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*Research article*

# A few things you always wanted to know about input-output multipliers, but were afraid to ask

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**Abstract:** Policy evaluation relies on validated modelling tools. Among these, the interindustry model is one of the most widely used, primarily due to its mathematical simplicity, which facilitates the calculation of economy-wide multiplier effects resulting from policy-induced changes in final demand. However, this simplicity can lead to conceptual narrowness, potentially overlooking broader contextual factors. As Oosterhaven (2017, 2022) highlights, the issue of multipliers has two key dimensions: the numerical calculations and, more importantly, the modelling assumptions underlying these calculations, as they determine the relevance and validity of policy-related results. In this text, I explored this issue by comparing the outcomes that arise under different scenarios regulating the economy's adjustment to policy-induced changes. My findings suggests that classical multipliers may provide a biased perspective on an economy's structural behaviour.

**Keywords:** Leontief multipliers; demand financing; budgetary effects; empirical input-output

**JEL Codes**: C67, D57, D58

## 1. Introduction

Professor Oosterhaven (2017; 2022, Ch. 9) puts the finger on the sore spot when he questions the usual calculation of multipliers in standard input-output (I-O) analysis. He argues that these calculations overlook essential factors, particularly how an increase in final demand is financed and the effects this financing can have on the value of the multipliers. Ignoring this aspect creates a paradoxical situation in which, within a discipline like economics that universally lectures on the principle that 'there is no such thing as a free lunch', the usual I-O multipliers turn out to be 'free lunches' after all, as they are assumed to have no implementation costs. Consequently, any quantitative doubt or theoretical caution regarding the value of multipliers will inevitably be transferred to the techniques that use multipliers as base information for identifying policy-responsive strategic sectors at any level: national, regional, or interregional (see Temurshoev & Oosterhaven (2014) for a thorough review of these techniques).

In the standard I-O quantity model, the Leontief inverse (denoted as matrix **L)** directly provides the matrix of multipliers. Using the columns and rows of **L**, key sector analyses can be conducted through backward linkages (pull effects or input demand effects for upstream industries) or forward linkages (push effects or output supply effects for downstream industries), respectively. These analyses also enable calculations of inflationary multiplier effects arising from changes in cost structures, among other applications. Since forward linkages using **L** have a cumbersome interpretation, the I-O literature has favoured the use of the inverse matrix derived from the Ghosh model (1958). However, it is important to note that this model is not without its challenges and controversies (Oosterhaven, 1989; De Mesnard, 2009; Guerra & Sancho, 2011; Oosterhaven, 2012; Manresa & Sancho, 2021). To avoid disputes regarding the coherence of the Ghosh model and its inverse, I will focus exclusively on backward linkages, which are well-defined within the Leontief model and its inverse **L**.

An important initial observation, often insufficiently emphasised, is that the matrix **L** is calculated under the implicit assumption that the economy adjusts solely through changes in gross output levels, without considering other dimensions of adjustment. Specifically, the $j$-th column of **L** represents the output effects across all sectors in response to an additional unit of final demand for good $j$, while ignoring other macroeconomic adjustment channels such as those associated with prices and disposable income. Consequently, this adjustment is partial, confined to the productive sphere of the economy, and isolated from interactions with other economic factors. Such behaviour does not accurately reflect the functioning of a real-world economy since, for instance, price and income effects are omitted.

There is no explanation for why or how there is a change in final demand; it simply occurs. All components of final demand are treated uniformly, whether they represent private consumption demand (households), investment demand (businesses), public consumption demand (government), or foreign sector demand (other countries). Since the decision criteria and constraints affecting these four components are fundamentally different, it would seem sensible not to treat them symmetrically. Given their significant contribution to gross domestic product (GDP), the internal mechanisms that drive consumption and investment demands should be incorporated, where possible, into the rules defining the economy's behaviour. In other words, these factors should be treated as endogenous variables when appropriate.

Public consumption demand is perhaps the most exogenous component, as the government can change its priorities at any moment, modifying the structure of its demand: 'more butter and fewer guns', or 'more butter here and less there'. Alternatively, it may choose to spend more on 'butter' or 'guns' while keeping the rest of its demand unchanged. Whatever the details of the policy, any positive increase in government demand requires financing, and there are only three possibilities: financing by increasing the public deficit and borrowing from the savings pool, by rising government revenues via higher taxes, or by reallocating overall government expenditure. In all three cases, the changes are not neutral.

Moreover, if the new demand is financed by increasing the deficit, it results in a decline in total savings in the economy, with contractive effects that may decrease the volume of investment. If public consumption increases, but investment reduces, the combined effect determines whether aggregate final demand rises or falls; an essential factor for evaluating the multiplier effect on output.

However, if the new expenditure is financed through increased taxes, economic theory suggests that households' real disposable income will decrease, thereby reducing private consumption demand. The increase in public consumption must be balanced against the decline in private consumption. The net effect on aggregate final demand, and consequently on the multiplier effects, remains once again uncertain, as it depends on a myriad of nominal and real income effects interacting simultaneously.

Finally, if financing occurs through a reallocation of expenditure within the government's budget constraint, the evaluation of multipliers must account for the positive effects of new sectoral spending and the contractive effects of reduced demand in other sectors. Guerra & Sancho (2011) highlighted the potential consequences of this type of financing, warning of the possibility of negative multipliers even in otherwise very standard Leontief models built from symmetric I-O data. Their explanation is straightforward: multipliers now depend on the interplay between the positive driving effects of new expenditure and the negative contractive effects imposed on the government consumption vector by budget constraints.

In summary, crowding-out effects on aggregate final demand may arise depending on how increased public consumption is financed and on the adjustment rules governing other components of final demand. In this case, however, the possibility of negative multipliers is not attributable to issues arising from joint production and the adjustment rules used to construct symmetric input–output matrices, such as those associated with the commonly applied commodity-technology algorithm, which can generate negative direct technical coefficients that propagate into multipliers through matrix inversion. Rather, in a single-production model, such as the one used in this analysis, negative multipliers emerge from structural characteristics of the system directly linked to budgetary constraints, and not from formal issues related to secondary products and their removal. See Lager (2011) and Ten Raa and Cantuche (2013) for discussions of the technical issues associated with joint production and its possible solutions, and Mariolis et al. (2021), who detail the mathematical foundations of joint production economies within a neo-Ricardian framework and provide numerous examples to facilitate understanding of the issues involved when joint production is present.

The fact that standard Leontief multipliers omit interdependence circuits was noted at the onset of models based on the Social Accounting Matrix (SAM) (Pyatt and Round, 1979; Thorbecke, 1998). These models represent the economy through a linear structure that extends interdependencies to capture so-called induced effects in transaction volumes, going beyond effects strictly tied to the productive structure. Positively, SAM models extend the I-O model to partially close the circular flow of income. Negatively, the informational requirements for implementing a SAM model necessitate having a SAM database, which, unlike I-O tables, is not compiled by national and international statistical offices, leaving researchers to construct them with the attendant difficulties that this entails.

Another approach involves using semi-closed input-output models (Miyazawa, 1976; Chen et al., 2016; Emonts-Holly et al., 2021). These extended models aim to partially close the standard I-O model by adding additional layers of influence between output and income. While these models can be constructed using SAM data, it is not a requirement. Their natural implementation is based on I-O data with specific behavioural assumptions about key parameters.

As is well known, in SAM and extended semi-closed models, multipliers are systematically higher than those obtained from the standard I-O model. The mathematical reason for this is that their enlarged coefficient matrices are built upon the standard I-O matrix, which is expanded in size (i.e., more rows and columns) to incorporate additional layers of induced interdependence. Consequently, the results of these models suggest that the standard inverse matrix **L** systematically underestimates multiplier effects. However, as I will demonstrate later, this conclusion may prove to be incorrect when the budgetary rules governing final demand components are explicitly specified.

It is also worth noting that these generalized I-O models do not typically include price effects, which influence final demand through real income effects and, possibly, substitution effects[1]. A distinction must be made between nominal income effects, captured by these models, and real income effects, or purchasing power, brought about by price changes (Varian, 1992, Ch. 9). This distinction is significant because analysing the multiplier effects in response to a change in final demand requires specifying how the change is financed, particularly when it affects prices via a tax hike. In principle, consumption and investment should be endogenously determined in equilibrium in response to variables that directly have an effect on them, leaving public consumption demand as a strategic variable controlled by political authorities.

From the perspective of the theoretical literature, Metcalfe and Steedman (1981) and, in particular, Kurz (1985), argue from a neo-Ricardian standpoint for the need to use multisectoral models that include quantity and price equations to study the constraints that the economic structure imposes on the determination of the multiplier matrix. They conclude that one should not speak of "the" multiplier matrix, but rather of distinct possible matrices that may arise depending on properties such as the production structure, the structure and behaviour of final demand, or the rules governing income distribution. Mariolis (2018) further extends Kurz's approach by considering changes in the level of exogenous final demand that are consistent with constant employment levels, thereby revealing the presence of an autonomous demand-transfer payments curve, which exhibits formal similarities with the well-known dual consumption-growth and wage-profit relationships in steady-state capital and growth theory. The practical applicability of the neo-Ricardian approach is illustrated by Mariolis and Ntemiroglou (2021), who use data from the ten largest economies to calculate their multiplier matrices and associate them with various structural characteristics, such as the structure of exogenous final demand and distributive variables.

My purpose in this text is not to present an exhaustive specification of all possibilities but to highlight the limitations of not doing so. I emphasise, however, the importance of considering the financing rules that enable an increase in public consumption demand, which is particularly relevant in applied policy modelling. Since data selection, assumptions, and modelling simplifications are necessary to make the analysis operational, I outline them in Section 2. In Section 3, I discuss the

[1] See Oosterhaven (2022), Ch. 6, for a discussion of price-quantity interactions and its effects yielding lower multiplier values.

numerical results of alternative multipliers under the three financing scenarios I consider. In Section 4, I conclude the paper.

## 2. Alternative multiplier calculations

### *2.1. Dataset*

I use the latest symmetric input-output data for Spain from 2020, published by the National Institute of Statistics (INE, 2023). The dataset classifies goods and industries into $n = 62$ distinct sectors (see the nomenclature in Table 1), offering a detailed overview of the country's economic interactions. Although I use the dataset of a national economy as the statistical basis for the subsequent analysis, the methodological implications are equally applicable to any spatial I-O model using multiplier matrices built from standard matrix inversion.

### *2.2. The modelling approach*

I employ a quasi-linear model that integrates the two traditional components of the I-O framework: quantity and price linear equations, both adhering to standard assumptions and formulations in interindustry economics (Miller & Blair, 2022, Ch. 2). On the quantity side (Eq. 1), I distinguish domestic and imported output using an Armington (1969) assumption tailored to the tenets of the input-output model (Sancho, 2019). Price determination (Eq. 2) is then dual to this specification. Private consumption is treated as endogenous in all cases and is modelled using a non-linear Leontief - demand function (Eq. 3). This ensures that any income and price adjustments are adequately integrated, capturing their feedback on output. Gross income (Eq. 4), in turn, depends on domestic activity levels and factor prices, including payments to two primary factors: labour and capital services.

The basic behaviour of the economy is synthetically represented by this set of equations:

Quantity Equations:

$$\mathbf{x} = \mathbf{A} \cdot \mathbf{x}_d + \mathbf{c}(\mathbf{p}', y) + \mathbf{f} \tag{1a}$$

$$\mathbf{x}_d = \hat{\alpha}_d \cdot \mathbf{x}, \qquad \mathbf{x}_m = \hat{\alpha}_m \cdot \mathbf{x} \tag{1b}$$

Price Equation:

$$\mathbf{p}' = (w \cdot \boldsymbol{\ell}' + r \cdot \mathbf{k}' + \mathbf{t}' + \mathbf{p}' \cdot \mathbf{A}) \cdot \hat{\alpha}_d + \bar{\boldsymbol{p}}'_m \cdot \hat{\alpha}_m \tag{2}$$

Consumption demand:

$$\mathbf{c}(\mathbf{p}'', y) = \frac{(1-\delta) \cdot y}{\boldsymbol{p}' \cdot \boldsymbol{\beta}} \cdot \boldsymbol{\beta} \tag{3}$$

Gross income:

$$y = (w \cdot \boldsymbol{\ell}' + r \cdot \mathbf{k}') \cdot \mathbf{x}_d \tag{4}$$

I now comment on the notation. All vectors, row or column, are $n$ dimensional. The $n\times n$ non-negative matrix $\mathbf{A}$ and row vectors $\boldsymbol{\ell}'$ and $\mathbf{k}'$ represent the current technology using unitary coefficients for material inputs, labour, and capital services, respectively. The column vectors $\mathbf{x}$, $\mathbf{x}_d$, $\mathbf{x}_m$, $\mathbf{c}$, and $\mathbf{f}$ denote, respectively, total output, domestic output, total imports, consumption demand, and other sources of final demand, such as investment, public consumption, and exports. Consumption demand depends on prices $\mathbf{p}'$ and gross income $y$ adjusted by parameter $d$, which represents the proportion of income retained by taxes and the preference for savings. Gross income $y$, in turn, depends on domestic activity levels. Column vector $\boldsymbol{\beta}$ captures the consumption shares from the dataset. In the price equation, scalars $w$ and $r$ represent labour and capital retributions per unit of factor, respectively, while the vector $\mathbf{t}'$ indicates indirect taxes on production activities. International prices $\bar{\mathbf{p}}'_m$ are taken as exogenous and I consider them fixed at the benchmark levels. Finally, the diagonal matrices $\hat{\alpha}_d$ and $\hat{\alpha}_m$ in Eqs. (1) and (2) denote the Armington shares of domestic and imported outputs over total gross output, respectively. Thus, for each commodity $j$, it follows that $\alpha_j^d + \alpha_j^m = 1$.

## *2.3. Simulation strategies*

I focus exclusively on backward linkages, as initially defined from the columns of the inverse matrix $\mathbf{L}$ in the standard I-O open model. Forward linkages, on the other hand, remain a distinct topic that has yet to be adequately addressed outside the Ghosh model, which is generally considered unsuitable for representing the functioning of a market economy.

Each cell $m_{ij}$ in $\mathbf{L}$ shows the change in output in sector $i$ after the economy is adjusted, following a unitary increase in final demand in sector $j$: $m_{ij} = \Delta x_i^{(j)} = x_i^1 - x_i^0$, where the superscripts 0 and 1 indicate initial and adjusted outputs of $x_i$, respectively, after the demand shock in $j$ is absorbed. The aggregate multiplier initiated by the change in $j$ is just the sum of column $j$ in matrix $\mathbf{L}$; in other words, the aggregation of all derived output changes[2]. In the open model, matrix $\mathbf{L}$ is calculated as $\mathbf{L} = (\mathbf{I}-\mathbf{A})^{-1}$.

For the alternative multiplier calculations, I assume:

1. Public consumption demand represents the government's policy preferences, which can change at any time. Modifications in demand originate in this component of final demand, which initiates the response and adjustment process.
2. Private consumption demand is, in all cases, considered endogenous and dependent on prices and disposable income. In my case study, private consumption demand constitutes approximately 54% of GDP.
3. Investment demand is considered endogenous when directly impacted by an increase in the public deficit that affects available liquidity. In my dataset, aggregate investment demand is about 20% of GDP.
4. Export demand remains an exogenous variable.

These assumptions are, of course, far from exhaustive but will serve to illustrate the limitations of focusing exclusively on the standard Leontief model and its matrix $\mathbf{L}$.

[2] Thus, the multipliers are related to Laspeyres quantity indices, which use initial prices as a reference base. The standard normalisation guarantees that all initial prices are unitary.

I therefore assume unitary increases in public consumption demand for each of the goods in the database and evaluate the ensuing effects under three scenarios:

1. The new demand is financed by an increase in the public deficit, which imposes a liquidity constraint that hinders the realisation of investment demand. *Ceteris paribus*, aggregate investment contracts accommodate the increase in the deficit, and I assume that this reduction is proportionally distributed across all investment goods. Given the dynamic nature of investment, the modelling of its behaviour in static models, such as the present one, is always problematic, but even in far more complex Computable General Equilibrium models, this assumption is typically used[3]. Given investment levels $I_i^0$ in the benchmark dataset, I use the scaling factors $I_i^0 / \sum_j I_j^0$.
2. The new demand is financed by an increase in indirect taxes, calculated using initial collection data. *Ceteris paribus*, the new tax rates suffice to finance the new expenditure before economic adjustments occur. The increase in tax rates that finances the new public demand can be seen to be $1/\sum_i x_i^0$, with $x_i^0$ being the reported output levels in the dataset.
3. The new demand is financed through budgetary reallocation, with total public consumption expenditure remaining fixed. An increase in demand for a specific good is offset by a proportional reduction in demand for other goods. *Ceteris paribus*, this reallocation is sufficient to finance the additional expenditure before adjustments occur. Suppose that $\Delta g_k$ is a change in the initial public consumption for good $k$, i.e., $g_k^0$. Then the adjustment rule stipulates:

$$\begin{cases} g_i = g_i^0 + \Delta g_i (i = k) \\ g_i = g_i^0 - \Delta g_i \cdot \dfrac{g_i^0}{\sum_{j \neq k} g_j^0} (i \neq k) \end{cases}$$

For more details on the budgetary rules, I refer to Guerra & Sancho (2011) and Agnani et al. (2024). However, their approach considers only changes in gross output without accounting for further economic repercussions. Here, I generalize their approach by incorporating feedback effects on income levels and private consumption demand (Eqs. 3 and 4).

In all three scenarios, the economy readjusts after the initial shock and reaches a new equilibrium state. I simulate this new state by solving Eqs. (1) to (4). Since the model is static, I use the technique of comparative statics to calculate the multiplier effects, which are then compared with the results obtained directly from the Leontief inverse from the standard open model.

## 3. Results

Table 1 shows the multiplier results under the standard I-O model; I call it scenario S0, and the three financing alternatives I contemplate.

The first notable fact is that all three alternative scenarios exhibit negative multipliers. The stimulus effect of a new public spending policy deviates from Keynesian orthodoxy and may, in fact, produce results opposite to those initially desired. Contrary to the expansionary effects predicted by

[3] See Kehoe et al. (1988); Hosoe et al. (2010), Ch. 6; Cardenete et al. (2017), Ch. 4.

open, SAM, and semi-closed input-output (I-O) models, such effects do not necessarily materialize. Budgetary constraints affecting economic interactions among agents play a role, limiting or counteracting the predicted expansionary impact.

A second observation is the asymmetry among financing options. On average, the least favourable approach is financing through an increase in the deficit. The implicit cost of this strategy emerges as a liquidity restriction, which negatively impacts investment demand. Financing through expenditure reallocation, while negative on average, is essentially neutral in terms of aggregate volume. In other words, this approach merely redistributes the effects of public spending without providing substantial macroeconomic stimulus.

Financing through an increase in taxation is the only option that delivers a positive stimulus, though not universally. Two sectors still experience negative multipliers from the new spending. Overall, the average stimulus is positive but falls short of the predictions made by standard Leontief multipliers. This discrepancy can be explained by a double influence on private consumption demand. On the one hand, there is a real income effect caused by a loss of purchasing power due to price increases driven by higher tax rates. On the other hand, there is a nominal income effect stemming from increased production and its subsequent transfer to factor incomes. In most cases, the nominal income effects outweigh the real income effects associated with diminished purchasing power, but this is not always the case.

In the last two rows of Table 1, I present two synthetic indicators that provide summary values. The arithmetic average simulates a simultaneous injection of 1/62 units of public consumption into each sector, while the weighted multiplier allocates the same unit of public consumption according to output shares. In scenario 1, the aggregate multiplier values are negative in both cases, aligning with certain macroeconomic estimates of the aggregate expenditure multiplier[4]. In scenario 3, the aggregate indicators change sign, but both are small and close to zero. In general, small and/or negative aggregate multipliers are explained by the interplay of crowding-out effects at the sectoral level. One key message is that global summary effects, under any aggregation scheme, incorporate the negative contributions of sectoral multipliers. Another key message is that, even when effects appear small, the policy distribution of new public expenditures matters and merits consideration.

**Table 1.** Competing multiplier evaluations.

| | Input-output sectors | Scenario 0 | Scenario 1 | Scenario 2 | Scenario 3 |
|---|---|---|---|---|---|
| 1 | Agriculture | 1.4721 | 0.0925 | 1.6810 | 0.1767 |
| 2 | Forestry | 1.9400 | 0.6242 | 2.2127 | 0.7087 |
| 3 | Fishing | 1.1125 | −0.7764 | 0.8128 | −0.6923 |
| 4 | Extractive industries | 0.3044 | −2.1667 | −0.5767 | −2.0826 |
| 5 | Foodstuffs | 1.8973 | 0.2229 | 1.8118 | 0.3071 |
| 6 | Textiles | 0.5707 | −1.7024 | −0.1127 | −1.6182 |
| 7 | Wood products | 1.7493 | −0.1059 | 1.4832 | −0.0218 |
| 8 | Paper products | 1.6379 | −0.2005 | 1.3886 | −0.1164 |

*Continued on next page*

[4] See Barro (2009) for a synthetic discussion of aggregate multipliers in macroeconomics.

| | Input-output sectors | Scenario 0 | Scenario 1 | Scenario 2 | Scenario 3 |
|---|---|---|---|---|---|
| 9 | Printing and recording | 1.7763 | 0.1714 | 1.7602 | 0.2556 |
| 10 | Coke and petroleum | 1.1835 | −1.2484 | 0.3415 | −1.1642 |
| 11 | Chemical products | 1.1775 | −0.9032 | 0.6862 | −0.8190 |
| 12 | Pharmaceutical products | 0.8026 | −1.3174 | 0.2721 | −1.2755 |
| 13 | Rubber and plastic products | 1.2883 | −0.6855 | 0.9038 | −0.6013 |
| 14 | Other non-metallic products | 1.6829 | −0.0976 | 1.4914 | −0.0135 |
| 15 | Metallurgy | 1.4645 | −0.5725 | 1.0169 | −0.4884 |
| 16 | Metals | 1.6635 | −0.1689 | 1.4202 | −0.0847 |
| 17 | Electronic equipment | 0.2745 | −2.2521 | −0.6621 | −2.1680 |
| 18 | Electrical equipment | 1.0534 | −1.1344 | 0.4551 | −1.0503 |
| 19 | Machinery | 1.0397 | −1.0854 | 0.5041 | −1.0012 |
| 20 | Motor vehicles | 1.3355 | −0.8111 | 0.7784 | −0.7269 |
| 21 | Other transport equipment | 1.3748 | −0.6375 | 0.9518 | −0.5534 |
| 22 | Furniture | 0.9892 | −1.0849 | 0.5046 | −1.0013 |
| 23 | Services of equipment | 1.8461 | 0.3289 | 1.9176 | 0.4131 |
| 24 | Energy | 1.8162 | 0.4096 | 1.9981 | 0.4939 |
| 25 | Water | 1.8175 | 0.3421 | 1.9307 | 0.4276 |
| 26 | Waste management services | 1.8233 | 0.1805 | 1.7694 | 0.2691 |
| 27 | Construction | 1.9701 | 0.4403 | 2.0290 | 0.5293 |
| 28 | Commercial services for motor vehicles | 1.7105 | 0.2572 | 1.8458 | 0.3413 |
| 29 | Wholesale services except motor vehicles | 1.7347 | 0.3237 | 1.9122 | 0.4107 |
| 30 | Retail services except motor vehicles | 1.5630 | 0.2307 | 1.8192 | 0.3167 |
| 31 | Land transport services | 1.8010 | 0.2755 | 1.8642 | 0.3620 |
| 32 | Water transport services | 2.2690 | 0.9147 | 2.5032 | 0.9994 |
| 33 | Air transport services | 2.4815 | 0.5620 | 2.1512 | 0.6472 |
| 34 | Auxiliary transport services | 1.8944 | 0.4062 | 1.9948 | 0.5039 |
| 35 | Postal and courier services | 2.0320 | 0.4889 | 2.0776 | 0.5730 |
| 36 | Accommodation and foodstuffs services | 1.7767 | 0.3685 | 1.9570 | 0.4531 |
| 37 | Publishing services | 1.3392 | −0.4041 | 1.1849 | −0.3201 |
| 38 | Image and sound services | 1.4345 | −0.2875 | 1.3014 | −0.2051 |
| 39 | Telecommunications services | 1.7638 | 0.2705 | 1.8592 | 0.3558 |
| 40 | Consultancy services | 1.5082 | −0.0510 | 1.5377 | 0.0332 |
| 41 | Financial services, except insurances | 1.3112 | −0.2303 | 1.3584 | −0.1464 |
| 42 | Insurances | 1.7683 | 0.2962 | 1.8848 | 0.3805 |
| 43 | Financial and insurances auxiliary services | 1.5931 | 0.1290 | 1.7176 | 0.2132 |
| 44 | Real estate | 1.1985 | −0.0174 | 1.5708 | 0.0668 |
| 45 | Legal and accounting services | 1.5610 | 0.1561 | 1.7446 | 0.2408 |
| 46 | Engineering services | 1.7427 | 0.1550 | 1.7438 | 0.2395 |
| 47 | Research and development | 1.4571 | 0.1040 | 1.6924 | 0.1899 |
| 48 | Marketing services | 1.7286 | 0.1784 | 1.7671 | 0.2626 |
| 49 | Other professional services | 1.5546 | 0.0480 | 1.6366 | 0.1322 |
| 50 | Rental services | 1.5261 | 0.0193 | 1.6079 | 0.1034 |
| 51 | Employment-related services | 1.1211 | −0.3188 | 1.2698 | −0.2346 |
| 52 | Travel services | 2.2204 | 0.6602 | 2.2489 | 0.7450 |

*Continued on next page*

| | Input-output sectors | Scenario 0 | Scenario 1 | Scenario 2 | Scenario 3 |
|---|---|---|---|---|---|
| 53 | Other support services for businesses | 1.5095 | 0.0051 | 1.5937 | 0.0893 |
| 54 | Public services | 1.3412 | −0.0660 | 1.5226 | 0.0251 |
| 55 | Education services | 1.1756 | −0.2243 | 1.3643 | −0.1751 |
| 56 | Healthcare services | 1.4135 | −0.0559 | 1.5327 | 0.0378 |
| 57 | Social services | 1.4585 | 0.0139 | 1.6025 | 0.1054 |
| 58 | Cultural services | 1.6297 | 0.3030 | 1.8914 | 0.3948 |
| 59 | Recreational services | 1.6100 | 0.1518 | 1.7404 | 0.2401 |
| 60 | Services provided by associations | 1.4150 | 0.0487 | 1.6372 | 0.1361 |
| 61 | Household repair services | 1.6936 | 0.2247 | 1.8133 | 0.3088 |
| 62 | Other personal services | 1.2086 | −0.0915 | 1.4969 | −0.0074 |
| | Average multiplier | 1.5098 | −0.1499 | 1.4390 | −0.0658 |
| | Weighted multiplier | 1.5518 | −0.0020 | 1.5885 | 0.0845 |

Source: Official 2020 input-output data for Spain and our model calculations. Scenario 0 = Leontief multipliers, Scenario 1 = Multipliers with deficit financing, Scenario 2 = Multipliers with tax financing, and Scenario 3 = Multipliers with expenditure financing.

## 4. Concluding remarks

A review of the literature reveals that open Leontief multipliers are the most commonly used in empirical analyses. However, they are also possibly the least realistic because they fail to account for the complex interplay of economic forces that characterize market economies.

On the other hand, SAM and semi-closed I-O models produce inflated multipliers compared to open Leontief multipliers. This occurs because these models introduce additional layers of interdependence but omit the implicit costs of increased expenditures and the potential for price changes. Like open Leontief multipliers, they also ignore the budgetary constraints that pervade economic reality.

The model I use adheres to input–output principles based on fixed coefficients in production and, in my case, also in consumption demand, which is nonetheless responsive to income and prices. Its implementation is constructed using a symmetric input–output table and takes, as its central focus, the need to explicitly define the financing channels for any change in the government's preferences regarding the structure of its consumption. Therefore, there is no joint production, and the negativity of some multipliers is solely the result of the constraints imposed by the financing mechanisms for new public spending.

An important caveat concerns aspects not addressed in our analysis. A significant theoretical challenge in static models, such as the basic I-O model and its semi-closed extensions, is the treatment of investment. Investment is inherently dynamic, and its demand is heavily influenced by expectations about future economic prospects. an element that is difficult to integrate into a static framework[5]. Additionally, the economic cost of adding capital goods complicates the analysis further. My approach is thus limited, as it considers only liquidity constraints.

[5] Dejuán et al. (2022) provide an interesting approach to addressing this issue within a static framework, using a pure quantity I-O model and incorporating the investment accelerator.

Another difficult dynamic question is the speed with which a sector can react to changes in its final demand, since the direct capacity for a response varies between sectors. However, the issue extends beyond this direct speed of response. For example, suppose we know that sector $i$ is “fast” and sector $j$ is “slow.” When the final demand for sector $j$ increases, sector $j$ must source inputs from sector $i$, which is slower to respond. As a result, the speed at which sector $j$ can adjust is dependent on the slower response of sector $i$. In this way, the slower sector constrains the response speed of the others, and this indirect speed affects how quickly multiplier changes can materialize. Unfortunately, by their very definition, static models do not lend themselves to incorporating temporal concepts such as speed of response. The most prudent interpretive approach is to assume that multiplier evaluations in static models reflect a situation where all necessary adjustments, whether fast or slow, have occurred.

Export demand is also held constant in the model, on the premise that these decisions are made externally to the economy under consideration. Furthermore, the use of a Leontief consumption function presents another limitation. By design, it does not account for price-induced substitution effects. However, as long as tax-induced price changes remain relatively small, this approximation should suffice.

Given the limitations of the model used in this work, particularly the linearity implicit in the behavioural functions and the nature of the response mechanisms, the key takeaway is that negative multipliers are a real possibility, even under assumptions and within modelling frameworks that do not differ substantially from the standard input–output model. Consequently, the primary message of this short paper is that budgetary constraints matter, significantly influence quantitative evaluations, and should not be overlooked in models designed to assess the economy-wide impulse effects of expenditure policies.

## Use of AI tools declaration

The author declares he has not used Artificial Intelligence (AI) tools in the creation of this article.

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## Data availability statement

The data used is publicly available from the government repository cited in the text (INE, 2023).

## Conflict of interest

The author declares no conflict of interest in this paper.

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