedures. Thus, for example, it succeeds only if traditional national accounts are an identifiable part of it, and hence if aggregates such as GNP and GDP can be readily ascertained.

Secondly, it should extend conventional accounts far beyond this, and embrace classifications which are capable of tracing the essential interconnections throughout the economic system. Simultaneously with this, the classifications must reflect those areas of particular concern to policy makers in planning to meet their development objectives.”

The SAM framework presented above meets these two objectives:

First, key macroeconomic identities can be readily obtained from the SAM framework, which ensures macroeconomic consistency in the data presented. The income identity is embedded in columns and rows 1 and 2.

The identity underlying row and column 1 is the following

$$Q = V + Y^f \tag{1}$$

where: Q = Total output gross value

V = intermediate consumption

Y = factor income or GDP at factor cost

On the other hand, the identity underlying row and column 2 is

$$Q + M + T^{ind} = V + C + G + I + E \tag{2}$$

where: M = imports

T^{ind} = net indirect taxes

C = private consumption

G = government consumption

I = fixed capital formation

E = exports

Substituting (1) into (2) and rearranging we obtain the economy's income identity:

$$Y^m = C + G + I + E - M \quad (3)$$

Where: Y^m = GDP at market prices

Likewise, column and row 8 presents the economy's saving-investment balance

$$S_h + S_e + S_g + S_f = I \quad (4)$$

where: S_h = households' savings

S_e = enterprises' savings

S_g = government savings

S_f = foreign savings (— current account balance of the balance of payments)

I = investments

On the other hand

$$S_d = S_h + S_e + S_g \quad (5)$$

$$S_d + S_f = I \quad (6)$$

where: S_d = domestic savings

Using the numeric SAM data presented in Table 2, and substituting those values in equation (3), we can calculate Mexico's income identity:

$$Y = C + G + I + E - M$$

$$12.2 \text{ (trillion Mexican pesos)} = 8.2 + 1.3 + 3.0 + 3.3 - 3.6$$

Likewise, the saving-investment identity can be calculated by substituting the figures from Table 2 in equation (4):

$$S_h + S_e + S_g + S_f = I$$

$$1.6 + 0.6 + 0.6 + 0.2 = 3.0 \text{ (in trillion Mexican pesos)}$$

In order to comply with the second objective of extending conventional accounts by including classifications that reflect those areas of particular concern to policy makers in planning to meet their development objectives, each of the accounts presented in Table 1, has been disaggregated

into categories relevant to the objectives pursued in this research project, i.e. analyzing the macroeconomic and sectoral effects of climate change on the Mexican economy, with a focus on income distribution across different labor and households categories. The criteria adopted to further disaggregate each of the accounts of the Mexico SAM are discussed in detail in the following section.

The information needed to build a SAM comes from a variety of sources, such as national accounts, household surveys, government budgets, and the balance of payments (see Section 4). Placing these data within the SAM framework inevitably reveals inconsistencies between the incomes and expenditures of each account (e.g., government spending in national accounts may not be the same as what is reported in state budgets). A number of statistical estimation techniques exist to “balance” a SAM’s accounts (i.e., reconcile incomes and expenditures). Cross-entropy estimation is the preferred method and the two-stage balancing procedure is described in Section 5.

4. Assembling the full-fledged Mexico 2008 SAM

Most of the accounts presented in Table 1 – activities and commodities, factors of production, and households – were disaggregated into a more detailed set of accounts. For this purpose, various data sources were used, including national accounts, household surveys, data on agricultural output, etc. This section describes in detail the process followed in disaggregating each of the accounts included in the Mexico SAM.

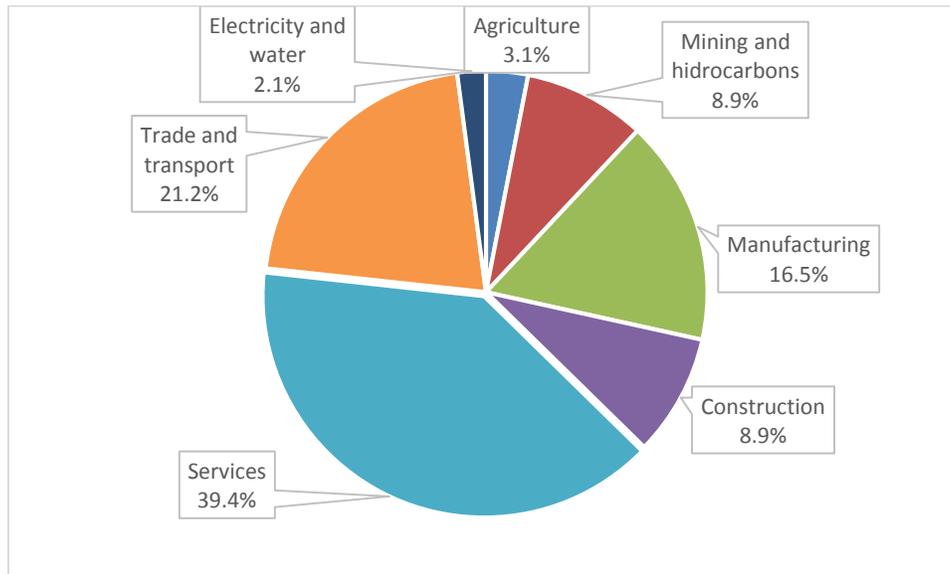
4.1 Activity and commodity accounts

The basic data source used to compile the sub-matrices comprised in column 1 and row 2 was the 2008 input-output table for Mexico, which is available at the website of the National Bureau of Statistics and Geography of Mexico (INEGI¹).

Figure 1, prepared based on INEGI’s 2008 input-output table, shows that the share of agriculture in Mexico’s GDP at factor costs is only of 3.1%. The sector with the largest share in GDP at factor costs is services, with 39.4% of the total, followed by trade and transport (21.2%) and manufacturing (16.5%).

¹ See INEGI’s web site, where a very detailed and complete input-output table for the Mexican economy is available: <http://www3.inegi.org.mx/sistemas/tabuladosbasicos/tabniveles.aspx?c=33600>.

Figure 1
Composition of GDP at factor cost



Source: INEGI's input-output table for 2008.

Note: Agriculture includes crops, livestock, forestry, fishing and hunting.

In order to address the policy questions referred to assessing the economic and income effects of climate change, the Mexican SAM has to be disaggregated in a relevant fashion. The effects of climate change are basically transmitted to the economy through the agricultural sector and these effects tend to differ by crop. Thus, the agricultural activity and commodity accounts in the Mexican SAM were disaggregated at a significant detail, which included individual accounts for the most important crops produced in the country. Agricultural activities were further disaggregated region-wise, since the climate change effects will be different for the various Mexican agro-ecological regions.

The Mexican territory was classified into four regions, based on the major agro-ecological characteristics in the country:

- Region 1 (R1): West arid
- Region 2 (R2): North and east arid
- Region 3 (R3): Central-high arid
- Region 4 (R4): Southern humid

Figure 2 illustrates the regional disaggregation while Annex Table A2 shows the Mexican federal states that were included in each of the regions.

Figure 2:
The regional disaggregation adopted for the Mexican SAM



Source: Andersen et al. (2014).

Although INEGI's input-output table comprises significant detail for all sectors, a more detailed version of it was required, especially within the agricultural sector. The input-output table of INEGI already comprised important detail regarding the agricultural sector, including individual accounts for various crop categories, livestock, forestry, fishing and hunting. Table 3 shows how the agricultural activities and commodities included in INEGI's input-output table were further disaggregated in the Mexican SAM. For those crops representing at least 5% of the total agricultural gross output value at the national and regional levels individual accounts were singled-out, i.e. maize, wheat, sorghum, bean, tomato, avocado, chili, potato, banana, nuts, apple, sugarcane, pastures and alfalfa. Other input-output table categories, such as pigs, sheeps and goats, animal breeding etc. were lumped together with other livestock, primary fishing and forestry activities and commodities were grouped together in forestry, fishing and hunting within the Mexican SAM.

Table 3
Agriculture categories of INEGI's I/O table and the 2008 Mexico SAM

INEGI I/O categories	SAM categories	
	Commodities	Activities
Oilseeds, legumes, and cereals	Maize	Maize (R1, R2, R3 and R4)
	Wheat	Wheat (R1, R2, R3 and R4)
	Sorghum	Sorghum (R1, R2, R3, and R4)
Vegetables	Beans	Beans (R1, R2, R3, and R4)
	Tomato	Tomato (R1, R2, R3, and R4)
	Avocado	Avocado (R1, R2, R3 and R4)
	Chili	Chili (R1, R2, R3 and R4)
Fruits and nuts	Potato	Potato (R1, R2, R3 and R4)
	Banana	Banana (R1, R2, R3 and R4)
	Nuts	Nuts (R1, R2, R3 and R4)
	Apple	Apple (R1, R2, R3 and R4)
	Sugarcane	Sugarcane (R1, R2, R3 and R4)
Greenhouse crops and floriculture	Pstures	Pstures (R1, R2, R3 and R4)
Other crops	Alfalfa	Alfalfa (R1, R2, R3 and R4)
Agriculture services	Other agriculture	Other agriculture (R1, R2, R3 and R4)
Bovines	Cattle	Cattle (R1, R2, R3 and R4)
Poultry	Poultry	Poultry (R1, R2, R3 and R4)
Porcines	Other livestock	Other livestock (R1, R2, R3 and R4)
Sheeps and goats		
Other livestock		
Animal breeding services		
Aquaculture	Forestry, fishing and hunting	Forestry, fishing and hunting
Silviculture		
Forestry		
Timber		
Fishing		
Hunting		
Forestry services		

Source: INEGI and Mexican 2008 SAM

Agricultural activity accounts were further disaggregated according to the regional location of the activity.

The disaggregation of the input-output table's sectors into the Mexican SAM's commodity and activity accounts was carried out using detailed data on agricultural gross output value for different crops and for different Mexican states obtained from the website of the Agriculture and Livestock Information Service (SIAP) under the Secretary for Agriculture, Livestock, Rural Development, Fishing and Food (SAGARPA²). This data was used to calculate the output value shares for individual crops at the national and regional levels. Table 4 summarizes the calculated shares used for the disaggregation of the agricultural activity accounts of the 2008 SAM.

² SIAP's web site from where detailed data on output gross value for crops and regions is available is the following: <http://www.siap.gob.mx/cierre-de-la-produccion-agricola-por-cultivo/>

Table 4
Agriculture output value shares by region and crops (percent of regional and national output values)

	NORTH AND CENTRAL			SOUTHERN	NATIONAL
	WEST ARID	EAST ARID	HIGH ARID	HUMID	
Maize	12.4	3.8	28.1	12.7	56.9
Wheat	7.5	0.7	3.9	0.0	12.1
Sorghum	2.4	5.3	5.3	0.6	13.6
Beans	1.9	0.6	4.3	1.1	7.9
Others	1.4	1.1	6.1	0.9	9.5
Total Oilseeds, legums and cereals	25.4	11.6	47.6	15.3	100.0
Tomato	11.4	1.5	8.3	1.9	23.1
Avocado	0.2	0.0	18.7	0.2	19.2
Green chilli	5.7	3.8	6.6	1.3	17.4
Potato	6.0	2.4	3.1	0.6	12.1
Others	9.6	2.6	14.5	1.5	28.2
Total Vegetables	32.9	10.3	51.2	5.6	100.0
Banana	0.3	0.0	1.5	8.0	9.8
Nuts	0.8	5.7	0.7	0.4	7.6
Apple	0.0	4.8	0.9	0.2	5.9
Other Fruits	16.0	4.8	27.4	28.4	76.6
Total Fruits and Nuts	17.1	15.3	30.5	37.1	100.0
Total Greenhouse farming and floriculture	2.4	0.0	96.1	1.4	100.0
Sugarcane	3.6	2.0	11.9	17.8	35.2
Pastures	1.5	2.9	8.5	13.9	26.7
Green Alfalfa	2.8	3.5	10.7	0.2	17.3
Others	2.5	2.4	7.9	8.0	20.8
Total Other crops	10.3	10.7	39.0	39.9	100.0

Source: SAGARPA, SIAP

SIAP also provides detailed data about gross output value for livestock and animal breeding activities, disaggregated by livestock category and regional location³. This data was used to calculate output shares for livestock related activities by region. Table 5 presents the shares used to disaggregate the livestock accounts in the Mexican 2008 SAM.

³ SIAP's web site where detailed data on output gross value for livestock and regions is the following: <http://www.siap.gob.mx/ganaderia-resumen-estatal-pecuario/>.

Table 5
Livestock output value shares by region and species

	Cattle	Poultry	Other Livestock
West Arid	18.0	6.3	17.1
North and East Arid	11.8	8.1	7.1
Central High Arid	38.0	61.1	51.3
Suthern Humid	32.2	24.6	24.6
Total	100.0	100.0	100.0

Source: SAGARPA, SIAP

4.2 Supply-demand balances

Column and row 2 of Table 1 present the supply-demand balances of the economy. Column 2 shows how commodity supply is composed of domestic output and imports. Row 2 on the other hand presents aggregate demand for commodities, comprising household and government consumption, investment and exports.

Import values were taken from INEGI's 2008 input-output table. However, the agricultural imports' categories included in the input-output table had to be adjusted to the categories comprised in the SAM. For this purpose, more detailed data on agricultural goods was obtained from INEGI's website.

Table 6 presents the commodity composition of Mexico's supply-demand balance in the 2008 SAM. Some important features about Mexico's economic structure can be observed from this table.

First, agricultural activities only comprise a small share of total GDP (3.1%) and of total output (2.8%). Likewise, agricultural commodities constitute only a small share of total imports (3.2%), domestic absorption (1.6%) and exports (2.2%). Services and manufacturing activities comprise 77% of total GDP and 80% of total output value.

Second, the import absorption ratio for agricultural goods is 16.3%, meaning that Mexico is satisfying most of its domestic demand for agricultural products through domestically produced products Agriculture's share of total imports is only 3.2%.

Third, only 12% of Mexico's agricultural production is exported and agriculture's share of total exports is only 2.2%.

Table 6
Mexico's supply-demand balance

	Value Added (%)	Total Output (%)	Total Demand (%)	Exports (%)	Export/ Output ratio	Imports (%)	Import/ Demand ratio
Cereals	0.7	0.5	0.6	0.1	4.3	1.4	31.4
Vegetables	0.3	0.3	0.2	0.8	48.3	0.2	13.0
Fruits and nuts	0.1	0.1	0.1	0.0	8.1	0.2	30.4
Other agriculture	0.9	0.7	0.8	1.0	21.1	1.3	23.4
Livestock	0.8	1.1	0.9	0.1	1.3	0.1	1.2
Forestry, fishing and hunting	0.2	0.2	0.1	0.2	18.0	0.0	0.0
Agriculture	3.1	2.8	2.8	2.2	12.4	3.2	16.3
Mining & hydrocarbons	8.9	6.0	5.1	14.5	38.3	0.9	2.4
Electricity and water	2.1	2.3	1.9	0.2	1.4	0.0	0.1
Construction	8.9	9.3	7.8	0.0	0.0	0.0	0.0
Manufacturing	16.5	33.4	42.3	72.5	34.1	93.8	32.2
Services	60.6	46.3	40.0	10.6	3.6	2.2	0.8
Total	100.0	100.0	100.0	100.0	15.7	100.0	14.5

Source: Mexican 2008 SAM

4.3 Income distribution to factors accounts

The disaggregated factor income accounts were built based on INEGI's input-output table, national accounts and the micro data processed from the 2008 National Survey on Households' Incomes and Expenditures (ENIGH)⁴. The total labor force, which amounted to 47.4 million workers in 2008, was grouped in six categories: non-skilled, semi-skilled and skilled labor, for male and female workers. Table 7 presents the factor income shares for these 6 labor categories and for capital and land. All these values were calculated based on micro-data obtained from the 2008 ENIGH and on the income data contained in INEGI's 2008 input-output table.

⁴ The 2008 National Survey on households' Incomes and Expenditures (ENIGH) was obtained from INEGI website:
<http://www.inegi.org.mx/est/contenidos/Proyectos/Encuestas/Hogares/regulares/Enigh/Enigh2008/ncv/default.aspx>.

Table 7
Factor income shares by sector, gender and skill level

	Labor						Capital	Land rent	Total factor costs
	Male			Female					
	Non-skilled	Semi-skilled	Skilled	Non-skilled	Semi-skilled	Skilled			
Maize	21.4	6.8	3.1	1.8	0.4	0.1	31.7	34.7	100.0
Wheat	17.6	5.9	5.5	0.8	0.1	0.2	47.6	22.4	100.0
Sorghum	17.6	5.1	2.4	1.2	0.2	0.1	42.8	30.7	100.0
Beans	18.1	6.0	2.8	1.4	0.4	0.0	40.7	30.7	100.0
Tomato	5.0	1.4	0.7	1.1	0.4	0.0	55.8	35.6	100.0
Avocado	5.9	1.4	0.2	0.7	0.1	0.0	55.9	35.7	100.0
Chili	5.0	1.3	0.8	0.8	0.3	0.0	56.1	35.8	100.0
Potato	5.8	1.7	0.2	0.4	0.0	0.0	56.1	35.7	100.0
Banana	11.2	5.4	1.0	0.8	0.0	0.0	43.5	38.1	100.0
Nuts	12.0	3.5	0.3	0.8	0.3	0.0	44.7	38.5	100.0
Apple	11.8	3.5	0.3	1.0	0.3	0.0	44.3	38.8	100.0
Sugarcane	39.3	11.1	6.5	1.7	0.3	0.1	6.3	34.7	100.0
Pasture	35.2	14.0	4.1	4.1	1.0	0.6	4.0	37.1	100.0
Alfalfa	33.2	10.1	4.4	5.0	1.9	0.1	8.2	37.1	100.0
Other agriculture	19.6	6.2	4.1	2.1	1.0	0.3	29.8	36.8	100.0
Cattle	12.9	3.8	6.6	0.6	0.2	0.6	46.5	28.8	100.0
Poultry	5.0	1.0	0.7	0.9	0.8	0.1	91.4	0.0	100.0
Other livestock	27.7	11.5	3.7	3.3	0.5	0.4	26.7	26.3	100.0
Forestry, fishing & hunting	9.1	5.1	2.9	0.7	0.9	3.7	33.0	44.6	100.0
Hydrocarbons	0.5	0.8	1.2	0.0	0.0	0.0	97.5	0.0	100.0
Mining	7.5	5.4	8.6	0.6	0.5	0.5	77.0	0.0	100.0
Electricity and water	4.1	8.2	6.7	0.0	0.1	0.2	80.7	0.0	100.0
Construction	29.4	15.5	11.3	0.1	0.1	0.7	42.9	0.0	100.0
Food processing	4.9	4.8	3.0	4.9	3.3	1.1	78.0	0.0	100.0
Textiles	6.7	7.0	2.7	9.6	6.7	1.8	65.6	0.0	100.0
Paper and wood	11.1	11.7	5.9	1.2	1.8	0.9	67.4	0.0	100.0
Chemicals and oil refinery	2.9	5.9	8.5	1.1	1.9	2.3	77.4	0.0	100.0
Metallics, machinery and equipment	8.3	12.7	7.6	0.8	1.8	0.7	68.1	0.0	100.0
Commerce, transport & storage	17.4	25.5	19.3	5.3	9.4	7.0	16.1	0.0	100.0
Communication	1.3	4.7	15.0	0.1	1.0	3.0	74.9	0.0	100.0
Financial services	0.2	2.1	16.9	0.2	2.1	9.3	69.3	0.0	100.0
Rent of dwellings	0.1	0.2	1.1	0.0	0.1	0.4	98.1	0.0	100.0
Services to firms	1.4	6.0	25.7	1.5	12.6	20.2	32.6	0.0	100.0
Education services	6.6	9.0	31.0	4.9	9.5	34.6	4.4	0.0	100.0
Health services	1.0	3.3	30.1	2.2	13.4	31.9	18.0	0.0	100.0
Communal, social & personal services	1.5	3.6	10.5	0.4	2.7	4.8	76.6	0.0	100.0
Restaurants and hotels	1.9	8.6	19.6	2.4	2.4	5.3	59.7	0.0	100.0
Other private services	7.3	7.6	13.6	10.6	7.6	6.4	46.9	0.0	100.0
Public services	15.5	31.8	38.7	0.8	3.9	7.2	2.1	0.0	100.0

Source: Mexico 2008 SAM

Land rental cost was singled out as a separate factor remuneration from the gross operating surplus using land rent costs to gross output value ratios taken from the GTAP 8 Data Base⁵. These ratios are presented in table 8.

Table 8
Land rental cost as a share of gross output value

Activity	Percentage
Paddy rice	25.3
Wheat	16.8
Cereal grains nec	23.1
Vegetables, fruits, nuts	27.1
Oil seeds	28.4
Sugarcane, sugar beet	25.2
Plant-based fibers	13.9
Crops nec	26.8
Bovine cattle, sheep and goats, horses	13.2
Animal products nec	0.0
Raw milk	12.2
Wool, silk-worm cocoons	5.1
Forestry	50.4

Source: GTAP 8 Data Base

4.4 Income accounts for institutions

Institutional accounts in the Mexican SAM were built based on Mexico's national accounts system published by INEGI, which comprises a detailed set of institutional accounts⁶. These accounts are fully consistent with the other components of the national accounts system, including the input-output table figures. The institutional sectors comprised in the system are:

- financial firms
- non-financial firms
- households
- non-profit institutions
- general government
- rest of the world

⁵ GTAB 8 web site where data on land rental costs can be obtained is:

(<https://www.gtap.agecon.purdue.edu/databases/v8/default.asp>)

⁶ INEGI's web site where a detailed set of institutional accounts is available is:

<http://www3.inegi.org.mx/sistemas/tabuladosbasicos/tabniveles.aspx?s=est&c=33634>

INEGI's institutional accounts present very detailed data on incomes, expenditures and savings for each of the institutional sectors.

In the Mexican 2008 SAM, financial and non-financial firms were grouped into one single category called enterprises. Households and non-profit institutions were also grouped into one single category called households.

Government income basically comprises tax revenues. Taxes paid by sectors, import duties and commodity taxes were all taken from INEGI's 2008 input-output table.

Household accounts were further disaggregated according to three criteria: i) gender of the household head, ii) regional location of households, and iii) income decile to which the household belongs. In total, there were (2 x 4 x 10) 80 household categories identified in the Mexican 2008 SAM.

Income shares for each of the household categories were calculated based on detailed micro data obtained from the 2008 National Survey on Households' Incomes and Expenditures (ENIGH).

Table 9 presents the income structure of households grouped by gender of the household head and location, while Table 10 shows the same structure by income deciles. The ENIGH household survey contains a lot of missing observations for people who were unable to estimate their own labor incomes. In these cases, we estimated the income for them, using a simple Mincer equation including education level, years of experience, years of experience squared and gender as explanatory variables.⁷

⁷ In the household survey 38,339 out of 168,203 occupied persons had not declared their income, so we estimated it for them using a simple Mincer earnings regression based on the 2008 National Survey of Occupation and Employment.

Table 9
Households' income structure by gender of household's head and region
(percentage)

	labmns	labmss	labmsk	labfns	labfss	labfsk	land1	land2	land3	land4	Profits	Government transfers	Remittances	Total
Male headed HH West arid	13.1	15.1	19.2	1.9	5.2	7.3	2.3	0.0	0.0	0.0	30.9	4.2	0.7	100.0
Male headed HH North & East arid	10.0	16.6	19.1	1.6	4.9	6.0	0.0	1.4	0.0	0.0	34.3	5.3	0.9	100.0
Male headed HH Central-high arid	11.0	13.4	15.9	2.0	4.2	5.7	0.0	0.0	0.8	0.0	35.5	8.6	2.9	100.0
Male headed HH Southern-humid	18.6	16.5	20.2	3.0	4.1	7.3	0.0	0.0	0.0	2.0	18.2	5.9	4.3	100.0
Female headed HH West arid	6.5	9.8	9.5	5.7	10.5	13.4	0.9	0.0	0.0	0.0	32.9	9.4	1.4	100.0
Female headed HH North & East arid	5.5	11.2	10.3	5.3	9.7	12.8	0.0	0.4	0.0	0.0	31.5	12.5	0.8	100.0
Female headed HH Central-high arid	4.6	6.6	8.5	4.9	8.0	10.4	0.0	0.0	0.5	0.0	37.5	15.8	3.3	100.0
Female headed HH Southern-humid	8.9	9.3	9.7	6.7	8.1	14.3	0.0	0.0	0.0	0.9	25.9	11.4	4.8	100.0

Source: Mexico 2008 SAM

Table 10
Households' income structure by income decile
(percentage)

	labmns	labmss	labmsk	labfns	labfss	labfsk	land1	land2	land3	land4	Profits	Government transfers	Remittances	Total
Households decile1	45.2	13.5	2.3	13.7	6.8	1.3	0.0	0.0	0.0	0.0	23.3	11.8	27.1	100.0
Households decile2	44.7	20.8	4.3	10.3	8.7	2.5	0.0	0.0	0.0	0.0	22.8	13.8	16.8	100.0
Households decile3	34.6	25.4	6.2	7.9	10.0	3.6	0.0	0.0	0.0	0.0	22.7	14.4	9.8	100.0
Households decile4	30.4	29.3	8.4	6.7	10.0	4.2	0.0	0.0	0.0	0.0	20.8	14.0	6.5	100.0
Households decile5	26.0	31.2	10.3	6.1	10.2	5.2	0.0	0.0	0.1	0.1	19.0	13.2	4.6	100.0
Households decile6	21.4	29.6	13.2	5.3	10.6	7.5	0.0	0.0	0.2	0.2	18.0	12.2	3.2	100.0
Households decile7	17.0	26.7	16.5	3.9	9.0	8.7	0.1	0.1	0.2	0.2	21.5	10.6	2.4	100.0
Households decile8	12.1	21.0	21.3	2.9	7.9	10.2	0.1	0.2	0.4	0.4	21.8	12.3	1.5	100.0
Households decile9	8.5	15.7	24.9	1.8	7.0	11.8	0.3	0.1	0.6	0.4	24.8	11.5	1.0	100.0
Households decile10	2.4	5.0	20.2	0.7	2.3	8.2	0.4	0.4	0.8	0.4	54.7	6.2	0.7	100.0

Source: Mexico 2008 SAM

5. Balancing the Social Accounting Matrix

The different data sets used to construct the detailed SAM implies that there will inevitably be imbalances (i.e., row and column totals are unequal). Cross-entropy econometrics is used to reconcile SAM accounts (see Robinson et al., 2001). This approach begins with the construction of the so-called prior SAM, which used a variety of data from a number of sources of varying quality. This prior SAM provided the initial “best guess” for the estimation procedure. Additional information is then brought to bear, including knowledge about aggregate values from national accounts and technology coefficients. A balanced SAM was then estimated by minimizing the entropy ‘distance’ measure between the final SAM and the initial unbalanced prior SAM, taking into account all additional information.

Balancing procedure for the SAM

The balancing procedure takes place in two stages. First, a very detailed national SAM was constructed using the supply-use table, national accounts, state budgets, balance of payments, and agricultural survey. At this stage, the SAM contains aggregate entries for factors and households, and activity entries at the national level. This aggregate national SAM was then balanced using cross-entropy.

After balancing the national SAM, it was then disaggregated across agricultural regions, factors and households. Since the aggregate national SAM is balanced, this results in imbalances for the household accounts only. These household accounts were again balanced using cross-entropy, but holding all other non-household-related entries of the national SAM constant. Given the imbalances in the household survey between incomes and expenditures, the target household income/expenditure total for the final balanced SAM was the expenditure totals in the unbalanced prior SAM.

The cross-entropy estimation of a balanced SAM is described by Thurlow (2008).

6. Imputation of labor incomes

We used the 2008 National Survey of Occupation and Employment (Encuesta Nacional de Ocupación y Empleo (ENOE) 2008) as basis for the calculation of the extended (sectorally and functionally disaggregated factor income matrix of the 2008 Social Accounting Matrix. However, in this survey 22.8 percent out of 168,203 occupied persons did not declare their income. In order to overcome the data deficiency, individual income for the missing records were estimated using a simple Mincer earnings regression, including years of schooling, experience, experience squared, a gender dummy and regional dummies. The Mincer equation was estimated based on the 129,709 records for which there was a declared labor income. This yielded the results shown in Table 11. This equation indicates the natural logarithm of the average monthly labor income (in Pesos) compared to the reference group (unskilled male workers in the Mexican central high arid region). The estimated Mincer equation was then applied to all records with missing labor income.

All estimated coefficients are highly significant. We use this earnings equation to estimate the monthly income for all missing individual in the 2008 household survey. For example, for unskilled male workers in the central

high arid region, the yearly income would be $\exp(9.523542) =$ Pesos 13,678 (about 1,050 US Dollars). And for female workers in the same region, the yearly income would be $\exp(9.523542 - 0.370918) =$ Pesos 9,439.

Table 11 – Mincer Earnings Equation

Source	SS	df	MS			
Model	28409.4513	7	4058.49305	Number of obs =	129709	
Residual	66570.4105129701		.51326058	F(7,129701) =	7907.28	
Total	94979.8618129708		.732259088	Prob > F =	0.0000	
				R-squared =	0.2991	
				Adj R-squared =	0.2991	
				Root MSE =	.71642	

lny	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]	
years_school	.0929516	.0005091	182.58	0.000	.0919538	.0939495
experi	.0349815	.0003847	90.93	0.000	.0342275	.0357355
experi2	-.0005129	6.57e-06	-78.08	0.000	-.0005258	-.0005
woman	-.370918	.0041001	-90.46	0.000	-.3789542	-.3628818
w_arid	.1696343	.0057318	29.60	0.000	.1584001	.1808685
ne_arid	.0962571	.0063146	15.24	0.000	.0838806	.1086337
s_humid	-.0970742	.0049015	-19.80	0.000	-.1066811	-.0874673
_cons	9.523542	.0080231	1187.02	0.000	9.507817	9.539267

Source: Authors' estimation based on Mexico's employment survey.

7. Conclusions

This paper describes the process of constructing a Social Accounting Matrix (SAM) for the Mexican economy. It presents the methodology adopted, data sources used, assumption made, criteria chosen to disaggregate the SAM's accounts and the main results obtained as a result of this process.

The Mexican SAM was built as the main data base for the construction of a Computable General Equilibrium (CGE) Model that has been used later to assess the macroeconomic, sectoral and distributional effects of climate change on the Mexican economy.

A standard methodology was used in the construction of the Mexican 2008 SAM. Mexico's statistic system demonstrated to be quite complete, detailed and updated, and thus, all required data bases were easily available, including national accounts, input-output table, institutional accounts, household surveys, output gross value for individual crops and livestock, and household incomes and expenditures.

Since the effects of climate change are mainly transmitted to the economy through the agricultural sector, the Mexican SAM presents a significant disaggregation in the agricultural accounts and in the accounts referred to income distribution.

Table A1 – Detailed accounts in the 2008 SAM for Mexico

<i>Nr.</i>	<i>39 activities and commodities, 1-18 differentiated by agro-ecological regions</i>	<i>4 agro-ecological regions</i>	
1	maize	Central high arid	
2	wheat	West arid	
3	sorghum	North and east arid	
4	beans	Southern humid	
5	tomato		
6	avocado		
7	chili		
8	potato	<i>8 factors of production</i>	
9	banana	Male non-skilled labor	
10	nuts	Male semi-skilled labor	
11	apples	Male skilled labor	
12	sugarcane	Female non-skilled labor	
13	pastures	Female semi-skilled labor	
14	alfalfa	Female skilled labor	
15	other agriculture	Capital	
16	cattle	Land	
17	poultry		
18	other livestock		
19	forestry, timber, fishing, hunting		
20	hydrocarbons	<i>80 households, differentiated by regions (1-4), gender (m/f), and income deciles (01-10)</i>	
21	mining		
22	electricity, water and gas	hh1-4m/f01-10	
23	construction		
24	food processing		
25	textiles and leather products		
26	paper and wood	<i>Other accounts</i>	
27	chemicals and oil refinery	ent	Enterprises
28	metallic products, machinery, equipment	dtax	Direct taxes
29	commerce, transport and storage	stax	Indirect taxes
30	communication	mtax	Import tariffs
31	financial services	gov	Government
32	renting of dwellings	s-i	Savings and Investment
33	services to firms	row	Rest of the world
34	education	total	Total
35	health services		
36	communal and social services		
37	restaurants and hotels		
38	other private services		
39	public services		

Table A2 – Mexico’s agro-ecological regions

Central High Arid	West Arid	North and East Arid	Southern Humid
Durango Aguas Calientes Zacatecas San Luis Potosí Jalisco Colima Michoacan Guanajuato Queretaro Hidalgo Mexico Puebla Tlaxcala Distrito Federal Morelos	Baja California Baja California Sur Sonora Sinaloa Nayarit	Chihuahua Coahuila Nuevo Leon Tamaulipas	Quintana Roo Yucatán Campeche Tabasco Chiapas Veracruz Oaxaca Guerrero

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⁸ SIAP's web site from where detailed data on output gross value for crops and regions is available is the following: <http://www.siap.gob.mx/cierre-de-la-produccion-agricola-por-cultivo/>