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We present the structure and the process of construction of a social accounting matrix for the Spanish region of Andalusia, for the year 2016. The SAM includes 359 accounts with their respective balances of revenues and expenses, and distinguishes exchanges and income transfers between Andalusia, the rest of Spain and the rest of the world. As the dataset provides a detailed summary on the economic structure, we illustrate some key characteristics of the Andalusian economy at the year 2016, by presenting some relevant statistics and indexes.

Keywords
Social Accounting Matrix, Input-Output, Andalusia, Economic Structure

JEL Codes
E01, E16

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A Social Accounting Matrix for Andalusia

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We present the structure and the process of construction of a social accounting matrix for the Spanish region of Andalusia, for the year 2016. The SAM includes 359 accounts with their respective balances of revenues and expenses, and distinguishes exchanges and income transfers between Andalusia, the rest of Spain and the rest of the world. As the dataset provides a detailed summary on the economic structure, we illustrate some key characteristics of the Andalusian economy at the year 2016, by presenting some relevant statistics and indexes.

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1. Introduction

A Social Accounting Matrix (SAM) is an accounting framework, formulated as a matrix, depicting the circulation of income flows among various agents inside an economic system (Pyatt and Round, 1985). It usually takes the form of a square matrix, where each entity is associated with a row (identifying sources of income) and a column (showing expenditure outlets), such that the two vectors correspond to a double-entry bookkeeping balance.

A SAM is an essential piece of information for a wide variety of studies about the structure of an economy: input-output, computable general equilibrium models, network analysis, and others. It may be conceived as an extension and generalization of an input-output table, where the main difference relates to the additional information provided about income flows, connecting different components of value added and final demand.

Although regional SAMs do exist (e.g. Lewis and Thorbecke, 1992; Cansino, Cardenete and Roman, 2007), the large majority of SAMs have been constructed at the national level (e.g., Adelman and Robinson, 1986), essentially because their estimation is primarily based on input-output tables, which are often only available for countries. Nonetheless, since the Institute of Statistics and Cartography of Andalusia (IECA) has produced a regional input-output table for the year 2016 (IECA, 2020), alongside other relevant statistics, we were able to build a SAM for Andalusia, the southernmost and most populated region of Spain. This is, to our knowledge, the very first attempt of estimation of a detailed social accounting matrix for this region.

This paper is structured as follows. In the next section, we present the overall structure of the Andalusian SAM, showing which accounts are considered and how they are linked through exchange blocks. Section three illustrates the process followed to integrate different information sources into an internally coherent and balanced structure. Section four presents some key characteristics of the Andalusian economy as they are made evident by our estimated SAM. An ending section provides some final remarks.

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2. The structure of the Andalusian SAM

Several accounts/entities are considered in the SAM, each one corresponding to a row (receipts) and a column (expenses). Since the monetary circulation of income is mirrored by a countercyclical circulation of real services, it is also possible to interpret entries in a row as sales and entries in a column as purchases.

"Commodities" refer to physical products of good and services, distinguished by place of origin: Andalusia (A), Rest of Spain (E), Rest of World (W). There are 87 categories of commodities in the SAM.

"Activities" are production activities taking place in Andalusia. An activity could be associated with multiple outputs, whereas one product may be realized by several activities. There are 84 activities in the SAM.

"Primary Factors" refer non-produced production factors: employees, service and shop workers, agriculture and unskilled workers, technicians, land, managers, physical capital and infrastructure, natural resources.

There are two categories of "Households": residents and non-residents (mainly tourists). "Public sector" accounts for all public administrations, state or local. There is a special account for "Savings and Investments", to consider the purchases of goods and services for investment purposes, and how they are funded.

Finally, "Rest of Spain" and "Rest of World" are specific accounts associated with Andalusian external trade, transfers, and payments to non-Andalusian factors.

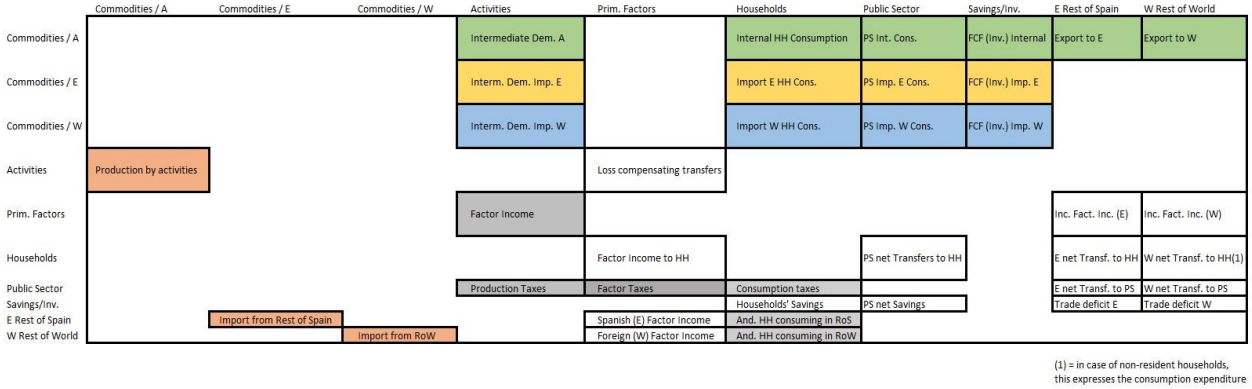

Figure 1. Structure of the 2016 Andalusian SAM

Figure 1 displays the structure of the SAM, which is a sparse matrix, where some non-empty blocks or sub-matrices can be identified. In Figure 1, the colored cells correspond to data obtained directly *or indirectly* from the 2016 input-output table of Andalusia (IECA, 2020). White cells correspond to data which we estimated, using additional information sources, as it will be better explained in the following section.

We now proceed to presenting the various blocks in the SAM, from left to right and from top to bottom.

In the "Production by activities" block, we identify which activities are producing which goods in Andalusia.

The row vectors of imports from Rest of Spain and from Rest of World provide total values of imported goods and services in Andalusia.

"Intermediate demand" blocks, distinguished by market source (A, E, W) and commodity, inform about the supply of intermediate production factors employed by Andalusian activities.

Households, both residents and non-residents, as owners of primary factors receive income flows from the various activities, as shown in the "Factor Income" block. However, income is first assigned to primary factors, and then transferred to households, depending on their ownership shares.

The various activities also pay some taxes directly, mainly related to output levels, and those are accounted for in the "Production Taxes" block.

The "loss compensating transfers" sub-matrix is introduced to correct for the possible existence of negative components of value added in some production activities. This could happen if, in the year 2016, some activities recorded losses, appearing as negative entries in the input-output table. This fact may complicate the employment of the SAM for many economic models, where it could be assumed that competitive markets bring the compensation of each factor equal or close to its marginal productivity. A negative entry would then imply negative marginal productivity (you would produce less by using more of a factor, which is not a plausible assumption). To fix this, we estimated the industrial value added independently from data in the input-output table (only for the sectors with negative numbers), introducing in the "loss compensating transfers" block the sum of the newly estimated value added and the loss (with reverse, positive sign). This ensures the equality of totals by row and column. The interpretation is in terms of money paid (or rather not received) by households, which covers the losses in some sectors.

The matrix below ("Factor Income to HH") indicates the flow of money received by Andalusian households, because of their ownership of primary factors. There are also two other similar blocks ("Spanish/Foreign Factor Income"), referring to households in the Rest of Spain and in the Rest of World.

In the "Factor Taxes" block we can find the taxes paid on factor income to the public sector: taxes on the different types of labor, taxes on capital (profits), on land and on natural resources rents.

The "Households" columns illustrate the expenditure structure of residents and non-residents. Households spend money to buy goods and services produced in Andalusia ("Internal HH Consumption"), in the Rest of Spain ("Import E HH Cons.") and in the Rest of World ("Import W HH Cons."). Consumption of Andalusian products by non-Andalusian households, realized outside the region, is considered as export. Households pay consumption taxes ("Consumption taxes"), save ("Households' Savings")[3], and spend money when travelling outside the region ("And. HH consuming in RoS/RoW"). The latter does not apply to non-resident households.

Similarly, the public sector generates a demand for commodities needed to provide public goods and services ("PS Int./Imp. E/W Cons."). It also makes transfers to households ("PS net Transfers to HH"), and savings ("PS net Savings") if in the base year 2016 it was running a primary public surplus. Conversely, in case of primary deficit (not accounting for interest payments on accumulated debt) it would absorb savings, so that the entry would be negative, which does not pose any conceptual problem in terms of modelling.

Rest of Spain and Rest of World appear in the rightmost columns of the SAM as entities generating exports ("Export to E/W"), no matter whether their demand is final or intermediate, paying for Andalusian resources ("Inc. Fact. Inc. (E/W)"), assigning transfers to regional households ("E/W net Transf. to HH") or the public sector ("E/W net Transf. to PS"), for example when the central Spanish government give funds to the Andalusian government.

The difference between income received by the external entities RoS and RoW, and their expenses directed to Andalusia ("Trade deficit E/W") can be interpreted as external or foreign savings. Alternatively, because of the accounting identity between net internal savings and the trade balance, the gap could be interpreted as trade deficit (if positive) or trade surplus (if negative).

3. The estimation process

In this section we will briefly explain how some data, that could not be deducted from the 2016 input-output table (IECA, 2020), was estimated. The blocks in the SAM that were missing are the following: factor income to households, foreign factor income, households' savings, public sector savings, public sector

[3] Savings may include purchases of some durable goods and investments.

transfers to households, the trade balance and other transfers from Spain and the rest of the world to Andalusia.

Fortunately, IECA and other institutes provide data on most of the topics related to the missing blocks. This complementary information needs, however, to be processed further to make it consistent with the rest of the SAM. For instance, row and column totals must be equal for each account, meaning that received income equals employed income (the balancing requirement). An especially useful source of information has been the Spanish SAM for the year 2000, created by Alvarez-Martinez and Polo (2014), which was regularly used as a benchmark. Another recent SAM for Spain is the one by Cansino et al. (2013). Although the absolute numbers in the SAM for Spain and the one for Andalusia will obviously differ, it is reasonable to assume that the underlying structure of the economy could be comparable.

Many of the entries in the SAM that could not be based on IECA's I-O table can be found in macroeconomic accounts of Andalusia, such as the government budget, trade data and savings and investment data. In this respect, the most important sources that were consulted are IECA, the Spanish Statistical Office (INE), the Consejería de Turismo y Deporte, Eurostat, the OECD and the Junta de Andalucía.

The 2016 report by the Andalusian Tourism and Sports ministry provides detailed data on consumption by tourists in 2016 (Consejería de Turismo y Deporte, 2016). In the SAM, transfers from the rest of Spain and the rest of the world to the non-resident account fundamentally represent spending by tourists in Andalusia. Consequently, the 2016 statistical report on tourism in Andalusia can provide the key information in terms of the total expenditure by Spanish (non-Andalusian) and foreign tourists in Andalusia. Expenditure by Spanish tourists reached 4,388.72 million EUR in 2016 and that by foreign tourists was 8,213.04 million EUR (Consejería de Turismo y Deporte, 2016).

Transfers from the rest of Spain to residents in Andalusia encompass a wide range of items. These include remittances to Andalusian households, profits made on intellectual property rights and others. Data encompassing all transfers from abroad is not available. Nonetheless, by imposing the balancing requirement between rows and columns, it is possible to infer the total transfers. We found net transfers from the rest of Spain to Andalusian households would amount to 23,277.16 million EUR, whereas net transfers from the rest of the world would amount to 16,783.91 million EUR.

The outgoing gross operating surplus and mixed income was estimated according to regional Eurostat data on household income (Eurostat, 2020b). Similar Eurostat data was not available for wages and salaries flowing out of Andalusia and consequently these values in the SAM are based on the relevant shares in Alvarez-Martinez and Polo, 2014. To gain insight into inward and outward flows of Foreign Direct Investment (FDI), we consulted UNCTAD data about Spain (UNCTAD 2020). Likewise, incoming factor income from Spain and the rest of the world is based on the corresponding shares in Alvarez-Martinez and Polo (2014).

The IECA input-output tables include taxes on factor income for wages and salaries, however, taxes on gross operating surplus and mixed income were missing. Therefore we consulted tax data by the Spanish Agencia Tributaria that indicated that the tax on these factors should be around 22% (Agencia Tributaria, 2017).

The budget for the Autonomous Community of Andalusia provided by the Andalusian government (Junta de Andalucía) can be used to extract data on public sector income and spending. On the income side, much of the income is generated through transfers from the rest of Spain and transfers from abroad. These figures enter the Andalusian budget as current transfers and capital transfers from the State or from the rest of the world. In total, transfers in 2016 from the rest of Spain to the public sector in Andalusia equalled 9,141.44 million EUR. The same calculation can be made for transfers from the ROW to the Andalusian

public sector. All transfers from abroad were coming from the European Union (EU). Current transfers and capital transfers from the EU to Andalusia totalled 3,160.46 million EUR (Junta de Andalucía, 2016).

Because of accounting identities, the trade surplus (deficit) of a region is balanced by a deficit (surplus) in the capital account. The Convivencia Civica Catalana published a report in 2016 on trade flows between Spanish autonomous communities (Convivencia Civica Catalana, 2016). According to this report, Andalusia had a trade surplus with other autonomous communities in 2016 of 8,084 million EUR.

Conversely, economic accounts of Andalusia indicate that, considering all trade flows, Andalusia had a trade deficit of 7,697.51 million EUR (Junta de Andalucía, 2019). Combining this information with the previous trade surplus, it can be inferred that Andalusia had a trade deficit with the rest of the world, excluding the rest of Spain, worth 15,781.51 million EUR.

The I-O table by IECA contains data on spending by Andalusian households in the rest of the world. There is, however, no distinction between tourism in the rest of the world and in the rest of Spain. To get the desired disaggregation, we employed INE figures, showing that in 2016 the total Spanish travel expenditure abroad was 13,233.73 million EUR (INE, 2019b). The Andalusian share of this expenditure was estimated on the basis of Andalusia's share of national GDP. The result, interpreted as transfers from Andalusian households to the rest of the world, amounts to 1,760.09 million EUR. Total national spending on tourism in the rest of Spain was 4,576.45 million EUR (INE, 2019b). Once again using share of GDP as a weight this results in transfers from households to the rest of Spain worth 608.67 million EUR.

Although exact data on Andalusian households' savings is not available for 2016, the OECD provides yearly country-level data on households' savings rates. Since the savings rate for Spain in 2016 was 3% of disposable household income, the same rate was applied to Andalusian savings (OECD, 2020). While balancing the SAM, the value for households' savings increased considerably. This aligns with the interpretation of the SAM, however, where expenses in some goods are interpreted as investments.

The budget for the Autonomous Community of Andalusia published by the Junta de Andalucía also contains data on the destination of government spending. The budget of expenses by economic classification indicates that in 2016 the government transfers to households equalled 10,066.69 million EUR (Junta de Andalusía, 2016).

3.1 Calibration of the SAM

Once the missing entries were estimated using the available data, there were a few entries that could not be derived from available data and some imbalances between the row and column totals for the following accounts: residents, non-residents, public sector, savings/investment, the rest of Spain and the rest of the world. The missing values were estimated using simple RAS biproportional adjustment (Fofana et al., 2005) based on the balancing requirement. RAS is an iterative algorithm of biproportional adjustment originating in the field of information theory that Theil (1967) adapted to input-output economics (McDougall, 1999). This is a maximum likelihood estimator suitable for estimating missing values in a SAM, as well as for updating and calibrating a SAM or input-output tables (Schneider and Zenios, 1990).

Some of the values for expenditure in the accounts for the public sector, the rest of Spain and the rest of the world were not within the range that could be expected, for example in comparison with the national SAM. Consequently, accounts of residents, non-residents, the public sector and savings/investment were appropriately rescaled and rebalanced. Specifically, residents' savings, public sector savings and the trade deficit changed considerably during calibration. Nevertheless, the final values align with the interpretation of the SAM and respect the accounting identity.

3.2 Disaggregation of primary factors

The IECA input-output tables contain two accounts for primary factors. Primary factors are registered either as wages and salaries or as mixed income and gross operating surplus. After the estimation of missing values, as described in the previous section, primary factors in the SAM were further disaggregated into eight different accounts. This disaggregation is based on that of the Global Trade Analysis Project (GTAP) SAM for 2014 (Aguiar et al., 2019), which is consistent with the International Standard Classification of Occupations (ISCO-08 Structure) (ILO, 2008). The eight categories include: clerks, service and shop workers, agricultural and unskilled labour, technicians, land, officials and managers, capital and natural resources. Weights were assigned to the eight factors to determine the relative importance of the different primary factors for each productive industry. These weights for the new disaggregated factors were calculated per productive industry based on the data GTAP data for Spain (Aguiar et al., 2019).

Lastly, as there were some negative values in the factor income block, those have been adjusted to get positive values, while keeping the accounting balance through the "loss compensating transfers" sub-matrix.

4. Some key statistics

4.1 Household consumption

Household data in the SAM differentiates between consumption by Andalusian households and tourists (non-resident). It would be interesting to analyse whether, how and how much the consumption structure of the two groups differs (Figure 2). Both Andalusian and foreign households spend slightly more than 50% of their total consumption on the same three services industries: retail, food services and real estate. The biggest spending sector for tourists is food services. In 2016 tourists coming from outside Andalusia spent 3.71 billion EUR on consumption in this sector, which amounted to over 33% of their total consumption in Andalusia. Real estate services and retail respectively made up 13% and 6% of tourists' consumption. The relative importance of these three sectors looks different for Andalusian resident households. They spent more than 17 billion EUR on real estate services in 2016, which accounts for 25% of total household consumption. Andalusian households additionally spent around 10 billion EUR on retail and food services, meaning that each of these two sectors make up about 15% of total consumption.

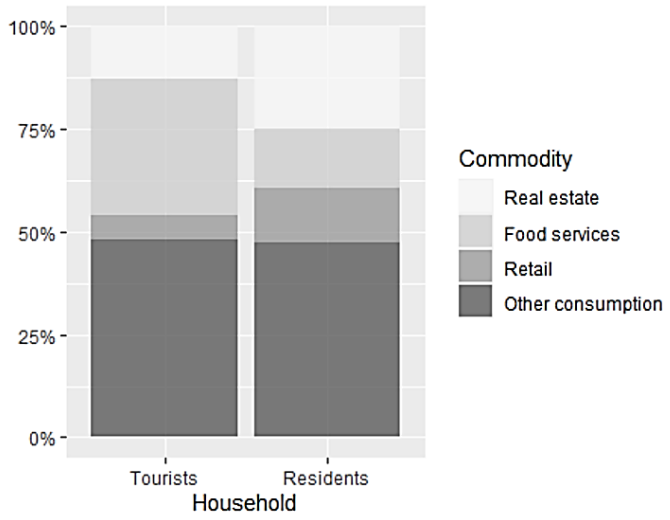

Figure 2. Structure of tourist and resident consumption

Besides food services, retail and real estate, tourists spent considerable amounts on transportation, accommodation and recreation. Considering only the latter three commodities, tourist consumption was about equal or even larger than resident consumption in absolute numbers.

Goods and services can either be produced locally or imported from the rest of Spain or the rest of the world, and the SAM allows viewing the origin of the consumed commodity, so that it is possible to know how much tourists spent on locally produced, non-imported commodities. In 2016, tourists and resident households respectively spent 645 million EUR and 716 million EUR on recreation. Tourist spending on accommodation was almost 10 times larger than spending by Andalusian households and totalled 2.31 billion EUR. However, Andalusian households spent more than tourists on land transportation: almost 1 billion EUR compared to 753 million EUR.

4.2 Primary factors

The SAM contains information on the employment of eight primary factors in each activity.

Two primary factors are employed to only a handful of industries: land and natural resources. In line with the assumptions underlying the GTAP global SAM, in our dataset land is only utilised by industries that are involved in agricultural activities, whereas natural resources are only involved in extractive industries such as mining. The activities reliant on land are: production of fruits and vegetables, production of vine and olive crops, dairy production, production of textiles, other agricultural activities, livestock and hunting, forestry. The value added share of each primary factor for these eight activities is detailed in Table 1. Land is relatively more important for the production of crops, livestock and hunting. For the textiles industry, land is only needed for the production of wool, making up only 5% of costs. Six out of the seven sectors are relatively capital intensive, the only exception being forestry.

Primary Factor	*Fruits & Vegetables*	*Vine & Olive Crops*	*Dairy Production*	*Textiles*	*Other Agricultural Production*	*Livestock & Hunting*	*Forestry*
Agricultural & Low-Skilled Labour	0,17	0,23	0,33	0,21	0,07	0,08	0,84
Capital	0,44	0,41	0,39	0,49	0,53	0,56	0,07
Clerks	0,00	0,00	0,03	0,03	0,00	0,00	0,02
Land	**0,24**	**0,22**	**0,08**	**0,05**	**0,26**	**0,24**	**0,01**
Managers & Professionals	0,13	0,12	0,08	0,12	0,12	0,12	0,00
Service & Shop Workers	0,00	0,01	0,01	0,01	0,00	0,00	0,02
Technicians	0,01	0,01	0,08	0,09	0,01	0,00	0,04

Table 1. Primary factors as shares of total production cost for selected industries

There are other sectors that are even more reliant on capital. Some of the most capital intensive industries are rental activities, real estate and postal services. The SAM clearly illustrates the dependence of energy producing sectors on capital. Capital makes up over 80% of costs for the production, transport and distribution of electric energy. The same holds for the supply of gas, steam and air conditioning.

While forestry is not very reliant on capital, it does rely heavily on agricultural and low-skilled labour for production. Other sectors that are strongly dependent on low-skilled labour are sports activities for recreational and entertainment purposes and the repair and installation of machinery and equipment. For these sectors, low-skilled labour makes up between 70% and 87% of total production costs.

Activities related to research and development require the use of significant amounts of high-skilled labour. Other sectors that are highly dependent on high-skilled labour are administrative office activities and health and veterinary services. For these industries, high-skilled labour makes up between 50% to 65% of total expenditure on primary factors.

4.3 Output multipliers

Output multipliers are indicators that can be derived from a social accounting matrix and are frequently used in input-output based impact analysis. An industry output multiplier is the total value that would be generated across the regional economy (under the assumptions of Leontief's model), when one product unit in the subject industry is made available for consumption in final demand (Miller and Blair, 2009). These multipliers can be derived from the SAM, by calculating the Leontief inverse of the (derivable) square industry-by-industry matrix, as the output multipliers are the column-wide sums of elements in the inverse matrix.

We found that industries with the largest output multipliers are the production of IT, electronic and optical equipment, the production of electrical equipment, the production of motor vehicles and other transport material and the manufacture of fats and oils. All these industries have output multipliers ranging between 3.3 and 3.5, meaning that an increase of 1 unit in final demand will stimulate increases in gross output more than three times larger. This is because these industries are highly connected and dependent from

intermediate factors produced by other (Andalusian) sectors. Consequently, stimulating demand (private or public consumption, investment, exports) in these industries would maximise the Keynesian expansionary effect for the regional economy.

4.4 Andalusian exports

Andalusian exports refer to two different destinations: the rest of Spain and the rest of the world. Since export data is available for all the goods and services, one can easily observe what Andalusia's most valuable export sectors are.

Indeed, there are seven sectors that stand out because of their high export values. Most noticeable among these sectors is the export of petroleum and chemicals, for which exports totalled around 10 billion EUR in 2016. More than half of these exports were destined to the rest of Spain. For other important export sectors, there generally are more exports that end up abroad than in the rest of Spain. This is the case for fruits and vegetables, where in 2016 exports were worth more than 5 billion EUR and more than 85% of this value is obtained from exports to the rest of the world. Other export sectors with values exceeding 1.5 billion EUR are fats and oils, iron and steel, wholesale trade services, certain types of transport material and services for terrestrial and pipeline transportation.

Which export sectors in Andalusia are most reliant on foreign inputs, so that they could be considered part of global value chains? As can be seen in Figure 3, four sectors stand out in this respect. For the production of petroleum and chemical products more than 75% of intermediate factors were sourced from outside Andalusia, with more than 60% imported from abroad. Similar characteristics emerge for the production of electric machinery and equipment, for certain types of transport material and computer, and for electrical and optical products.

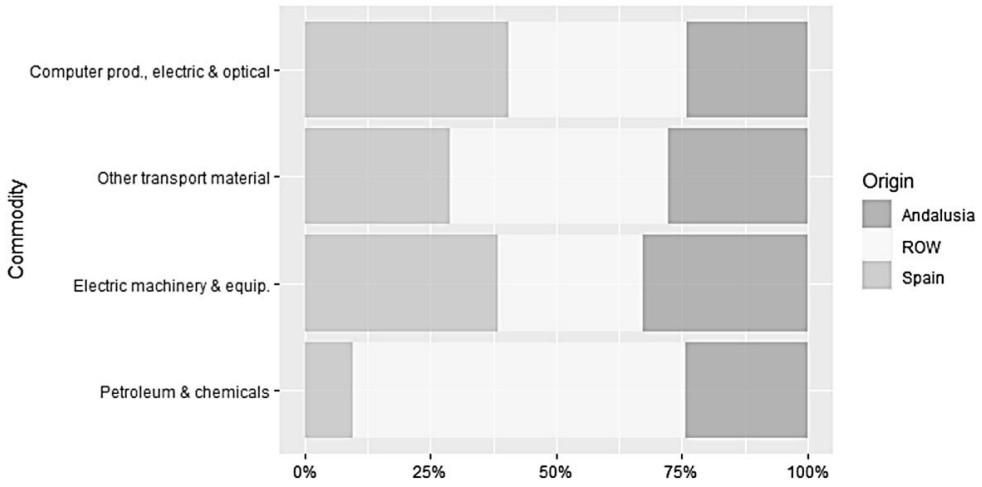

Figure 3. Structure of intermediate demand in some selected sectors

5. Concluding remarks

The availability of a social accounting matrix with the level of detail illustrated in this paper paves the way for the realization of several analyses of the Andalusian economy. Most parameters of computable general equilibrium models, for instance, could be calibrated on the basis of values in the matrix. In this way, CGE or input-output models can take into account the market interdependences which exist among industries and sectors in Andalusia, making it possible to simulate the impact of economic policies or processes of structural change.

When matrix flows are interpreted as links in a network, network analysis can shed light on several important characteristics of the Andalusian economy and its "nodes", like properties driving the spread of contagion in the presence of real or financial shocks.

Furthermore, in this paper we have shown that even a simple reading of the data in the SAM can highlight some peculiar characteristics of the Andalusian economy: the structure of consumption of tourists (non-residents) vs. that of residents; the reliance of agriculture on land resources; the export orientation of industries like "fruits and vegetables"; the belonging of "petroleum and chemical products" to global value chains;...

Getting the SAM data

The SAM database is freely available from the authors upon request. Data is currently available in three formats: as Excel spreadsheet (XLSX); as GAMS Data Exchange File (GDX); as GEMPACK Header Array File (HAR).

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