A few things you always wanted to know about 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 themselves and, more importantly, the modelling assumptions underlying these calculations, as they ultimately determine the relevance and validity of policy-related results. In this text, we explore this issue by comparing the various outcomes that arise under different scenarios regulating the economy's adjustment to policy-induced changes. Our findings suggest that classical multipliers may provide a biased perspective on an economy's structural behaviour.

Keywords: Classical multipliers, demand financing, budgetary effects.

JEL codes: C67, D57, D58

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1. Introduction

Professor Oosterhaven (2017; 2022, Ch. 9) puts the finger on the sore spot when he questions the usual calculation of multipliers in 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—hereafter referred to 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) instead. 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, we will focus exclusively on backward linkages, which are well-defined within the Leontief model and its inverse **L**.

An important initial observation, often insufficiently emphasized, is that the Leontief inverse 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 assuming no impact on other economic variables. 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 effects are entirely 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 structure. 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 cases, the changes are not neutral.

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 eventually 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.

If, on the other hand, 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 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 both 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 about the possibility of negative multipliers. The explanation is straightforward: multipliers now depend on the interplay between the positive driving effects of new expenditure and the negative contractive effects imposed by budget constraints.

In short, various crowding-out effects on aggregate final demand may arise depending on how increased public consumption is financed and the adjustment rules for other components of final demand.

The fact that standard Leontief multipliers omit interdependence circuits was already 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 Leontief inverse systematically underestimates multiplier effects.

However, as we will demonstrate later, this conclusion proves to be erroneous 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.

Our purpose in this text is not to present an exhaustive specification of all possibilities but to highlight the limitations of not doing so. Since data selection, assumptions, and modelling simplifications are necessary to make the analysis operational, we outline them in Section 2. In Section 3, we discuss the numerical results of alternative multipliers under the three different financing scenarios we consider. Section 4 briefly concludes.

2. Alternative multiplier calculations

2.1 Dataset

We 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 nomenclature in Table 1), offering a detailed overview of the country's economic interactions. Although we 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

We employ a quasi-linear model that integrates the two traditional components of the I-O framework: quantity and price linear equations (Eqs. 1 and 2), both adhering to standard assumptions and formulations in interindustry economics (Miller & Blair, 2022, Ch. 2). In the quantity equation, 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 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 equation:

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

Price equation:

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

$$\mathbf{p}' = w \cdot \boldsymbol{\ell}' + r \cdot \mathbf{k}' + \mathbf{t}' + \mathbf{p}' \cdot \mathbf{A} \quad (2)$$

Consumption demand:

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

Gross income:

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

We 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 $\mathbf{x}$, $\mathbf{c}$, and $\mathbf{f}$ denote, respectively, total output, 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 the parameter α, which represents the proportion of income retained by taxes and the preference for savings. 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, while the vector $\mathbf{t}'$ indicates indirect taxes on production activities.

2.3 Simulation strategies

We focus exclusively on backward linkages, as initially defined from the columns of the Leontief 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 adjusts following a unitary increased 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 x_j after the demand shock in i is absorbed. The aggregate multiplier initiated by the change in i is just the sum of column i 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 we assume:

A1. 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.

A2. Private consumption demand is in all cases considered endogenous and dependent on prices and disposable income. In our case study, private consumption demand constitutes approximately 54 per cent of GDP.

A3. Investment demand is considered endogenous when directly impacted by an increase in the public deficit that affects available liquidity. In our dataset, aggregate investment demand is about 20 per cent of GDP.

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

A4. 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 **L**.

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

S1. The new demand is financed by an increase in the public deficit, which imposes a liquidity constraint that hinders the realization of investment demand. *Ceteris paribus*, aggregate investment contracts to accommodate the increase in the deficit, and we assume that this reduction is proportionally distributed across all investment goods. Given investment levels I_i^0 in the dataset, the scaling factor can be proven to be equal to $1 / \sum_i I_i^0$.

S2. 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.

S3. 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. For details on the specific budgetary rules, we refer to Guerra & Sancho (2011). However, their approach considers only changes in gross output without accounting for further economic repercussions. Here, we 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 eventually reaches a new balanced state. We simulate this new state by solving Eqs. (1) to (4). Comparative statics are then used to calculate the multiplier effects, which are compared with the results obtained directly from the Leontief inverse.

3. Results

Table 1 shows the multiplier results under the standard I-O model, we call it scenario S0, and the three financing alternatives we 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 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 even counteracting the predicted expansionary impact.

A second observation is the asymmetry among different 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 row of Table 1, we present the simple arithmetic average of the multipliers as a synthetic indicator to provide a summary value. This corresponds to the simultaneous injection of 1/62 new units of public consumption in each sector. In scenarios 2 and 4 we can see that, in aggregate terms, the value of the multiplier would be negative and close to zero, aligning with certain macroeconomic estimates of the aggregate expenditure multiplier. The explanatory reason for the possible presence of negative aggregate multipliers lies in the joint interplay of the crowding out effects that appear at the sectoral level. On the other hand, the arithmetic average does not take into account the size of the sectors in the calculation. The message is, simply, that aggregate effects can inherit the negative sign of sector multipliers.

In the last row of Table 1, we present the simple arithmetic average of the multipliers as a synthetic indicator to provide a summary value. This would correspond to the simultaneous injection of 1/62 new units of public consumption into each sector. In scenarios 2 and 4, the aggregate multiplier value is negative and close to zero, aligning with certain macroeconomic estimates of the aggregate expenditure multiplier[3]. The presence of negative aggregate multipliers is explained by the interplay of crowding-out effects occurring at the sectoral level. However, the arithmetic average does not account for sector size in its calculation. The key message is that global summary effects, under any type of aggregation, will incorporate the negative sign of sectoral multipliers.

[Table 1 around here]

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 the *least* realistic because they fail to account for the complex interplay of economic forces that characterize market economies.

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.

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

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

future economic prospects—an element that is difficult to integrate into a static framework[4]. Additionally, the economic cost of adding capital goods complicates the analysis further. Our approach is thus limited, as it only considers liquidity constraints.

Another difficult dynamic question is the speed with which a sector is able to react to changes in its final demand since the direct capacity for 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 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 entirely 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 ultimately affects how quickly multiplier changes can materialize. Unfortunately, by their very definition, static models do not lend themselves to incorporate 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 already 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.

To wit, 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.

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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
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

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
Scenario 3 = Multipliers with expenditure financing

Table 1 (cont.): Competing multiplier evaluations

	Input-output sectors	Scenario 0	Scenario 1	Scenario 2	Scenario 3
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
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*

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
Scenario 3 = Multipliers with expenditure financing