PAPER

Title: Income distribution and inequality in multisectoral input-output models: the case of Spain, 1980-2014.

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Abstract: The main objective of this paper is to analyze if inequality has increased from 1980, for which we will use the input-output framework. To this end, we particularize the analysis to the case of Spain, as a representative case of what might have happened in the developed world, especially in Europe. For this purpose, we construct an input-output table series for 1980-2014, incorporating heterogeneous labor (by gender, age, and skills) and, where final demand, specifically the households' consumption, is disaggregated by types of consumers; the analysis with both disaggregations represents one of the contributions of the paper. In addition, Gini and Sen indexes are calculated using data from the tables. We also include a prices model that allows us to estimate uniform profit rates and labor and capital shares from the input-output tables. According to Gini indexes, inequality by age and levels of skills have increased, while it decreased by gender. Sen indexes also show a general increase in global inequality. Our results also suggest decreases in the labor shares and increases in capital profits shares during this period, which might be another source of inequality. The differences in the consumption patterns by income quintiles have also been aggravated, especially during 1996-2008.

Keywords: Income distribution, inequality, input-output, prices model.
JEL codes: D33, E02, E1

1. Introduction.

Since the very inception of Economics as a science, as Ricardo posited in the Preface of his *Principles* (1817), 'to determine the laws which regulate [income] distribution is the principal problem in Political Economy'. Economists usually pay attention to the countries' growth processes to enquire the causes according to which some grow more than others. Undoubtedly, this may require understanding the mechanisms that explain how income is distributed between the different economic agents in a determined society. This is not a straightforward task, as the process of income distribution is embedded in a given institutional framework and is certainly linked to the technological arrangements that are present in an economy.

Inequality within countries has been globally increasing since the 1980s, in contraposition with what happened during previous decades, namely, 1930-1980 (Piketty, 2020). Thus, the study of the income distribution mechanisms that have resulted in these trends during the past few decades could be useful for both reaching a better understanding of economic growth and facing the challenge of reducing inequality. This could also be linked to recent lines of research that focus on studying if the impact of the recent COVID-19 crisis has brought about a reversion of these increasing trends (Deaton, 2021). Other recent studies have focused on low wages as a source of inequality (Francese & Mulas-Granados, 2015; Karabarbounis & Neiman, 2014). Furthermore, inequality can also be approached from the perspective of consumption (Attanasio & Pistaferri, 2016; Meyer & Sullivan, 2013). The phenomenon of globalization and its links with increasing inequality has also been studied in recent literature (Lee, 2006; Munir & Bukhari, 2020; Zhou et al., 2011). In this paper, we will perform some income distribution analyses during the period 1980-2014, using Spain as a representative case of what might have happened in the developed world, especially in Europe.

Although the debate on inequality and income distribution has recently revived, it is certainly not a new topic. Looking back at the 'Cambridge controversies' (Harcourt, 1969), there has traditionally been two main visions concerning income distribution. On the one hand, the American Cambridge economists (Samuelson, 1962; Solow, 1955) defended that income distribution was strictly a matter of technical relations, and that factor compensations are independent from each other and strictly determined by their marginal productivities. On the other hand, the British Cambridge economists (Kaldor, 1960; Robinson, 1969; Sraffa, 1960) considered that income distribution not only depends on technology, but it is also embedded in a determined institutional framework,

leaving space for explanations of distribution as a conflictive process between agents with different interests. We believe that income distribution studies could certainly be more explanatory if the latter guidelines were followed.

In this context, the main aim of this paper is to check if inequality has increased since 1980. For achieving it, we suggest that the input-output framework might be an interesting tool. Input-output models can provide a useful framework for our vision and offer clear potentialities for income distribution research, as these can successfully integrate technical and institutional dimensions, at a sectoral level of detail, and offer the possibility of capturing direct and indirect effects concerning the process of production. Thus, the input-output framework can be used to integrate several perspectives of inequality in our analysis, such as wages, labor, and consumption.

Traditionally, income distribution research in input-output models has been based on multiplier analyses (Miyazawa, 1976) or in the construction of Social Accounting Matrices (Meade & Stone, 1941; Pyatt & Round, 1985). More recently, few studies on the input-output framework have recently paid attention to income distribution (Kim et al., 2016; Pyatt, 2001; Steenge et al., 2020; Steenge & Serrano, 2012). This work opens a novel line for studying income distribution in the input-output framework, focusing especially on labor heterogeneity (by levels of skills, age, or gender) and on differences in wages and consumption patterns. Our empirical analyses will also incorporate indicators of inequality, following the line of Gini and Sen indexes. Furthermore, we will empirically test the recent trends of the labor and capital shares of value added and the inverse relationship between them.

We will use the standard Leontief (1936, 1941) model as a starting point, using a series of Spanish tables from 1980 to 2014. We will also acknowledge the influence of posterior multisectoral models, in which the concepts of 'reproduction', 'surplus', and 'distribution' play an important role, namely those of Kurz & Salvadori (1995), Pasinetti (1977, 1981, 1993), and Sraffa (1960), which are key guidelines for discussing the conflict between labor retributions and capital profits from a theoretical point of view. Then, we will add some extensions to the standard Leontief tables, as heterogeneous labor, different consumption patterns, capital stocks and amortizations, and investment flow matrices, that will be used to prove the increasing inequality trends in the period 1980-2014, from the factorial perspective of the primary distribution of income.

Our income distribution analyses are going to follow these guidelines. First, a general overview of growth and income distribution trends will be presented, analyzing

the primary distribution of income, looking at total and sectoral factor shares of income, for which we use our constructed input-output tables, specifically disaggregated to this end. Then, will deal with intra-factor distribution, focusing on labor inequalities by gender, age, and skills, according to Gini index.

Second, and also resulting from our disaggregated tables, we will study how the previously studied inequalities crystalize in different consumption patterns, which are undoubtedly a result of the income distribution mechanisms. Here, we will also present the evolution of mean expenditures per capita by income quintiles, and we will analyze the different consumption patterns that are associated to each level of income. One of our main contributions to the 'British Cambridge' vision is that consumption patterns are important determinants of inequality.

Finally, to confirm if inequality has increased during our period, we will also use two types of global indicators: first, we will construct a Sen index that will provide an institutional vision of inequality; second, we will estimate labor shares, and capital surplus shares after amortizations and investments, which will give us a clear picture of the potential conflict between labor and capital.

Thus, this article will be structured as follows: in Section 2, data and methodology are explained. In Section 3, results obtained from our constructed and disaggregated tables are shown: Gini indexes will be calculated to study inequality from the perspectives of labor and consumption. In Section 4 we will jump to a global perspective of distribution, checking first the evolution of inequality in the Spanish economy through Sen indexes, and then moving on to the estimation of factor income shares. Finally, in Section 5, some conclusions will be drawn.

2. Data and methodology.

Our general framework of analysis is based on standard input-output tables, extended with disaggregated labor inputs and consumption patterns, and completed with amortizations, investment flows, and capital stock matrices. In this section, first, we will briefly explain the construction of the series of input-output tables from 1980 to 2014, as well as the process of the disaggregation of labor and households' consumption. Second, we will present two specific measures of inequality: Gini and Sen indexes. These will be constructed using data from the aforementioned disaggregated tables and will allow us to provide a better characterization of income distribution and the inequality present in the original tables. Finally, to obtain more robust results and to open future lines of research,

we construct a prices model associated to the tables. The prices equation will include capital amortizations, domestic investment flows, capital stocks, and a uniform rate of profits. These cost components of prices are not present in the original Leontief tables. Hence, we will be able to obtain new estimations of the labor shares of value added, the profits related to capital stocks, and the weight of amortizations and investment flows, which will be used to confirm the previous results, related to the increase of inequality.

2.1. Constructing annual Spanish input-output table for 1980-2014.

The original data used to construct the tables were extracted from EORA database (Lenzen et al., 2013), as it fully covers these years. Initially, we have the information in supply and use tables (SUTs), that we have to transform into input-output tables (IOTs). Supply tables show the commodities that each sector produces, as well as imports, and, in this case, follow the structure of a (119x76) commodity-by-industry matrix. Use tables show which sector or industry is consuming each commodity to be included in the production process, value added, and the components of final demand, presented here as a (119x76) commodity-by-industry matrix. Following Eurostat (2008) and Rueda-Cantuche et al. (2009), an industry-by-industry input-output table (where technological relations between industries are shown) is estimated, using Model D, which assumes a *fixed product sales structure*. We choose Model D because the symmetric input-output tables published by the Spanish Statistical Office (INE) for this period are also industry-by-industry tables. Furthermore, as we focus on the sectoral structure of the economy, this approach seems to be coherent.

Reading each row of the resulting tables, we can see the intra- and inter-sectoral transactions of intermediate inputs, final demand divided in six categories (Household final consumption, Non-profit institutions serving households consumption, Government final consumption, Gross fixed capital formation, Changes in inventories, Acquisitions less disposals of valuables, and Exports). If we read each column of the table, we can see the inputs needed by each industry (inputs from other industries), labour compensations, capital compensations, capital amortizations, and imports. For the sake of simplicity, we perform a sectoral aggregation, reducing the original 76 industries to 8 sectors. This sectoral aggregation is assigned following a technological classification, under the criteria established by the OECD (2017).

Once we have these standard tables constructed, following the objective of this paper, we proceed to disaggregate Labor costs and Households' consumption.

To disaggregate Labor costs, some auxiliary data, which are not directly contained in the tables, are extracted from EUKLEMS database (van Ark & Jäger, 2017). These data are specifically related to labor compensation, shares of total labor compensation and of total hours worked by category of labor and number of workers. This allows us to disaggregate labor compensations by different categorizations. We obtain labor cost for three categories of labor in the case of skills: High-skilled, Medium-skilled, and Low-skilled workers; three categories in the case of age: 15-29 years, 30-49 years, and older than 50; and finally, for two groups in the case of gender: male and female. Hence, we obtain three complementary tables with disaggregated labor compensations, besides the basic aggregated tables, for each year.

Concerning consumption patterns data, we used the Spanish 1980-2005 annual Household Budget Surveys, and the continuous 2006-2014 Surveys (Spanish Statistical Office [INE], 2021). First, we retrieve from these surveys the different consumption patterns (the sectoral proportions of total consumption) associated to the different categories of labor. Then, we proportionally allocate total households' consumption to the weight of each labor category's compensation. Finally, a table-balancing GRAS algorithm (Junius & Oosterhaven, 2003; Lenzen et al., 2007) is applied and the resulting table yields the desired estimation, namely, households' consumption disaggregated for each labor category.

See Table 1 below for a simplified structure of the resulting symmetric input-output tables.

Table 1: Structure of the disaggregated symmetric input-output tables.

<table>
<tr><td colspan="2" rowspan="2"></td><td colspan="3">Sectors</td><td colspan="6">Final demand</td></tr>
<tr><td>Sector 1</td><td>….</td><td>Sector n</td><td>Type 1 households' consumption</td><td>…</td><td>Type r households' consumption</td><td>Gross capital formation</td><td>Government consumption</td><td>Gross exports</td></tr>
<tr><td rowspan="3">Sectors</td><td>Sector 1</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>…….</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Sector n</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="5">Value added</td><td rowspan="3">Workers</td><td colspan="3">Type 1 employees' wages</td><td colspan="6" rowspan="5">Gross Domestic Product</td></tr>
<tr><td colspan="3">……</td></tr>
<tr><td colspan="3">Type m employees' wages</td></tr>
<tr><td>Capital proprietors</td><td colspan="3">Profits</td></tr>
<tr><td>Government</td><td colspan="3">Taxes</td></tr>
<tr><td colspan="2"></td><td colspan="3">Self-employed workers' compensations</td></tr>
<tr><td colspan="2"></td><td colspan="3">Fixed capital amortizations</td></tr>
</table>

Foreign sector		Imports	

Source: own work.

2.2. Specific measures of inequality: Gini and Sen indexes.

To analyse and measure inequality, we calculate two types of indexes using the data from our input-output tables: Gini and Sen indexes.

The Gini (1921) index is a traditional unidimensional measure of inequality. It is going to be used to measure inequality within three categories of heterogeneous labor: gender, age, and skills. For our estimations, we use a standard formulation, following a similar procedure to that in Alonso-Villar & del Río (2010):

$$G = \left| 1 - \sum_{k=0}^{k=n-1} \left(X_{k+1} - X_k \right) \left(Y_{k+1} + Y_k \right) \right| \quad (1)$$

where Y_k represents the accumulated proportion of income (wages) up to labor category k, while X_k stands for the accumulated proportion of population (workers) up to labor category k. Note that we only have three categories of labor in the case of skills (High-skilled, Medium-skilled, and Low-skilled), other three in the case of age (15-29 years, 30-49 years, and older than 50) and two in the case of gender (male and female). That is, our Lorentz curves will have four points in the cases of skills and age, and three points in the analysis of gender.

We now move on to explaining the Sen index obtained from our I-O tables, which will be used as a global measure of inequality (in contraposition to the Gini indexes, which are intra-labor inequality measures). We have decided to construct a global inequality index inspired in Sen (1976) and later extensions (Foster et al., 1984), because we think that it can be easily adapted to the input-output datasets that we are using. Note that here the data concerning wages per worker is disaggregated both by sectors and levels of skills. Our inequality index, for which we follow the formulation in Sen (1976), can be described by equation (2):

$$S = H * (I + (1 - I) * G) \quad (2)$$

where H represents the proportion of workers receiving income under a certain threshold, to account for workers receiving low wages. We set this threshold in value added per capita, and we multiply it by 2 to discount the effect of the Spanish active population representing less than a 50% of the total. Thus, we interpret H as the level under which

labor payments could be considered to be unfair. *I* measures the gap existing between wages per worker and value added per capita, a higher gap meaning higher disparities from the average contribution to value added of each worker. And *G* is simply a global Gini index obtained from the World Income Inequality Database (UNU-WIDER, 2021). The range of values for this index goes from 0 to 1, being the former a situation of total equality, and the latter representing maximum inequality.

2.3. Prices models, capital profits and uniform profit rates

The traditional demand-driven Leontief model does not explicitly consider profit rates because neither capital stocks nor the sectoral destination of capital goods are explicit. However, these rates and capital flows are important elements of income distribution, as it was made clear by Sraffa (1960), Pasinetti (1977) and other researchers that have focused on multisectoral models. Furthermore, these models usually consider variations in prices, in contrast with the input-output framework, in which prices are unitary. Variations in prices are important because these affect both capital valuations and the uniform rate of profits. To consider these movements in prices, we include a system of prices for each one of our tables, as well as estimations of the rates of profits and of capital surpluses.

In the multisectoral models literature, as in Morishima (1973), we find price equations as the following:

$$\mathbf{p}_t' = (1 + r_t)\,\mathbf{p}_t'\,\mathbf{A}_t + w_t\,\mathbf{l}' \Leftrightarrow\ \mathbf{p}_t' = w_t\,\mathbf{l}'(\mathbf{I} - (1 + r_t)\mathbf{A}_t)^{-1} \qquad (3)$$

where r_t would be the uniform rate of profits and w_t is a uniform wage rate. Nonetheless, this equation is excessively schematic, as it does not include significant aspects as labor and wage heterogeneity, capital stocks, amortizations, investments, and capital stock retributions. If we are seeking estimated r_t to be taken as acceptable proxies of the real capital profits of an economy, we must incorporate these cost components to the price equation. Let us see its different components.

First, the contribution of the cost of intermediate inputs to the price vector $\mathbf{p}_t$, is given by $\mathbf{p}_t^{'}\,\mathbf{A}_t$. To incorporate labor costs and labor heterogeneity here, if $\mathbf{s}_i{}' = \left(s_{i,j}\right)$ are the retributions to type i labor in sector j ($i = 1,...,m$), and $\mathbf{c}_i$ are the final unitary

consumption patterns of type *i* workers, we may assume that the contribution of labor costs to the prices vector $\mathbf{p}_t$ will be: $\mathbf{p}_t^{'}\left(\sum_{i=1}^{m}\mathbf{c}_i\,\mathbf{s}_i\,'\right)$.

To include capital amortization costs, we will use the amortization coefficients vector $\mathbf{m}_t$, obtained from the tables, and the sectoral capital stock coefficients matrix $\mathbf{K}_t=\left(k_{i,j}\right)$; with $k_{i,j}$ being the capital stock of good *i* that is necessary for producing a unit of good *j*. The latter is obtained from EUKLEMS data, which offers information about Nominal Capital Stocks by 10 types of assets. After classifying these assets as explained in Table 1 below, and aggregating industries into our sectoral classification, we obtain capital stock matrices for each year.

Table 1. Sectoral correspondence to EUKLEMS asset classification.

OECD sectoral classification	**EUKLEMS asset classification**
1. Primary Sector (PS)	Cultivated assets.
2. Energy Sector (ES)	Other Intellectual Property assets (50%: mineral exploration).
3. High (HT) & 4. Medium-High (MHT) Technology Industry	Transport equipment, Computer hardware, and Telecommunications equipment.
5. Medium-Low (MLT) Technology Industry	Other machinery equipment and weapons.
6. Low (LT) Technology Industry	Other buildings and structures (50%).
7. Construction (C)	Dwellings, and Other building and structures (50%).
8. High Technology Services (HTS)	Computer software and databases, and Research and Development.
9. Rest of Services (RS)	Other Intellectual Property assets (50%: artistic originals).

After obtaining $\mathbf{K}_t$,[1] the contribution of amortizations costs to prices is given by $\mathbf{p}_t^{'}\mathbf{K}_t\hat{\mathbf{m}}_t$. On the other hand, $\mathbf{K}_t$ allows us to know the retributions to capital stocks, once we assume that the rate of profit is uniform and equal to r_t, and those will be $r_t\mathbf{p}_t^{'}\mathbf{K}_t$.

Finally, to include the annual cost of domestic investment flows, we use the gross capital formation vector $\mathbf{f}_{k,t}$, which can be found in the final demand part of the tables. This demand represents the domestic investment flows that will be annually incorporated into the capital stock. To distribute this demand vector over our 8 sectors, we will define matrix $\mathbf{T}_t$, obtained using a similar procedure to that in Södersten & Lenzen (2020) for

[1] We can now check if our estimations can be taken as valid. Summing in columns, we obtain sectoral capital stocks, and the sum of these elements would obviously yield the total capital stock. In real economies, the value of this total stocks usually oscillates between 1.5 and 4 times total value added (Kuznets, 1961). According to our yearly estimations, our total ratios are between 2.69 and 3.46, which would be acceptable values.

the inclusion of capital flow matrices not distinguishing between capital goods and other types of goods. We adapt this method to our symmetric input-output tables. In analogy to how we constructed the capital stock matrices, we use the EUKLEMS Capital Input Data (van Ark & Jäger, 2017), which contains sectoral Nominal Gross Fixed Capital Formation for 10 different assets, and we construct a matrix $\mathbf{T}_t$ according to the asset-sector correspondence explained in Table 1 above. The contribution of this component to the prices vector is $\mathbf{p}_t^{'}\hat{\mathbf{f}}_{k,t}\mathbf{T}_t\frac{\Delta y}{\Delta x}$, as we assume that this capital is automatically invested and destined to growth purposes (in the same year in which is generated, so we do not introduce it using a one-period lag). Furthermore, this new capital is associated to a unitary retribution r_t, which is also received the same year in which the investment takes place.

In short, the prices equation we suggest is the following:

$$\begin{aligned}&\mathbf{p}_t^{'}=\mathbf{p}_t^{'}\mathbf{A}_t+\mathbf{p}_t^{'}\left(\sum_{i=1}^{m}\mathbf{c}_i\,\mathbf{s}_i^{'}\right)+\mathbf{p}_t^{'}\mathbf{K}_t\,\hat{\mathbf{m}}_t+r_t\,\mathbf{p}_t^{'}\mathbf{K}_t+\mathbf{p}_t^{'}\hat{\mathbf{f}}_{k,t}\,\mathbf{T}_t\\&\Leftrightarrow\mathbf{p}_t^{'}=\mathbf{p}_t^{'}\left(\mathbf{A}_t+\left(\sum_{i=1}^{m}\mathbf{c}_i\,\mathbf{s}_i^{'}\right)+\mathbf{K}_t\,\hat{\mathbf{m}}_t+r_t\,\mathbf{K}+\hat{\mathbf{f}}_{k,t}\,\mathbf{T}_t\right)=\mathbf{p}_t^{'}\mathbf{M}\end{aligned}\qquad(4)$$

Equation (4) will then be used to obtain r_t, when the Frobenius root is equal to unity (note that the prices vector is the left-hand Perron-Frobenius eigenvector of **M**). According to equation (4), the capital stock receives a retribution equal to $r_t\,\mathbf{p}_t^{'}\mathbf{K}_t$, while labor compensation is given by $\mathbf{p}_t^{'}\left(\sum_{i=1}^{m}\mathbf{c}_i\,\mathbf{s}_i^{'}\right)$.

3. Results: has inequality increased?

In this section, we are going to study inequality using the information from our disaggregated tables. First, we will focus on inequality within labor, taking the disaggregation made in final demand into account, seeing three different categorizations: gender, age, and skills. Then, we will move on to the analysis of consumption patterns by levels of income.

3.1. Gini indexes for heterogeneous categories of labor.

We will now focus on how labor compensation has evolved by different categories of labor: gender, age, and skills. Here, we will construct Gini indexes using data of shares

of total compensation and of total hours worked held by each category of labor. These data, which is further aggregated into 8 sectors, can be found in EUKLEMS database (van Ark & Jäger, 2017).

First, Figure 1 shows the results for the categorization of labor by gender. There seems to be slight increases in inequality until around 1990. Then, the index stabilizes and remains constant or slightly decreases up until 2006. Finally, around 2008 there seems to be a structural break, and the indexes show sharper decreases in inequality. Thus, it could be implied that the 2008 crisis contributed to reduce disparities by gender. In addition, these were key years for the vindication of equal rights for men and women (it should be recalled that the 'Me too' movement was created in 2006). Looking at the average, labor inequality by gender was lower in 2014 than in 1980, or in other words, there has been a convergence in compensation per hour by gender during this period. We may still be far from labor equality by gender, but there is no denying that serious advances have taken place in life conditions for women along this period. At sectoral levels, inequality is higher in the two services sectors (two sectors with a high presence of female workers), and Low Technology industries. Furthermore, the Primary sector also stands out for experiencing the highest decreases, which has been traditionally characterized by a low presence of female workers.

Figure 1. Labor Gini inequality index by gender, Spain, 1980-2014.

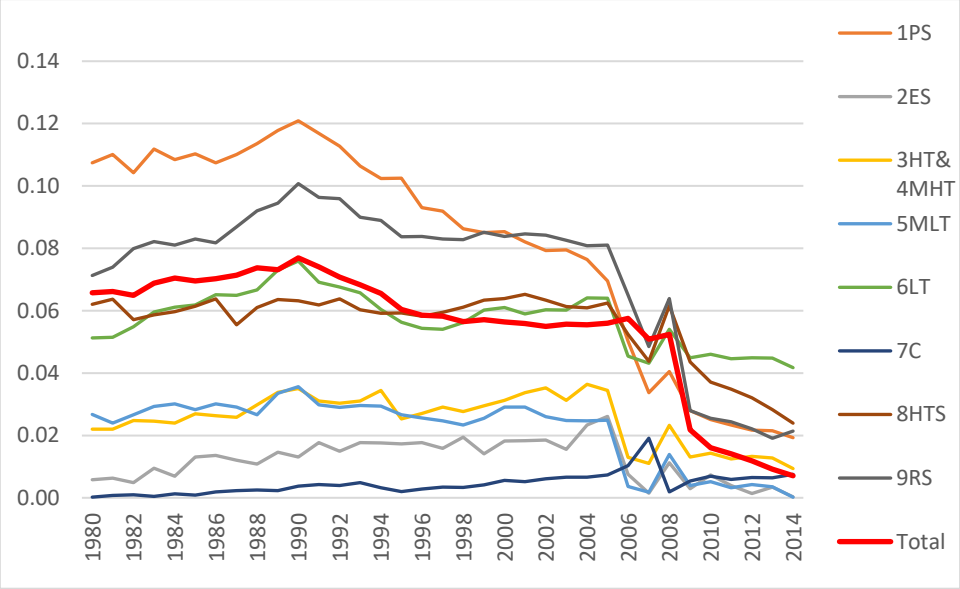
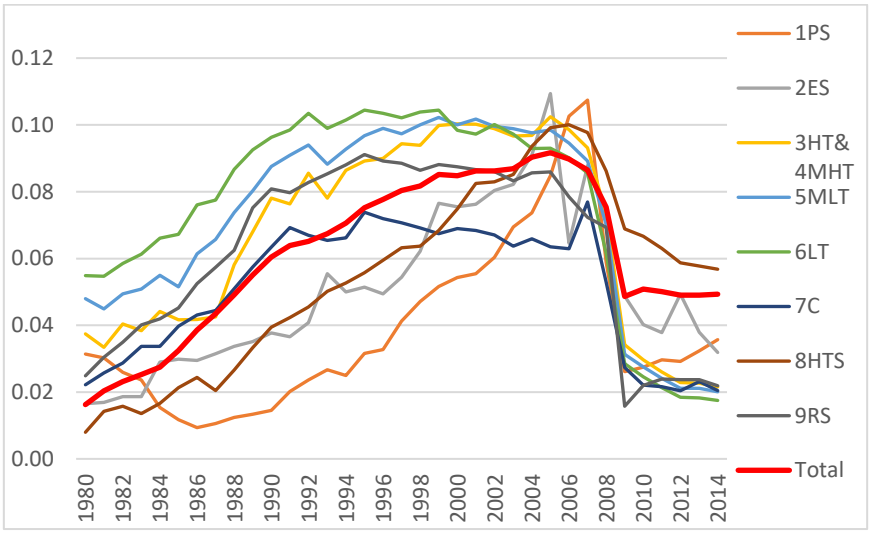


Figure 2 below shows the results for the calculated index by age cohorts (workers between 15 and 29 years, workers between 30 and 49 years, and workers older than 50 years old). In total, the inequality by age increased until around 2008, when it

experimented a sharp decrease, and then stabilized or even increased slightly. In total, labor compensations per hour worked by age cohorts were more polarized in 2014 than in 1980. The explanation behind these increases is that, although there might has been convergence between the medium and older cohorts, young workers have been left behind in this process. This is an especially worrying matter in Spain, where youth unemployment reached rates higher than 50% after 2008, and those who are working usually carry out precarious occupations. As in the previous case, the 2008 crisis also seems to have worked as a mechanism for sudden reductions of labor inequalities, probably related to the destruction of employments. At the sectoral level, inequality by age was usually higher in the three Industrial sectors and the Rest of Services. Meanwhile, it is lower in the Primary sector and Construction, where the distributions of wages and hours are alike. The case of High Technology Services must also be highlighted, as it evolved from a very reduced level of inequality in 1980 to being the only sector with higher inequality than the average. This is probably due to the structure of employment in this sector, with a relative low presence of old workers and low wages in most of the younger workers.

Figure 2. Labor inequality index by age, Spain, 1980-2014.

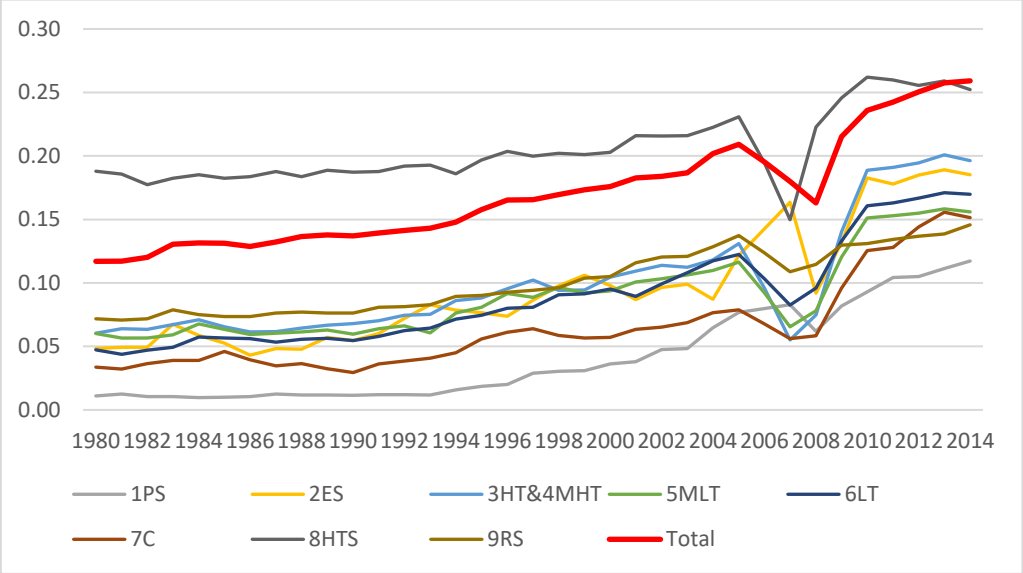


Source: own work.

Finally, Figure 3 shows the inequality index by three levels of skills (high-skilled, medium-skilled, and low-skilled). This index shows a clear increasing evolution during the entire period. It should be highlighted that a certain level of disparities might be socially acceptable under this categorization, once it is assumed that qualifications are working as a market signal for justifying higher compensations. Nonetheless, another bump can be perceived around 2008, in this case not permanent (it disappeared in 2010),

which confirms that the crisis might have worked as a mechanism for reducing inequality. However, the increasing trends were quickly resumed thereafter. In average, the index value was more than double in 2014 than in 1980. Furthermore, the only sector with higher values than the average is High Technology services, revealing a high demand of high qualification confronted to a low supply. Meanwhile, the Primary sector presents the lowest values.

Figure 3. Labor inequality index by skills, Spain, 1980-2014.



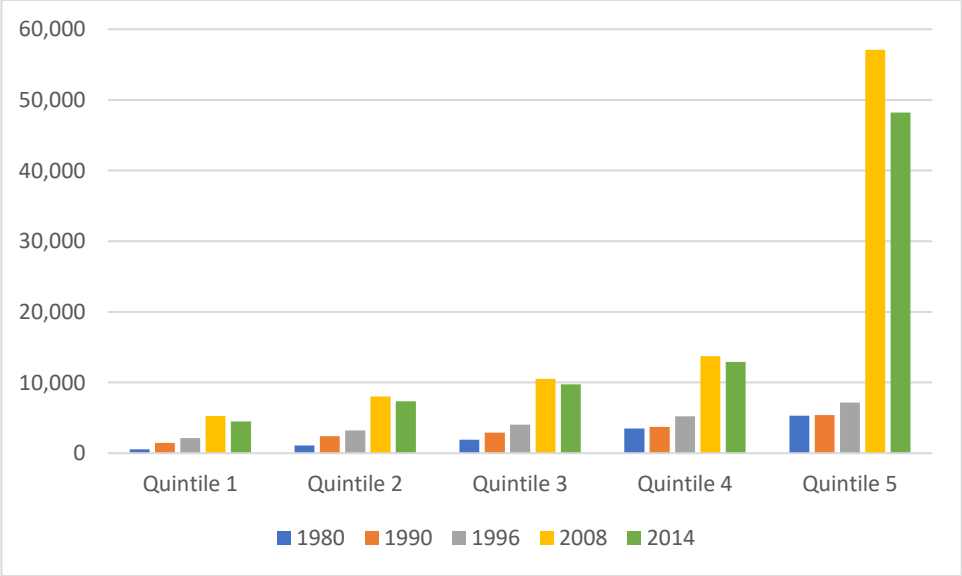
Source: own work.

3.2. Consumption patterns by income quintile.

The input-output tables constructed in this paper, which have a high level of detail, contain information about household's consumption patterns, which are associated to the different types of labor. These in turn are useful for inequality research, as consumers must adapt their consumption to their incomes, and basic needs are associated to lower elasticities of substitution. Thus, the study of consumption patterns can be of interest, and the disparities between different categories of consumers can depict situations of inequality. This will be related to the different character that is given to each of the goods (or industries) that we are considering. For example, goods produced by the Primary sector, the Energy sector, Construction, or Low Technology Industries can be given the character of goods purchased for covering basic needs. On the contrary, goods from High Technology Industries, or Services are often related to more leisure-oriented needs, and it could be assumed that a higher proportion of them would be acquired by high-income consumers.

As was explained earlier, households' consumption has been disaggregated for the three categorizations of labor. Now, we are focusing on a complementary disaggregation of the structures of consumption, by income quintiles, because it provides information that is more interesting for research on inequality. The process of disaggregation is the same as was explained in Section 2, and the consumption patterns data are also obtained from INE (2021). First, we can take a look at total average consumption per capita in Figure 4. Between 1980 and 1996, inequality in consumption was reduced: while total average consumption for the highest quintile was ten times higher than for the lowest quintile in 1980, it was less than 4 times higher in 1996. Then, a huge increase in inequality took place from 1996 to 2008. It can be seen how the highest disparities among quintiles appeared between the upper 20% incomes and the lower 80%. Namely, in 2008 the average expenditure in consumption per capita for the highest quintile was more than ten times higher than for the lowest quintile, and 4 times higher than for the fourth quintile. Furthermore, during these years, average consumption per capita doubled for the lower 80%, while it multiplied by 8 for the highest 20%. Thus, the highest increases in inequality concentrated during 1996-2008. Finally, the general decrease after the Great Recession must also be remarked.

Figure 4. Total annual average consumption per capita, Euros, Spain, 1980-2014.



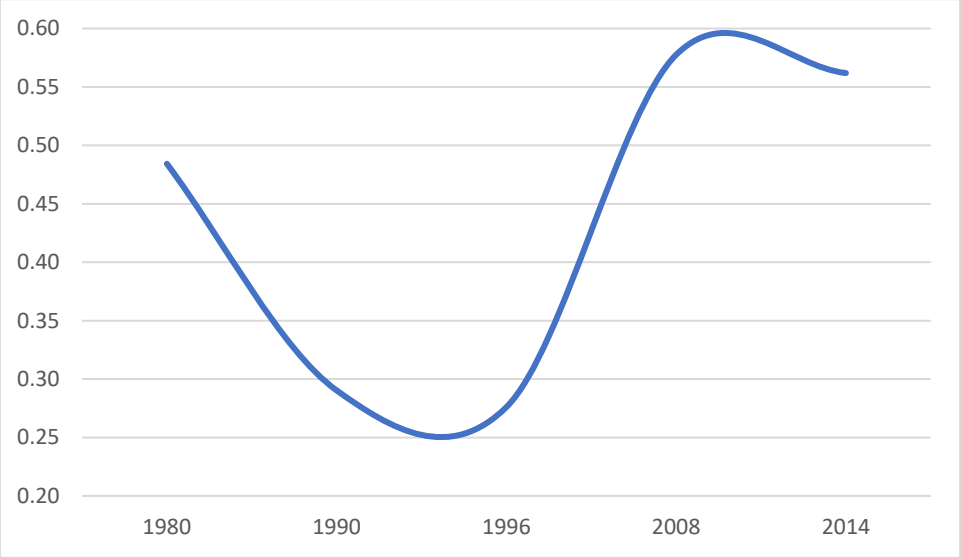
Source: own work with data from Spanish Household Budget Surveys (INE, 2021).

Now, we can move on to see how different resources crystalize in diverse consumption baskets, a fact that is related to the different income elasticities of each good. For achieving this, we should focus on the sectoral expenditures corresponding to each income leve. At the sectoral level, it can be seen how expenditures in the Primary and

Energy sectors, which can be related to more basic needs, keep similar proportions for all the quintiles. On the contrary, expenditures in the Rest of Services and Medium Technology Industry (namely, transport) are gradually more important as we move upwards the income structure. The latter can be considered as more leisure-oriented expenditures, and so proportions of income spent here are higher as income increases.

Finally, to complement this information, as we have consumption distributed by quintiles, we can construct a Gini index that reflects differences in total consumption. The methodology followed is the same used as in the case of the indexes calculated in Section 3.1. Results are presented in Figure 5 below. In total, disparities in consumption by income quintiles have increased from 1980 to 2014. However, different phases can be distinguished. From 1980 to 1990, a noticeable convergence in consumption was achieved. This continued for 1990-1996, but the process of convergence was slowed down. For 1996-2008, inequality in consumption increased sharply, doubling the value of the index. Finally, the Great Recession contributed to put the increases in inequality to a halt, even achieving a slight decrease.

Figure 5. Gini index for total average consumption per capita, Spain, 1980-2014.

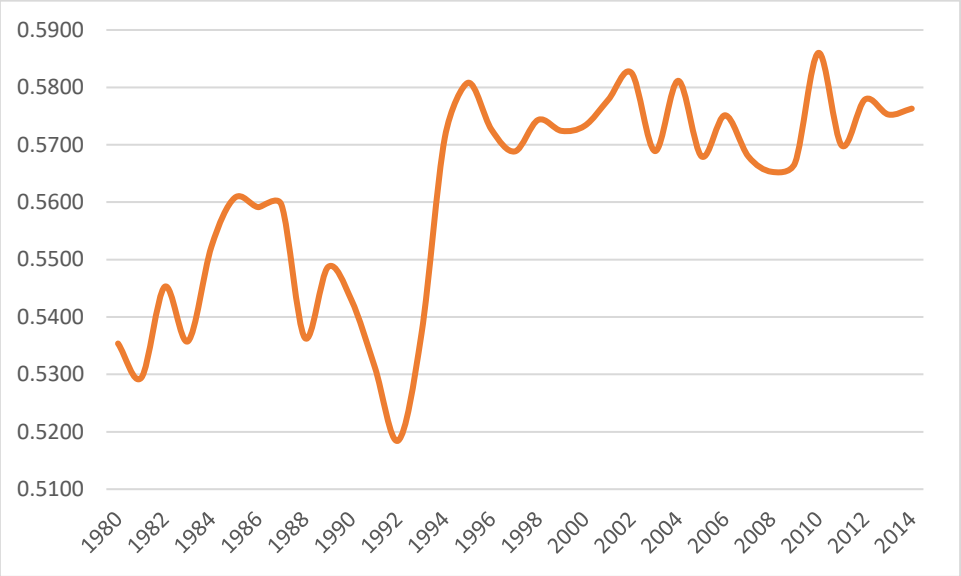


3.3. Sen index.

After introducing specific measures of inequality within labor, whose results have been shown in Section 3.1, here, we suggest a way of including a global measure of inequality into input-output models, something that, to the best of our knowledge, has not been addressed yet, at least at a broad scale. Figure 6 shows the results for the calculation of

this global index during our period of study, using data from our tables, as was explained in Section 2.

Figure 6. Sen index in an input-output model, Spain, 1980-2014.



Source: own work

It can be perceived that the Spanish economy experienced a general increase in inequality during this period, and a few distinct phases can be distinguished. Initially, inequality increased from 1980 to 1984, a period where the Spanish institutions were still adjusting from a dictatorial regime to a democratic system (it should be reminded that the Spanish constitution was reactivated in 1978). From a political perspective, the initial years of this period featured conservative governments, where social reforms were at best superficial; this was also a period of economic recovery from the 1975 oil crisis, where hard adjustments and restrictive monetary policies were globally taking place to tackle inflation. It is natural, then, that inequality might have increased during these years.

From 1985 to 1992, inequality clearly decreased, these years corresponding to a period of impressive growth. Around the start of this subperiod, the last effects of the oil crisis were being left behind. In addition, this period was marked by a socialist government, who developed an extensive social program, favoring the increase of wages and the consolidation of a consumerist middle class. In addition, the institutional adjustments to democracy can be assumed to have finished around these years, which brought about the end to the privileges of an oligarchy linked to the dictatorship.

Meanwhile, from 1993 to 1995, a sharp increase took place, coinciding a harsh economic crisis. This was linked to a huge downfall in investment after the celebration of the Seville International Exposition and the Barcelona Olympic Games, both in 1992. The

deep consequences of this socioeconomic crisis, that reached a peak around 1994, provoked a return to a conservative government in 1996. From 1996 to 2004, the index fluctuates around a narrow interval of values, but slightly increasing in total. Furthermore, these increases seem to concentrate around the final years of this subperiod, coinciding with crises related to the 'bubble.com' burst, the events of the Iraq war, and the 3/11 terrorist attacks.

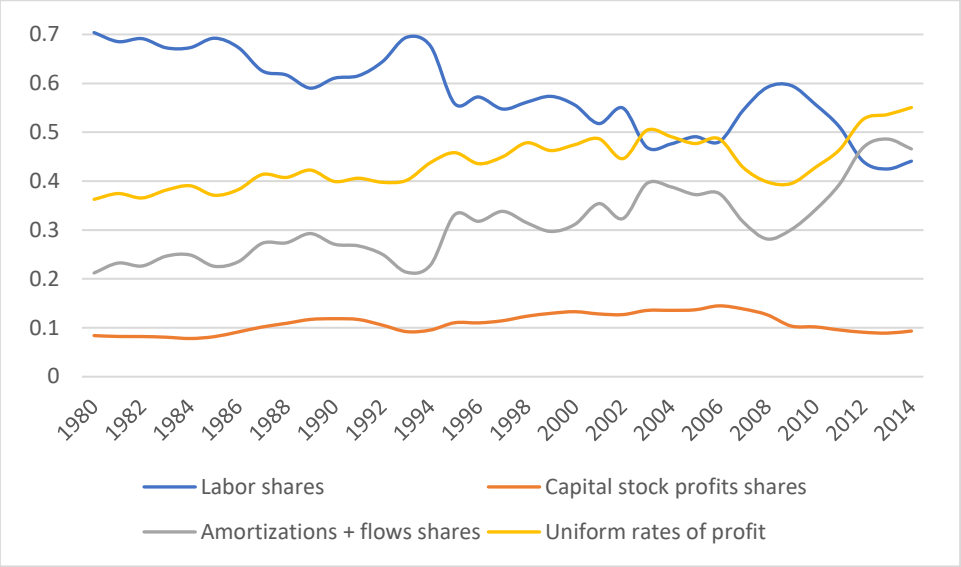
Then, 2005-2008 was marked by another socialist government with, in theory, a profound social program. However, according to our index, these reforms had superficial results, as inequality only decreased slightly. Finally, it decreased during the first years of the Great Recession, increasing thereafter and reaching a peak in 2010. In short, the evolution of our index seems coherent with real events and seems to be responsive to changes in governments and policies. Thus, our index embodies a clear institutional character.

4. Introducing another perspective of the evolution of inequality using a prices model

The antagonistic character in the distribution of income between labor and remaining incomes that do not correspond to labor (frequently identified with capital incomes, which is not always true) has been addressed before. We have analyzed some information about distribution and inequality, directly obtained from the Spanish input-output tables for 1980-2014 and from the indexes calculated. However, the explicative capacity of the tables has not been fully explored, as these can be used to check the validity of the conclusions obtained through other theoretical models. Specifically, we can use the prices model described in Section 2 in order to obtain additional estimations of the distribution of income between labor, capital, and other types of income. This will allow us to deepen in in the traditional debate on the relationship between labor and capital incomes, from an alternative perspective.

Looking at the lines depicted in Figure 7 below, we see that the labor shares of income are clearly decreasing during this period. This fall in the labor shares is sharper than the one shown by the data in the tables (calculated dividing total labor compensation by total value added). This continuous decrease in the participation of labor in total income could be interpreted as another facet of the increasing inequality during our period of study.

Figure 7. Income shares in a prices model from 1980 to 2014.



Source: own work

We can also look into the evolution of the uniform rate of profit. This is increasing along the period, which could mean that the unitary retribution of capital has been increasing since 1980. If we focus on the retribution to the capital stock (minus amortizations and the investment flows associated to gross capital formation), it can be seen that it is also increasing up until the 2008 crisis, when it started to decrease. Thereafter, it increased again, having a value in 2014 that is slightly superior to what was in 1980. The situation of capital in terms of income shares does not vary much along the period, but it certainly better than that of labor.

Finally, we can see that the share of income that is destined to capital amortizations and investment for growth purposes is increasing during 1980-2014. This means that the conflict between capital and labor is not so evident as it seems, and it should be addressed while taking into account institutional and productive factors. It seems that labor incomes have been losing weight on total income in Spain during these years, but these losses are not fully linked to a better situation for capitalists. The situation of capitalists keeps more or less unchanged, and the biggest part of the fall in labor shares corresponds to higher amortizations and domestic investment flows. The conflict between workers and entrepreneurs is then weaker than one should expect in principle.

5. Conclusions.

In this paper, we have presented extended Leontief input-output models in order to study the potentialities of this framework for income distribution research. We have also inclued

a prices model associated with the Leontief models, which includes capital stocks. These kinds of models can successfully integrate institutional and technical dimensions, which are both essential for unveiling the mechanisms of growth and how it is distributed among the different agents that participate in the process of production. For achieving our purposes, we first construct a series of symmetric input-output tables, aggregated to 8 sectors (classified according to technological criteria). We also include labor heterogeneity (by gender, age, and skills) household's consumption is disaggregated into different types of consumers, which is a contribution of the paper. This series of tables covers the Spanish economy, during the period 1980-2014.

First, we have moved on to intra-factor distribution, focusing on labor, analyzing shares of labor composition and hours per worked by age, gender, and skills. With this, we have constructed Gini indexes that are applied to these categorizations of labor, showing that inequality by both age and levels of skills have increased, due to the younger cohort and medium-skilled compensations plummeting. Attending to the categorization by gender, although inequality increased during the first part of the period, the index shows a general decrease of inequality from 1980 to 2014. This means that, although total equality in labor earnings between men and women does not exist yet, we have entered the right path to achieve this in the following decades. In addition, the 2008 crisis brought about a decrease in inequality in the three cases, although it only persisted by gender.

Second, we have studied consumption patterns by income quintiles. These are also important because, although inequalities arise in the process of distribution, those crystallize in the sphere of consumption. A given distribution of income can be described as unequal because all economic agents do not have the same resources to acquire a determined consumption basket. Our results show a great inequality by levels of income: in 2008, average annual consumption of the higher quintile was 10 times higher than that corresponding to the lowest quintile. Moreover, the disparities in consumption between income quintiles were aggravated during 1996-2008: average consumption per capita for the upper 20% incomes was 8 times higher in 2008 than in 1996, while it slightly more than doubled for the lower 80% incomes.

The analysis of consumption patterns reveals inequality either via different levels of consumption or through the different structures of consumption that are made possible by each level of income. Hence, high-income consumers can devote a higher share of their total expenditure in goods with high income elasticities, namely, Services. On the contrary, low-income consumers devote a higher share of their expenditures in covering

needs of a more basic character, as in the Primary and Energy sectors. Namely, the lowest quintile spent almost two thirds of total average consumption per capita in these two sectors in 2014.

Third, to complement this, we have calculated Sen indexes, which allow us to conclude that there has been a general increase in inequality in Spain along these years. Changes of higher quantitative importance are concentrated in the 1980s and the 1990s, which were decades of higher growth dynamism and with wider fluctuations: the greatest decreases in inequality concentrated in the first half of the 1980s, while the highest increases clustered around the first half of the 1990s. Then, the first decade of the 21st century was a period of narrower fluctuations in inequality, with a slight improvement of the situation up until a couple of years after the 2008 crisis, where inequality increased again.

Finally, using the input-output tables, we have constructed a prices model, which includes heterogenous payments to labor, capital amortizations, domestic investment flows, and capital stocks. These valuation of these components of prices allow the estimation of labor shares, capital shares (minus amortizations and investment flows) and uniform rates of profit. The results obtained with these models confirm our previous results, and also leave room for deeper discussion. The labor shares are clearly decreasing along this period, showing a more pronounced trend than that seen in the data found in the tables. On the contrary, the rates of profit show a increasing trend, revealing that the unitary retribution to capital has systematically improved along the period 1980-2014. However, the capital shares of income, once discounted amortizations and investment flows, slightly increase, which taken jointly to the fall in the labor shares, show that inequality has also increased from the factorial perspective of primary distribution. Nonetheless, these increases are not very impressive, and the biggest part of the losses are linked to increases in capital amortizations and domestic investments, which in principle are destined to growth purposes. Thus, here we can see the conflict between capital and labor from a global perspective, more cooperative and less competitive.

To sum up, this paper has shown the potentiality of input-output models to work in income distribution research, as it allows to combine different approaches from interesting perspectives, such as consumption, labor, capital, wages, prices, and profits. We have also achieved our objective of confirming that inequality has increased in Spain from 1980 to 2014, from these different perspectives. This could be taken as a representative case of what has happened in the developed world, especially in Europe,

during this period. However, a clear future line of research lies in the fact that this work could be now extended to a multiregional input-output model (MRIO) that would allow the inclusion of additional countries in a unified framework.

References.

Alonso-Villar, O., & del Río, C. (2010). Local versus overall segregation measures. *Mathematical Social Sciences*, *60*(1), 30–38. https://doi.org/10.1016/j.mathsocsci.2010.03.002

Attanasio, O. P., & Pistaferri, L. (2016). Consumption Inequality. *Journal of Economic Perspectives*, *30*(2), 3–28. https://doi.org/10.1257/jep.30.2.3

Deaton, A. (2021). *COVID-19 and Global Income Inequality*. https://doi.org/10.3386/w28392

Eurostat. (2008). Eurostat Manual of Supply , Use and Input-Output Tables 2008 edition. In *Office*. European Commision. https://doi.org/https://doi.org/http://ec.europa.eu/eurostat

Foster, J., Greer, J., & Thorbecke, E. (1984). A Class of Decomposable Poverty Measures. *Econometrica*, *52*(3), 761. https://doi.org/10.2307/1913475

Francese, M., & Mulas-Granados, C. (2015). Functional income distribution and its role in explaining inequality. *Banca d'Italia Workshop on "Beyond the Austerity Dispute: New Priorities for Fiscal Policy", Perugia, 9-11 April, 2015*.

Gini, C. (1921). Measurement of Inequality of Incomes. *The Economic Journal*, *31*(121), 124. https://doi.org/10.2307/2223319

Harcourt, G. C. (1969). Some Cambridge Controversies in the Theory of Capital. *Journal of Economic Literature*, *7*(2), 369–405. http://www.jstor.org/stable/2720556

International Labour Organization [ILO]; Organisation for Economic Co-operation and Development [OECD]. (2015). *The Labour Shares in G20 Economies*. https://www.oecd.org/g20/topics/employment-and-social-policy/The-Labour-Share-in-G20-Economies.pdf

Junius, T., & Oosterhaven, J. (2003). The Solution of Updating or Regionalizing a Matrix with both Positive and Negative Entries. *Economic Systems Research*, *15*(1), 87–96. https://doi.org/10.1080/0953531032000056954

Kaldor, N. (1957). A Model of Economic Growth. *The Economic Journal*, *67*(268), 591. https://doi.org/10.2307/2227704

Kaldor, N. (1960). *Essays on Value and Distribution*. Duckworth.

Karabarbounis, L., & Neiman, B. (2014). The Global Decline of the Labor Share. *The Quarterly Journal of Economics*, *129*(1), 61–103. https://doi.org/10.1093/qje/qjt032

Kim, K., Hewings, G. J. D., & Kratena, K. (2016). Household disaggregation and forecasting in a regional econometric input–output model. *Letters in Spatial and Resource Sciences*, *9*(1), 73–91. https://doi.org/10.1007/s12076-015-0140-8

Kurz, H. D., & Salvadori, N. (1995). *Theory of Production*. Cambridge University Press. https://doi.org/10.1017/CBO9780511625770

Kuznets, S. (1961). Quantitative Aspects of the Economic Growth of Nations: VI. Long-Term Trends in Capital Formation Proportions. *Economic Development and Cultural Change*, *9*(4, Part 2), 1–124. https://doi.org/10.1086/449936

Lee, J.-E. (2006). Inequality and globalization in Europe. *Journal of Policy Modeling*, *28*(7), 791–796. https://doi.org/10.1016/j.jpolmod.2006.04.013

Lenzen, M., Moran, D., Kanemoto, K., & Geschke, A. (2013). Building Eora: a Global Multi-Region Input-Output Database At High Country and Sector Resolution. *Economic Systems Research*, *25*(1), 20–49. https://doi.org/10.1080/09535314.2013.769938

Lenzen, M., Wood, R., & Gallego, B. (2007). Some comments on the GRAS method. *Economic Systems Research*, *19*(4), 461–465. https://doi.org/10.1080/09535310701698613

Leontief, W. (1936). Quantitative Input-Output Relations in the Economic System of the United States. *Review of Economics and Statistics*, *18*, 105–125.

Leontief, W. (1941). *The Structure of American Economy 1919-1939*. Oxford University Press.

Meade, J. E., & Stone, R. (1941). The Construction of Tables of National Income, Expenditure, Savings and Investment. *The Economic Journal*, *51*(202/203), 216–233. https://doi.org/10.2307/2226254

Meyer, B. D., & Sullivan, J. X. (2013). Consumption and Income Inequality and the Great Recession. *American Economic Review*, *103*(3), 178–183. https://doi.org/10.1257/aer.103.3.178

Miyazawa, K. (1976). *Input-Output Analysis and Interrelational Income Multiplier as a Matrix* (pp. 22–42). https://doi.org/10.1007/978-3-642-48146-8_2

Morishima, M. (1973). *Marx's Economics: A Dual Theory of Value and Growth*.

Cambridge University Press.

Munir, K., & Bukhari, M. (2020). Impact of globalization on income inequality in Asian emerging economies. *International Journal of Sociology and Social Policy*, *40*(1/2), 44–57. https://doi.org/10.1108/IJSSP-08-2019-0167

OECD. (2017). *OECD Science, Technology and Industry Scoreboard 2017*. OECD. https://doi.org/10.1787/9789264268821-en

Pasinetti, L. L. (1977). *Lectures on the Theory of Production*. Palgrave Macmillan UK.

Pasinetti, L. L. (1981). *Structural Change and Economic Growth*. Cambridge University Press.

Pasinetti, L. L. (1993). *Structural Economic Dynamics*. Cambridge University Press.

Piketty, T. (2020). *Capital and Ideology*. Harvard University Press, Belknap Press.

Pyatt, G. (2001). Some Early Multiplier Models of the Relationship between Income Distribution and Production Structure. *Economic Systems Research*, *13*(2), 139–163. https://doi.org/10.1080/09537320120052434

Pyatt, G., & Round, J. I. (1985). *Social accounting matrices: a basis for planning*.

Ricardo, D. (1817). *On the Principles of Political Economy and Taxation* (J. Murray (ed.)).

Robinson, J. (1969). *The Accumulation of Capital*. Palgrave Macmillan UK. https://doi.org/10.1007/978-0-230-30666-0

Rueda-Cantuche, J. M., Beutel, J., Neuwahl, F., Mongelli, I., & Loeschel, A. (2009). A SYMMETRIC INPUT–OUTPUT TABLE FOR EU27: LATEST PROGRESS. *Economic Systems Research*, *21*(1), 59–79. https://doi.org/10.1080/09535310802703429

Samuelson, P. A. (1962). Parable and Realism in Capital Theory: The Surrogate Production Function. *The Review of Economic Studies*, *29*(3), 193. https://doi.org/10.2307/2295954

Sen, A. (1976). Poverty: An Ordinal Approach to Measurement. *Econometrica*, *44*(2), 219–231. https://econpapers.repec.org/RePEc:ecm:emetrp:v:44:y:1976:i:2:p:219-31

Södersten, C.-J. H., & Lenzen, M. (2020). A supply-use approach to capital endogenization in input–output analysis. *Economic Systems Research*, *32*(4), 451–475. https://doi.org/10.1080/09535314.2020.1784852

Solow, R. M. (1955). The Production Function and the Theory of Capital. *The Review of Economic Studies*, *23*(2), 101. https://doi.org/10.2307/2296293

Spanish Statistical Office [INE]. (2021). *Household Budget Surveys*. https://www.ine.es/dyngs/INEbase/es/operacion.htm?c=Estadistica_C&cid=1254736176806&menu=ultiDatos&idp=1254735976608

Sraffa, P. (1960). *Production of Commodities by Means of Commodities*. Cambridge University Press.

Steenge, A. E., Incera, A. C., & Serrano, M. (2020). Income distributions in multi-sector analysis; Miyazawa's fundamental equation of income formation revisited. *Structural Change and Economic Dynamics*, *53*, 377–387. https://doi.org/10.1016/j.strueco.2019.04.007

Steenge, A. E., & Serrano, M. (2012). Income Distributions in Input-Output Models. *Economic Systems Research*, *24*(4), 391–412. https://doi.org/10.1080/09535314.2012.715281

UNU-WIDER. (2021). *World Income Inequality Database (WIID). Version 31 March 2021*. https://www.wider.unu.edu/database/wiid

van Ark, B., & Jäger, K. (2017). Recent Trends in Europe's Output and Productivity Growth Performance at the Sector Level, 2002-2015. *International Productivity Monitor*, *33*, 8–23.

Zhou, L., Biswas, B., Bowles, T., & Saunders, P. J. (2011). Impact of Globalization on Income Distribution Inequality in 60 Countries. *Global Economy Journal*, *11*(1), 1850216. https://doi.org/10.2202/1524-5861.1628