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Berlin School of Economics and Law

Institute for International Political Economy Berlin

A supermultiplier demand-led growth accounting analysis applied to the Spanish economy (1998-2019)

Author: Héctor Labat-Moles and Ricardo Summa

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A supermultiplier demand-led growth accounting analysis applied to the Spanish economy (1998-2019)*

Héctor Labat-Moles

Ricardo Summa

Abstract

In this paper, we analyse the demand-led determinants of Spanish economic growth from 1998-2019. We apply the supermultiplier demand-led growth accounting methodology by Freitas/Dweck (2013) with two modifications: First, we incorporate consumption out of public transfers, following Haluska et al. (2021) and Haluska (2021). Second, we incorporate consumption out of public wages as a source of autonomous demand, theoretically suggested by Serrano/Pimentel (2019). Our demand-led growth decomposition highlights (i) public demand and exports as important stable growth drivers, and a decreasing supermultiplier that reduces growth rates; (ii) the indirect effect of a real estate boom in the economic expansion of 1998-2008 caused by increasing public revenues and opening space to the expansion of public demand; (iii) the incapacity of exports to lead the recovery alone, as the latter started only with the resumption of the public and private demand.

Keywords: Supermultiplier; demand-led accounting; Spanish economy.

JEL Codes: O47; E11; E12.

Contact:

Héctor Labat-Moles: Phd Candidate at Université Sorbonne Paris Nord and Federal University of Rio de Janeiro, hector.labatmoles@univ-paris13.fr

Ricardo Summa: Professor of Economics at the Federal University of Rio de Janeiro and Visiting Researcher at the IPE-Berlin (winter term 2021-2022 and summer term 2022), ricardo.summa@ie.ufrj.br

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1. Introduction

The idea that economic growth is driven by effective demand is central to post-Keynesian economics. The authors from this perspective have a tradition in applying a demand-led growth perspective to analyse concrete experiences of economic growth of several countries, to study demand and growth regimes (Hein 2011, Hein/Martschin 2020, 2021), or the drivers of growth (Kohler/Stockhammer 2021). More recently, Comparative Political Economy also started to discuss the demand-led growth perspective applied to the concrete experiences of economic growth of several countries (Baccaro/Pontusson 2016) opening the possibility of debates with the post-Keynesian tradition.

The Sraffian supermultiplier model (Serrano 1995) and its Kaleckian version with autonomous demand has been used by a broader group of post-Keynesian researchers at a theoretical level (Allain 2015, Lavoie 2016, Fazzari et al. 2020, Hein/Woodgate 2021). This model has been applied to demand-led growth accounting to analyse concrete growth experiences (Freitas/Dweck 2013, Bastos/Porto 2016, Haluska 2021, Morlin et al. 2022, Passos/Morlin 2022, Barbieri-Góes 2022). Stockhammer/Kohler (2022) recognise the supermultiplier as an alternative perspective within post-Keynesian 'demand and growth regimes' and 'growth drivers' methods to analyse concrete episodes of demand-led growth and Campana et al. (2022) argue that these models can be complementary.

In this paper, we apply the supermultiplier demand-led growth accounting methodology to analyse the economic performance of Spain from 1998 to 2019. We follow the methodology by Freitas/Dweck (2013) but with two modifications. First, we incorporate consumption out of public transfers, following the theoretical discussion in Haluska et al. (2021) and the incorporation in demand-led accounting in Haluska (2021). Second, we incorporate consumption out of public wages as a source of autonomous demand, following the theoretical discussion in Serrano/Pimentel (2019). The introduction of the latter in demand-led growth accounting analysis is a specific contribution of this paper. These modifications are based on the theoretical distinction found in supermutiplier theory that consumption out of public transfers and wages are not systematically related to the production process. Moreover, they contribute to the disentanglement of what is commonly considered as induced private consumption arising from the private and public sectors.

We consider three different periods: the pre-crisis economic expansion (1998-2008), the great recession (2008-2013) and the economic recovery (2014-2019). We evaluate the role of both the induced and autonomous components of demand and its importance to the growth patterns in each of these three periods. Our demand-led growth decomposition highlights both the relevance of public demand and exports as growth drivers, and the role of the changing supermultiplier to reduce the rates of growth of Spain. We compare our results with interpretations of Spain's growth patterns found in the literature. We argue that the real estate boom was important to the pre-crisis economic expansion not only because its direct effect, as commonly seen in the literature, but also because of the indirect effect of increasing public revenues, opening space to the expansion of public demand. Our results also show that exports themselves

were not enough to lead the recovery alone, as is also mentioned in the literature. The recovery started only with the resumption of the public and private demand.

Besides this introduction, the paper is comprised of four more Sections. In Section 2, we briefly present the supermultiplier theory and the supermultiplier demand-led growth accounting methodology. In Section 3, we present our results. In Section 4, we compare our results with both the mainstream and post-Keynesian interpretation of Spanish growth patterns found in the literature. We make our final remarks in Section 5.

2. Supermultiplier theory and demand-led growth accounting

Supermultiplier theory (Serrano 1995) endorses the Keynesian-Kaleckian principle of effective demand and extends it to the long run, by a conceptual separation of aggregated demand between autonomous and induced components. The latter include those components of demand that are systematically related to the production process, such as the capacity-generating investment by business firms and (a part of) consumption financed out of contractual wages. These induced expenditures are considered systematically related to the production process since production generates contractual wages, which are (at least partially) spent by workers, and business investment is made to adapt the productive capacity to the expected level of demand, which depends on the actual levels of output and effective demand. On the other hand, the autonomous expenditures are not systematically related with the production process and in general are determined by a wide range of diverse factors reflecting social, political and institutional settings of specific economies and are influenced by the economic policy stance. Among these components typically categorized as autonomous in supermultiplier theory are households' demand financed out of debt (residential investment and credit-financed consumption), discretionary consumption by the wealthy, government demand (determined by the economic policy stance) and exports (importantly driven by the income growth of the rest of the world)[1].

Changes in the coefficients defining the value of the supermultiplier (the functional income distribution, the propensity to invest, the import content of demand and the tax burden) have a permanent effect on the level of output, as well as on the average growth rate during the time it takes the productive capacity to adjust to the new level of aggregate demand (Freitas/Serrano 2015, Lavoie 2016). On the other hand, the trend rate of economic growth is related to the growth rate of the autonomous components. Finally, supermultiplier theory considers functional income distribution as influenced by 'the bargaining power of the opposite classes, by customs and social norms concerning the fairness of remunerations and other social habits' (Pariboni 2016: 218).

Recently there have been some attempts to apply supermultiplier theory to analyse concrete experiences of growth both from advanced and developing economies. This

[1] The qualification of these demand components as autonomous does not mean that they are always exogenous to the production process or from interactions between them (Fiebiger 2018, Morlin et al. 2022). However, these links cannot be universalised and depend on the prevailing institutional framework in each case.

consists in adopting a demand-led growth accounting methodology, as an alternative to the well-known supply-side growth accounting inspired by the neoclassical theory of growth and distribution (Solow 1957, Hulten 2010). The supermultiplier-based growth accounting methodology allows for inspecting growth patterns by developing a 'theoretically informed decomposition' of economic growth building upon a taxonomy of demand between autonomous and induced components (Morlin et al. 2021: 32). This methodology has been used by Freitas/Dweck (2013) and Haluska (2021) to the Brazilian economy, Bastos/Porto (2016) for Portugal, Passos/Morlin (2022) for Latin American countries, Morlin et al. (2022) for a set of OECD countries, Campana et al. (2022) for the BRICs countries and Barbieri-Góes (2022) for the US.

We apply the same methodology to the Spanish economy. We will start by rearranging the national accounts' aggregate demand components in accordance with the supermultiplier theory. Our aggregate demand taxonomy will follow the supermultiplier literature (Freitas/Dweck 2013, Girardi/Pariboni 2016,2020). We add to the sources of autonomous demand both the consumption out of transfers, following Haluska et al. (2021) and Haluska (2021), and the consumption out of public wages, building upon the theoretical discussion of Serrano/Pimentel (2019). The latter is a specific contribution of the paper to the supermultiplier demand-led growth accounting literature. We group autonomous components into i) private demand, composed by credit-financed consumption, private residential investment and other private autonomous investment (investment in research and development and net acquisitions of valuable objects)[2]; ii) public demand, made up of public entities' demand (encompassing government consumption, government investment and public companies' investment[3]) and consumption out of public income (including consumption out of transfers and consumption out of government wages); and iii) external demand (exports). We should stress that this separation between both induced and autonomous, and public and private are somewhat arbitrary, and the results of the decomposition reflect the choices regarding this taxonomy.

According to this view, households' consumption out of public income is seen as autonomous as the income that finance it is not related with the production process but created institutionally. Also, our choice to include households' consumption out of public income as part of the public instead of private sector's demand is based on the idea that the purchasing power that finance it is generated by the public and not the private sector (although the expenditure is made by the households)[4].

We must consider some peculiarities to include public sector wages into our decomposition. Following Serrano/Pimentel (2019), government spending in public

[2] Deleidi/Mazzucato (2019) call attention that part of the business spending in R&D can be considered induced as it is important to innovation and productive capacity creation. To separate empirically the autonomous and induced parts of expenditures in R& D can be difficult in practice, and we thus consider this variable as part of the autonomous demand.

[3] We consider public companies' investment as autonomous following Freitas/Dweck (2013: 185) because 'capitalist competition did not exert a major influence on its behavior'. For a different interpretation see Campana et al. (2022) who consider public companies' investment as an induced component of demand.

[4] Our results considering alternatively consumption out of public income as part of the private sector's demand are shown in table 3 in the Appendix.

services has a double impact on output: as government consumption and as wage income spent by public servants on consumption. Only the latter leads to a (super)multiplier effect. This particularity of government wages stems from the fact that they constitute both gross value added (public services) and demand (government consumption) at the same time. The result is different when the government spends through transfers: this only affects the aggregate demand when the recipients spend that money. To properly account for the particularity of government wages, we define induced expenditures – induced consumption, induced investment and imports – as a function of aggregate income deducted from the public wage bill. This variable can be understood as the demand for domestic products and services that generates induced spending.

The variables are defined as follows. Aggregate supply, composed by GDP plus imports, is equal to aggregate demand (equation 1). Consumption is made by households and government (equation 2)[5]. We split households' consumption into an autonomous and an induced component (equation 3). Autonomous consumption encompasses credit-financed consumption and consumption out of public income (equation 4). Credit-financed consumption is equal to the volume of new consumer credit, once we consider the (average effective) tax on value added (equation 5)[6]. Consumption out of public income corresponds to the part induced by public transfers and government wages. This is obtained by multiplying these public transfers and government wages by the propensity to consume after deducting the corresponding taxes. For consumption out of transfers, only the tax on value added applies, whereas for consumption out of public wages we also consider the tax on wages (equation 6). Induced consumption is defined as the part of the after-taxes private-wage income spent on consumption of goods and services, which results from multiplying the private wage bill net of taxes by the propensity to consume (equation 7) [7].

The private wage bill is calculated as the product of the private (adjusted) wage share – workers' participation in value added in the private sector, including the part of mixed income attributed to wages[8] – and aggregate income, deducted from government wages (equation 9). Stockhammer (2013) provides a benchmark definition of the private wage share. This consists in adjusting the overall wage share by deducting the part corresponding to the public sector, proxied by government consumption, whose wage share is assumed to be equal to one since there are no profits. However, government consumption does not only encompass goods and services provided by the government, but also purchases of goods and services from the private sector (equation 8)[9]. We

[5] Households' consumption includes consumption by non-profit institutions serving households.

[6] We use the volume of new consumer credit instead of the consumption of durable goods as a proxy, as used by Freitas/Dweck (2013) and Bastos/Porto (2016). Our choice is motivated by the fact that credit was also widely used to finance the consumption of non-durable goods and services. Nevertheless, consumer credit is still an imperfect proxy since it does not encompass other forms of credit that are also used for consumption, such as credit card overdrafts and some part of mortgage loans.

[7] Taxes on value added and wages affect the composition of consumption, but not its aggregate value, ensuring accounting identity.

[8] Since an important part of Spanish workers is self-employed, mixed income represents a significant part of households' income in Spain.

[9] Government consumption also includes capital depreciation, which in our specification is included in government consumption of private goods and services.

consider it more accurate to estimate the private wage share by deducting government wages and not the whole government consumption (equation 9). We estimate the (average) propensity to consume residually as the ratio of households' income (wages and transfers) spent on consumption, deducted from taxes (equation 10). Our specification of households' consumption considers both the propensity to consume and the wage share, allowing for the differentiation of the effect of changes in the functional income distribution from other factors.

Investment is decomposed into public—autonomous government and public companies' investment—and private investment (equation 11). The latter is split into autonomous private investment (equation 12)—private residential investment and other autonomous investment (investment in research and development plus net acquisitions of valuable objects)—and induced investment, which we estimate residually (equation 13). Private residential investment is estimated by subtracting the government's residential investment and adding investment in non-residential constructions by the real estate sector from total residential investment. The latter is introduced as it constitutes an extension of residential investment and does not increase productive capacity[10]. In line with supermultiplier theory, productive investment keeps a certain relation to GDP captured by the propensity to invest (equation 13) and is considered an induced component of demand. Since the payment of public wages does not constitute demand for the private sector—only their later spending on consumption—we deduct such wages from GDP. Therefore, the propensity to invest is defined in relation to the demand for domestic goods and services that generates induced spending (equation 14).

Aggregate demand is the sum of autonomous and induced demand (equation 15). Autonomous demand encompasses autonomous consumption and investment, public expenditures, and exports (equation 16). Public expenditures comprise government consumption, government investment and investment by public companies (equation 17). Imports are defined through the import content of the demand that generates induced spending, i.e. aggregate demand minus government wages (equations 18 and 19). By replacing each term in equation 8 by their respective expressions, we obtain the ultimate definition of output as a function of the supermultiplier and autonomous demand (equation 20). The value of the supermultiplier depends positively on the propensity to consume out of wages, the private wage share and the propensity to invest, while it depends negatively on the import content and the effective average tax rates on value added and wages. This specification complies with Serrano/Pimentel's (2019) theoretical proposal: changes in public wages affect output through the 'supermultiplication' of its spending in consumption, and as public value added, which is not 'supermultiplied' (equation 21). Finally, we can express the rate of growth of GDP in terms of the rate of growth of autonomous expenditures and the parameters, multiplied by their corresponding coefficients and shares, and the supermultiplier (equation 22)[11].

[10] Any other investment in construction is considered as part of productive investment.

[11] Subscript *0* denotes previous year, while subscript *1* denotes end of current year. A dot over a variable denotes its growth rate. The β parameters are related to the tax burden and the propensity to consume (see the Appendix).

Table 1: Glossary of variables

Demand components		Main aggregates	
C	Consumption	Y	Income
C_G	Government consumption	D	Aggregate demand
C_{GPGS}	Government consumption of private goods and services	Z	Autonomous expenditures
C_A	Autonomous consumption	**Other aggregate variables**	
C_{Pub}	Consumption out of public income	W	Wage bill
C_{Cr}	Credit-financed consumption	W_{Priv}	Private wage bill
C_I	Induced consumption (out of private wages)	W_G	Public wage bill
I	Investment	Tr	Transfers
I_G	Government investment	Cr	Consumer credit
I_{PC}	Public companies' investment		
I_A	Private autonomous investment	**Coefficients**	
I_{Res}	Private residential investment	α	Supermultiplier
I_{OA}	Other private autonomous investment	ω	Adjusted wage share
I_I	Induced investment (productive investment)	ω'	Private adjusted wage share
G	Public entities' demand	c	(Average) propensity to consume (out of wages and transfers)
M	Imports	h	(Average) propensity to invest
X	Exports	t_w	(Effective average) tax rate on wages
		t_{VA}	(Effective average) tax rate on value added
		m	Import content (of the demand that generates induced spending)

Table 2: Equations

$$Y + M = C + I + X \quad (1)$$
$$C = C_H + C_G \quad (2)$$
$$C_H = C_A + C_I \quad (3)$$
$$C_A = C_{Cr} + C_P \quad (4)$$
$$C_{Cr} = (1 - t_{VA})Cr \quad (5)$$
$$C_P = c(1 - t_{VA})Tr + c(1 - t_{VA})(1 - t_w)W_G \quad (6)$$
$$C_I = c(1 - t_{VA})(1 - t_w)\omega'(Y - W_G) \quad (7)$$
$$C_G = C_{GBSP} + W_G \quad (8)$$
$$\omega' = \frac{W_{Priv}}{Y - W_G} = \frac{\omega Y - W_G}{Y - W_G} \quad (9)$$
$$c = \frac{C_H - (1 - t_{VA})Cr}{(1 - t_{VA})[Tr + (1 - t_w)\omega Y]} \quad (10)$$
$$I = I_G + I_{PC} + I_A + I_I \quad (11)$$
$$I_A = I_{Res} + I_{OA} \quad (12)$$
$$I_I = I - (I_G + I_{PC}) - I_A = h(Y - W_G) \quad (13)$$
$$h = \frac{I_I}{Y - W_G} \quad (14)$$
$$D = Y + M = Z + C_I + I_I \quad (15)$$
$$Z = C_A + I_A + G + X \quad (16)$$
$$G = C_G + I_G + I_{PC} \quad (17)$$
$$M = m(D - W_G) \quad (18)$$
$$m = \frac{M}{D - W_G} = \frac{M}{Y + M - W_G} \quad (19)$$
$$Y = \left(\frac{1 - m}{1 - (1 - m)[c(1 - t_{VA})(1 - t_w)\omega\prime + h]}\right)(Z - W_G) + W_G = \alpha(Z - W_G) + W_G \quad (20)$$
$$\frac{dY}{dW_G} = \left[1 + \alpha[c(1 - t_{VA})(1 - t_w)]\right]dW_G \quad (21)$$
$$\dot{Y} = \alpha_1 \left[\beta_{Cr}\frac{Cr_0}{Y_0}\dot{Cr} + \beta_{Tr}\frac{Tr_0}{Y_0}\dot{Tr} + \beta_{W_{Pub}}\frac{W_{G0}}{Y_0}\dot{W}_G + \frac{I_{Res0}}{Y_0}\dot{I}_{Res} + \frac{I_{OA0}}{Y_0}\dot{I}_{OA} + \frac{G - W_G}{Y_0}(\dot{G} - \dot{W}_G) + \frac{X}{Y_0}\dot{X} + \beta_c c_0 \dot{c} + \beta_{\omega\prime}\omega'_0\dot{\omega}' - \beta_{t_w}t_{w0}\dot{t}_w - \beta_{t_{VA}}t_{VA0}\dot{t}_{VA} + h_0\dot{h} - \beta_m m_0 \dot{m}\right] + \frac{W_{G0}}{Y_0}\dot{W}_G \quad (22)$$

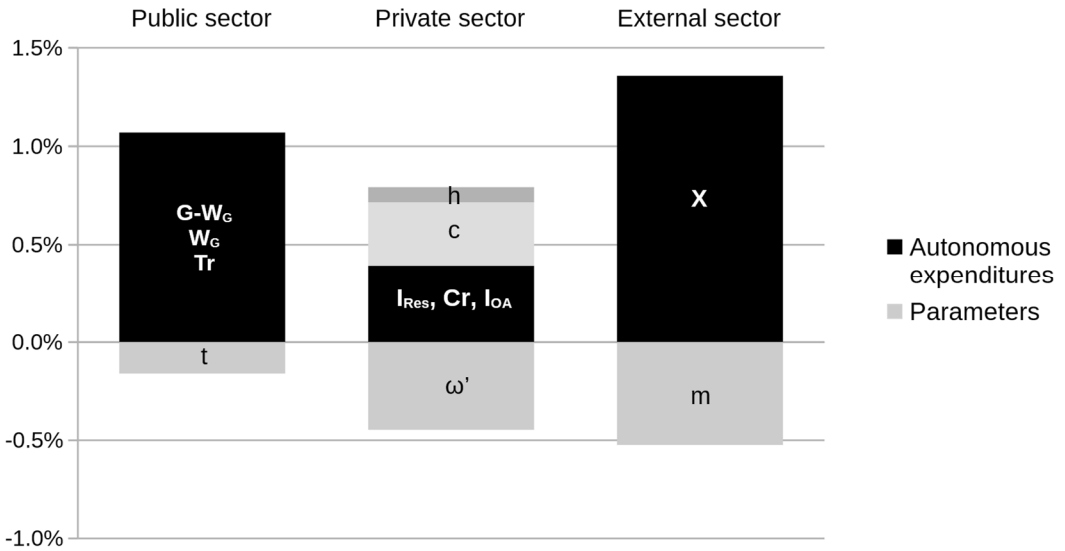
3. Results

3.1 General results

Our demand-led growth accounting points to some structural features and long-term trends in the Spanish economy. First, considering the whole period (1998-2019),

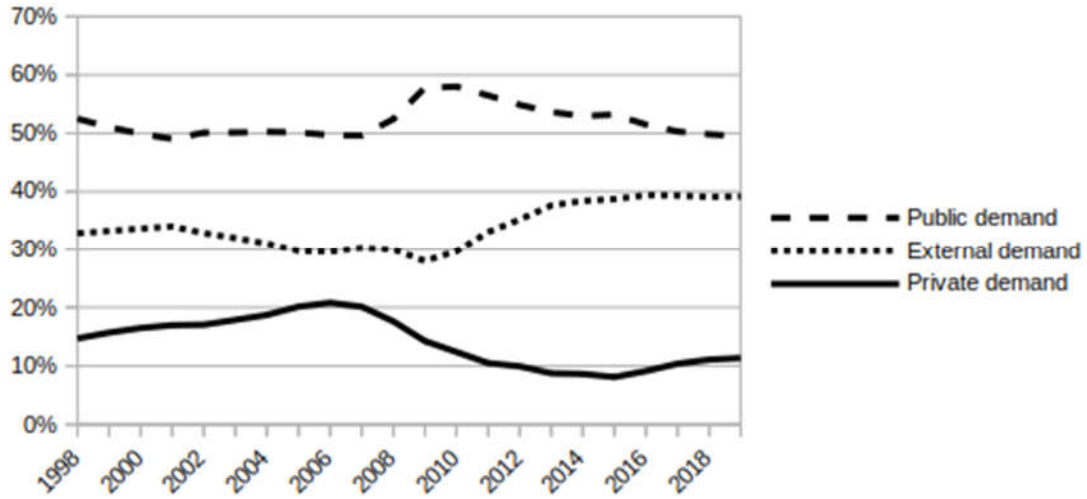
public expenditures and exports are the most important drivers of growth, while the contribution of private autonomous expenditures is much smaller (Figure 1). This result also holds when we calculate the net contribution of each sector adding the contributions of the supermultiplier parameters (taxes for the public sector, the wage share and the propensities to consume and to invest for the private sector, and the import content of demand for the external sector).

Figure 1: Average contribution to real GDP growth by sector (1998-2019)



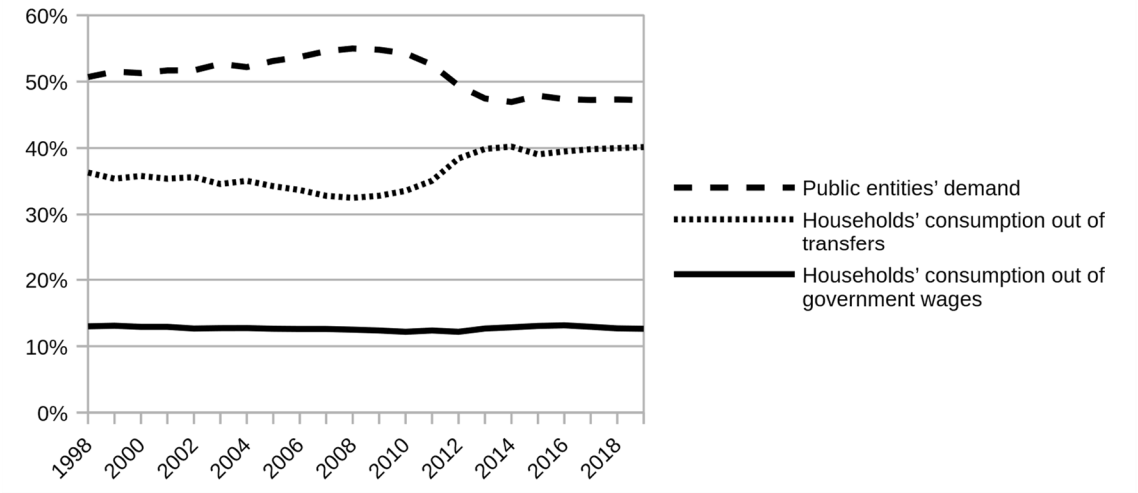
The importance of public expenditures and exports stems from the fact that the public sector's and the exports' share in autonomous demand are much higher than the private sector's share, as shown in Figure 2.

Figure 2: Composition of autonomous demand



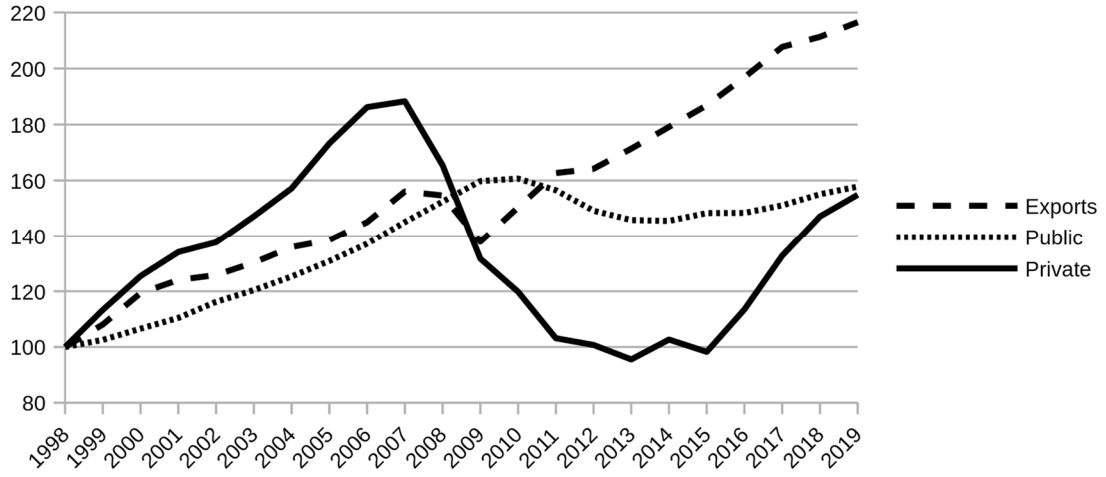
Importantly, this result is conditioned by our assumption that households' consumption out of public income makes up part of public autonomous demand. This roughly doubles the size of public autonomous demand, notably due to the weight of consumption out of transfers (Figure 3).

Figure 3: Composition of public (autonomous) demand



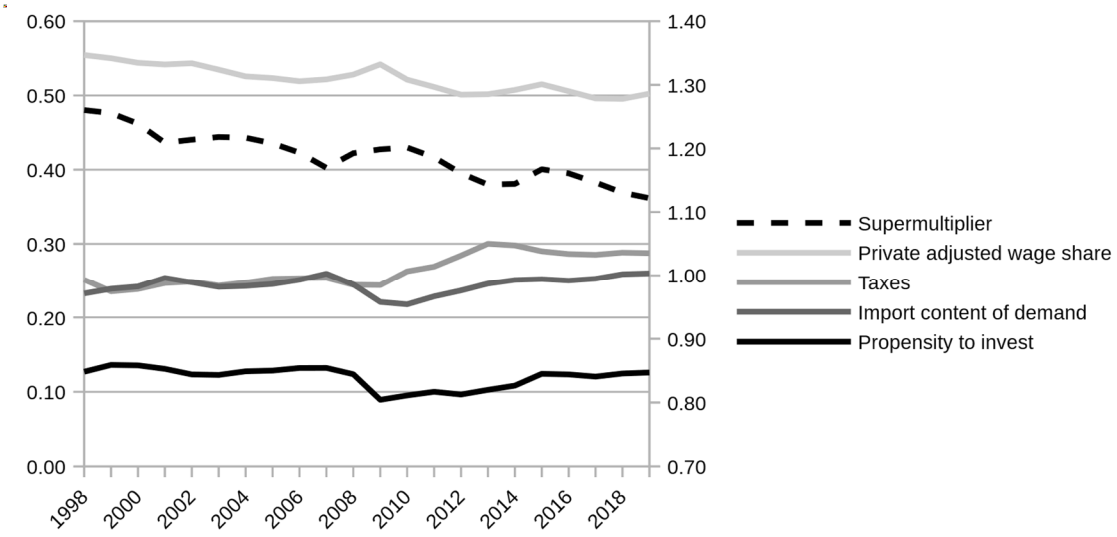
Second, the only component of the autonomous demand that has maintained its pace of growth over the period of analysis is exports (Figure 4). The upward growth trend of public spending was interrupted in 2010, when austerity programmes where initiated, while private autonomous demand suffered a huge and long slump in the recession, between 2007-2013. The latter did not resume growth until 2016 and ended the period far below its pre-crisis level. These divergent growth dynamics explain the autonomous demand's composition changes (Figure 2): the decrease in the weight of private and public demand in favour of exports.

Figure 4: Growth of autonomous demand components



A third noteworthy point regards the behaviour of the estimated supermultiplier, which has followed a downward trend, contributing negatively to growth in the whole period (Figure 5). This pattern resulted mainly from two long-term trends: i) a continuous shrinkage of the private wage share and ii) the increase of the import content of demand.

Figure 5: Model parameters (left axis) and the supermultiplier (right axis)



Left and right *y* axes have the same scale.
The variable taxes (t) approximates for the combined effect of wage and value added taxation in the following way:
$(1-t) = (1-t_w)(1-t_{VA}) \Rightarrow t = t_{VA} + t_w - t_w t_{VA}$.

The private wage share decreased from 56% in 1998 to 50% in 2018[12]. This can be attributed to the following structural changes: First, a regime of capital-labour relations based on wage moderation supported by trade unions (Muñoz de Bustillo-Llorente/Antón-Pérez 2007, Ferreiro/Gómez 2014: 111). Second, mid-1990s regulatory reforms facilitated the fall in the coverage ratio of collective agreements and in the ratio of union membership[13], and an increase in the ratio of involuntary part-time employment. Third, job creation biased towards sectors with less sectors with less of a tradition of wage negotiation and lower ratios of union membership (Blanco 2004). Fourth, the precarious conditions in which migrants from non-EU countries are incorporated into the labour marker, despite displaying similar levels of education with the nationals (Muñoz de Bustillo 2007). Fifth, the programme of structural reforms and fiscal consolidation implemented from 2010 onward involving changes in labour regulation implemented between 2010-2012 (Álvarez et al. 2018), cuts and freezing in

12 There was a slight recovery in 2019 which can be attributed to the significant increase in the minimum wage implemented that year.

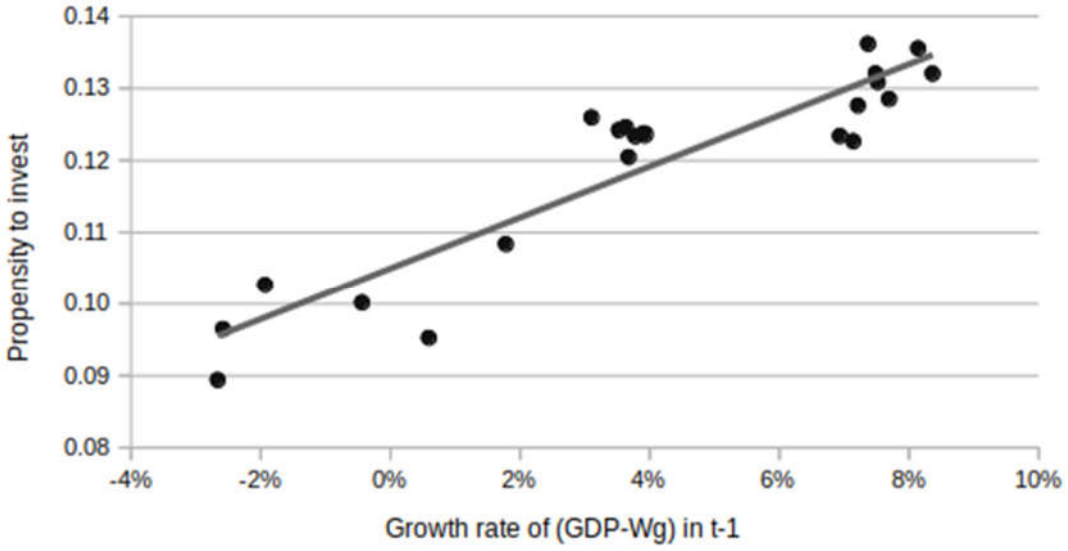
13 The ratio of coverage of sectoral collective agreements was relatively high in Spain compared to other countries, while the regulatory minimum wage too low, making the wages set by the former more determinant than the latter for the bargaining power balance (Fernández et al. 2006).

public wages between 2010-2014 (Uxo et al. 2016), and the reduction in the quantity and scope of unemployment benefits in 2012. Finally, the persistence and duration of unemployment (Stirati/Meloni 2021), reflected in the fall of the ratio of insured unemployed workers (Cárdenas-del Rey/Herrero-Alba 2021), may have also been important in explaining the fall in the wage share.

The upward trend of the import content may be explained by changes in the composition of the aggregate demand, as well as an increase in the import intensity of certain components of the demand. Exports, the component with the highest import content (Gandoy 2017), increased their relative weight on the aggregate demand. Also, exports increased their import content throughout the whole period, a fact typically attributed to the deepening in the integration of global value chains (Myro 2018). The import content also increased for private consumption and productive investment (Bussière et al. 2013, Bank of Spain 2017a: 93, 2020a: 28–29). Another key factor which might help to explain the structural increase in the import content is the EMU membership. Finally, the cyclical component of import content can be explained by the behaviour of the propensity to invest, since productive investment is the demand component with the second highest import content.

The behaviour of the propensity to invest seems to be consistent with the flexible accelerator mechanism advocated by the supermultiplier theory. From this theoretical perspective, induced investment moves with GDP, although with greater volatility, and the investment share is positively correlated with the rate of growth of GDP. The expected pattern can be observed in Figure 6[14]. This evidence seems to support our decomposition, which considered private capacity-generating investment as an induced variable.

Figure 6: Propensity to invest v. GDP-W_G growth rate



[14] For evidence in favour of the accelerator effect for OECD countries, including Spain, see Girardi/Pariboni (2020) and Pérez-Montiel/Erbina (2020).

3.2 Three phases of growth

The Spanish economy went through three different periods. The first one (1998-2007) was marked by the largest expansion experienced since democracy was re-established in 1975. The average growth rate (3.83%) was above all the euro area members except Ireland (Euro Area-12 grew 2.15%). The second period, 2008-2013, was marked by a recession, because of two shocks: the global financial crisis (GFC) and the euro area sovereign debt crisis. Real GDP shrank by almost 10% during this five-year recession. The third period (2014-2019) marked the recovery of the Spanish economy, initiated in the first quarter of 2014. Growth, however, was weaker than in the first period (average rate of 2.6%) and decelerated from 2016 onward. Our demand-led growth accounting decomposition results are displayed in Table 3, which shows the contribution of each autonomous expenditure and supermultiplier parameter to economic growth for each of these three growth periods. Table 3 of the Appendix displays the alternative results considering households' consumption out of public income as part of the private sector's autonomous demand.

Table 3: Growth decomposition

	1998-2007	**2008-2013**	2008-2009	2010-2013	**2014-2019**	**1998-2019**
GDP	**3.83%**	**-1.32%**	-1.44%	-1.26%	**2.60%**	**2.09%**
Public expenditures	**1.90%**	**-0.22%**	2.97%	-1.82%	**0.91%**	**1.07%**
Public entities' demand*	1.04%	-0.22%	1.07%	-0.87%	0.08%	0.43%
Public wages	0.44%	-0.23%	0.79%	-0.73%	0.33%	0.23%
Transfers	0.42%	0.23%	1.10%	-0.21%	0.50%	0.41%
Private expenditures	**1.38%**	**-1.63%**	-3.10%	-0.90%	**0.81%**	**0.39%**
Consumer credit	0.44%	-0.53%	-1.14%	-0.22%	0.41%	0.17%
Private residential investment	0.89%	-1.10%	-2.01%	-0.64%	0.36%	0.20%
Other autonomous investment	0.05%	-0.01%	0.05%	-0.04%	0.04%	0.03%
Exports	**1.76%**	**0.57%**	-1.83%	1.77%	**1.58%**	**1.36%**
Supermultiplier parameters	**-1.21%**	**-0.03%**	0.52%	-0.31%	**-0.70%**	**-0.73%**
Private wage share	-0.29%	-0.17%	0.00%	-0.26%	0.00%	-0.45%
Propensity to consume	0.35%	0.31%	-1.37%	1.15%	-0.74%	0.32%
Propensity to invest	0.26%	-0.62%	-2.31%	0.22%	0.48%	0.08%
Import content of demand	-1.50%	1.13%	3.79%	-0.20%	-0.60%	-0.52%
Wage taxation	0.01%	-0.15%	0.10%	-0.28%	0.12%	0.00%
Value added taxation	-0.04%	-0.53%	0.31%	-0.95%	0.03%	-0.16%
Net contributions						
Public sector	**1.87%**	**-0.90%**	3.37%	-3.04%	**1.06%**	**0.91%**
Private sector	**1.69%**	**-2.12%**	-6.78%	0.21%	**0.56%**	**0.35%**
External sector	**0.26%**	**1.70%**	1.97%	1.57%	**0.98%**	**0.83%**

The results show that in the pre-GFC economic expansion (1998-2007) the autonomous demand growth was driven mainly by public spending and exports, and then private demand (mainly residential investment), while the supermultiplier contributed strongly to reduce growth. Public spending expansion was mainly due to the discretionary increase in public entities' demand, although the contribution of transfers and public

wages was not negligible, but much more in line with the average. Meanwhile, private residential investment contributed to this period much more than the average[15]. If we consider the net contribution of each institutional sector, however, these results change mainly due to the negative contribution of the increase in the import content, both for structural reasons and for the increase in the propensity to invest. Hence, the public sector is still the most important source of demand, but followed closely by the private sector, and then, the external sector. However, it is important to stress, the three institutional sectors contributed positively to growth in the period.

The recession (2008-2013) was led by a strong negative contribution of private autonomous demand followed by a positive but moderate contribution of public autonomous demand, and it was not worse because exports contributed positively. The supermultiplier had a neutral contribution to growth: the positive contribution of the drop in the import content was offset by the negative contribution of the fall in the propensity to invest and the wage share, and the increase in tax burden. The results in terms of institutional sectors' net contribution to demand-led growth point to a strong negative impact of the private sector, followed by the public sector. The former was due to the combined effect of the crisis in the housing market and the financial sector (and its multiplier-accelerator feedback effects) while the latter was caused by subsequent austere fiscal policy. Even with a strong contribution of the external sector (because of positive contribution of growing exports and falling imports), the result was contractionary to output.

The recession can be divided into two phases. The first phase (2008-2009) was led by the collapse in private demand and exports, with the slump in global trade coinciding with the onset of the GFC. Fiscal policy acted counter-cyclically, with automatic stabilizers and public consumption and investment expansion with the 'Plan E'. The second phase of the recession (2010-2013) was mainly driven by a contraction in public spending coupled with an increase in wage and value-added taxation, following the implementation of austerity policies, while the exports recovered. The former had a decisive effect in prolonging the recession. In 2010, austerity policies started, and public expenditures had a neutral contribution to growth. Together with the recovery of exports, this made the economy grow at a negligible although positive rate. However, in 2011, austerity policies led to a strong negative contribution of the public sector. These policies included cuts in public consumption and investment and reductions in public wages, unemployment benefits and other public transfers. The increase in the value-added tax between 2010 and 2012 (from 16% to 21%) and wage income tax in 2010 had a significant impact on consumption.

The post-crisis recovery (2014-2019) was mainly led by exports, together with a moderated recovery of public and private autonomous demand. Exports and consumption out of public income contributed to growth almost the same as in the first boom. These were followed by a partial recovery in private spending, with a more modest increase in

[15] The role of credit for consumption can be underestimated, as our data does not account for the part of mortgage credit that was used for consumption (Bover et al. 2019). So, the increase in the propensity to consume can be overestimated, as it is calculated as a residual.

residential investment. The role of direct public spending (excluding transfers and public wages) was also much smaller than in the previous boom. The supermultiplier again contributed negatively, with the increase in the import content and a decrease in the wage share more than offsetting the recovery in the propensity to invest. In terms of the net contribution, the modest but positive contributions of the public, external and private sectors explains the moderate recovery.

4. A debate with the literature

4.1 The pre-GFC economic expansion (1998-2007)

Our results show that public spending and exports were more important for growth than private demand during the economic expansion of 1998-2007. In contrast to that, prior literature has attributed a central role to residential investment and consumption, paying a great deal of attention to the credit boom, which is attributed to different factors. The mainstream view states that residential investment and households' consumption were boosted by low interest rates emerging from a 'regime of macroeconomic stability' and further pushed down by the ECB (Bank of Spain 2004: 15, 24, 2007: 35–36, Malo-de Molina 2005). The important role of low interest rates on residential investment and households' consumption is also pointed out by heterodox authors, as Storm/Naastepad (2015) and Hein/Martschin (2021: 513). Other factors that could explain the credit boom are the role of financial liberalisation and large capital flows into peripheral euro countries on real estate (Rodríguez/Bustillo 2008, Tilford/Whyte 2011, Cesaratto 2013, Stockhammer 2016) and a credit-financed speculative process in which increases in house prices fed back on more credit through the revaluation of collaterals (Febrero/Dejuán 2009, Febrero et al. 2019).

Our results show that residential investment and credit-financed consumption grew more than other autonomous demand components during this period (see Figure 4). However, since the share of private expenditures on autonomous demand is much lower than that of the public sector and exports, in the end, the direct contribution of the former was small relative to the others. Nevertheless, we can identify one important feedback effect showing a larger impact of residential investment in the economy. The real estate boom was the key factor explaining the 4pp increase in the tax-revenue-to-GDP ratio during this period, because of the increase in housing prices and in the number of transactions and housing starts[16]. This extraordinary tax revenue was important in enabling the increase in public spending within the limits of the prevailing tight fiscal rules[17].

[16] The European Commission estimates that between 50% and 75% of the tax revenue increase was linked to the real estate boom (Martinez-Mongay et al. 2008), while the Bank of Spain's estimate is closer to the lower range of 50% (de Castro-Fernández et al. 2008).

[17] In 2001, Spain introduced a legal framework guiding fiscal spending that was even more demanding than the EU's Stability and Growth Pact (SGP): *every* administration was obliged to run a *current* balanced budget, instead of the SGP's medium-term target of close-to-balanced budget for the aggregate public administration. The easing of the SGP's rules in 2006 was more ambiguous in Spain, where surpluses became mandatory whenever significant growth was expected in the following years.

Assuming that consumption induced by capital income is not significant, this facilitated the expansionary effect of the fiscal policy seen in our results, especially, in the last three years of the period when the overall budget balance turned into a surplus position. This finding is in line with Serrano/Pimentel's (2019: 4) theoretical discussion building upon Haavelmo's take on fiscal policy, according to which 'even if a primary surplus has to be obtained, an increase in government demand financed by taxes can be expansionary, provided the primary surplus target' is 'smaller than the marginal propensity to save of the private sector'. Moreover, as Serrano/Pimentel (2019) claim, the expansionary effect is amplified by the increase in the supermultiplier stemming from the reaction of the propensity to invest to larger demand[18].

The prominent role that our results give to the public sector, in contrast to prior literature is explained by two facts. First, our taxonomy considers consumption out of public income and public companies' investment as public and not private demand as is typically assumed. When the latter is assumed, the private sector becomes the main contributor to growth, although the contribution of the public sector continues being sizeable (see Table 3 in the appendix). Second, the supermultiplier approach treats the expansionary effects of public spending separately from the contractionary effects of increased taxation. On the contrary, in the literature, the public sector's impact on growth has been typically analysed by looking at budget balances, reaching opposite conclusions. For example, Kohler/Stockhammer (2022: 16) assess the fiscal stance through the average cyclically adjusted primary balance for the period 2000-2007, concluding that it was contractionary. Meanwhile, the Bank of Spain uses the *change* in the cyclically adjusted primary balance as an indicator of fiscal impact, which followed an upward trend (from decreasing deficits to increasing surpluses) until 2007, concluding that the fiscal policy stance was restrictive (Bank of Spain 2017b: 35, Malo-de Molina 2014, Ortega/Peñalosa 2012: 28). The same indicator is used by Hein/Martschin (2021: 511, 513) in combination with the public investment-GDP ratio, drawing similar conclusions. An exception in the literature is the IMF (2006), which estimates separately the impacts of government spending and of taxation. According to its results, the IMF argued that, in 2005, despite the government running a cyclically adjusted (overall) fiscal surplus, fiscal policy contributed positively to economic growth. This resulted from 'public spending increases [having] a significantly larger expansionary impact on demand and the current account than the contractive impact of equivalent revenue gains' (ibid: 13-14).

Finally, our results show a small but positive net contribution of the external sector that contradicts prior literature. This result emerges from the decomposition that considers separately the direct expansionary effects of exports from the contractionary effects of imports on demand. Prior literature has privileged the current account balance as indicator of the external sector's contribution to growth (Hein/Martschin 2020: 567, 2021: 514, Bank of Spain 2007: 106)[19]. Since Spain increasingly ran deficits, it was

[18] Other interesting line of further investigation based on insights on the supermultiplier would be to check the empirical evidence on the importance of the public sector demand to sustain episodes of private autonomous demand boom and indebtedness. For a theoretical reference, see Pariboni (2006).

[19] For a comparison of the results of contribution of the external and public sector to growth using the methods of national income and financial accounting decomposition, following the demand and growth

assessed that the external sector's contribution was negative. Following our results, the import content increased in this period, having a strong negative contribution to growth (-1.5%). Nevertheless, Spanish exports performed relatively well, or at least not worse than the main advanced economies besides Germany (Myro 2018)[20]. Exports contributed 1.7% to growth, more than compensating for the negative effect of the increase in imports.

4.2 The recession of 2008-2013

In the Spanish recession (2008-2013), GDP contracted by almost 10%,. It is generally interpreted as a double-dip recession with a first phase initiated with the GFC and the burst of the housing bubble, and a second phase coinciding with the euro area debt crisis. Our results suggested that, overall, the main cause of the recession was the strong contraction in private spending, but that fiscal austerity was the decisive factor explaining the second phase of the recession (2010-2013). The literature tends to agree in pointing to the collapse in private demand, but the diagnoses are diverse. Some economists attribute the crisis to balance-of-payments problems (Bank of Spain 2013: 7, 59; 2017; Higgins/Klitgaard 2014; Ferreiro et al. 2016). Some focus on the role of financial liberalisation to external imbalances and its effects on indebtedness of the non-financial corporate sector (Aglietta 2012, Caldentey/Vernengo 2018). Others believe that the credit crunch that triggered the crisis was related with the deleveraging of households and firms in a context of a balance-sheet recession (Torrero-Mañas 2014, Álvarez-Peralta 2014, Febrero et al. 2019, Hein/Martschin 2021). In addition, Febrero et al. (2019) focus on the role of credit cycles and banks' risk-taking decisions in contracting lending to the private sector. For Febrero/Bermejo (2013) and Hein/Martschin (2021) the recession was later aggravated by fiscal consolidation, implemented through a mix of cuts in government consumption, investment and wages and an increase on indirect taxes. Uxó et al. (2016) focus on the impact on households' consumption of the contraction in both the private wage bill, due to the collapse in construction activity, and the public wage bill, following cuts and freezes of civil servants' wages.

Considering the whole period of recession, our results are consistent with the credit-bust thesis, as the contraction in autonomous consumption and residential investment together had the most negative contribution to growth in the period 2008-2013. Moreover, the reduction in private induced spending was in line with the contraction of aggregate income. Consumption was negatively affected by the fall in the private wage share but positively affected by the increase in the propensity to consume. This finding does not support the balance-sheet recession thesis, although, since our propensity to consume is calculated as a residual, we must interpret this result with caution. Considering the whole recession, the drop in private productive investment seems to be compatible with the

regimes perspective with the autonomous demand (or supermultiplier) demand-led growth decomposition for the BRICS countries, see Campana et al. (2022).

[20] Despite Spain's share in world exports decreased from 2004, it increased when considering the whole period (Febrero/Bermejo: 2013).

adjustment of productive capacity to a much lower expected growth of effective demand (although we do not exclude financial impacts on businesses' investment in the short run).

Our results also support the importance of the public sector's consolidation to reduce the growth rate of the economy, especially between 2010-2013 when it became the main driver of the recession. Hein/Martschin (2021) also identify a contractive fiscal stance from 2010 onwards, since the public spending cuts were accompanied by a reduction of the cyclically adjusted primary deficits. On the contrary, Kohler/Stockhammer (2021) do not qualify Spain's fiscal stance as contractionary since the government run cyclically adjusted primary deficits.

Finally, our results show that the external sector contributed strongly to growth in the recession. This stemmed from both the slump in imports resulting from the contraction in aggregate demand (with the fall in productive investment' share contributing to reduce the overall import content) and the positive contribution of exports in second phase of the recession. We cannot reach the same conclusion through the indicator typically used in the literature: Spain ran current account deficits until 2012 and the period average of the current account was clearly negative. In any case, for an economy like Spain, characterised by a large weight of domestic demand and, especially, public expenditures, the external sector alone does not seem to be able to lead a growth regime.

4.3 The economic recovery (2014-2019)

Following our results, the recovery resulted from the continuation of export growth followed by a slight expansion in public and private autonomous spending. Prior literature agrees that the recovery was driven by exports, although there is a debate on the role played by external competitiveness and, especially, real wage devaluation. Some authors believe that this was important to the recovery (Bank of Spain 2015: 23)[21]. Hein/Martschin (2021: 516) state that the external demand push did not only result from price competitiveness gains, but also from the recovery of economic growth in foreign countries. Other authors are more critical of the importance of price competitiveness to exports, and reject the hypothesis that wage moderation had relevant effect in stimulating exports in Spain in this period (Cárdenas et al. 2020, Villanueva et al. 2020, Kohler/Stockhammer 2021, Bilbao-Ubilos/Fernández-Sainz 2022).

Although exports contributed significantly to growth in the economic recovery, imports also resumed, pulled by the upturn in consumption and investment. As a result, the net contribution of the external sector was indeed lower than during the recession. Hence, as we noted above, the recovery would not have been possible without the growth of domestic spending. This finding contradicts the conclusion reached by Hein/Martschin (2020: 571), who, focusing on the growth contribution of the balance of goods and services and the financial balance of the external sector, qualify the growth period of the Spanish recovery as an 'export-led mercantilist regime'. Kohler/Stockhammer (2021: 23) argue that such approach 'may give misleading results' for the post-GFC period, since

[21] However, the Bank of Spain (2017a) estimates that price competitiveness had a lower contribution to exports expansion after 2012's labour market reform than in the years that preceded it.

some ‘countries may appear “export-led”, but neither did they deliver a notable export performance nor did their exports lead to growth’.

Hence an important factor explaining the economic recovery is the return of the positive contribution of private autonomous demand (credit-financed consumption and residential investment) and, especially, of public spending from 2015 onwards. The latter is also noted by Cárdenas et al. (2020: 568) who, focusing on the rate of growth of public demand and not on the budget balance, argue that the fiscal stance turned expansionary in 2015 when austerity policies were eased. Hein/Martschin (2021:514) also identify that shift in the fiscal policy stance through the changes in the cyclically adjusted primary balance, although from 2016 onward. Finally, business investment also contributed positively to growth, as is expected due to the accelerator mechanism.

5. Final remarks

In this paper, we analysed the pattern of economic performance in Spain from 1998 to 2019 from a demand-led growth accounting perspective, based on the supermultiplier theory. Our general findings show that (i) public demand has an important contribution to autonomous demand in the Spanish economy, with the role of public wages and transfers acting as an important stabilizing component to demand growth; (ii) exports also have an important contribution to autonomous demand in the Spanish economy, also acting as an important stable contribution to demand growth; (iii) residential investment and credit-financed consumption played an important role in the pre-GFC economic expansion, not only because of the direct effect, but also through the indirect effect of increasing public revenues and discretionary public spending, with expansionary results to growth; (iv) the private business investment share is positively correlated with output growth, as predicted by the supermultiplier approach; (v) there is a downward trend of the supermultiplier during the whole period, mainly attributed to the continuous shrinkage of the private wage share, increasing import content and lower private productive investment share (as a result of lower growth).

Our demand-led growth accounting exercise presented here helped us to show some general patterns regarding the contribution of induced and autonomous components of demand, and the relative importance of the institutional sectors to demand-led growth. This kind of accounting exercise, as we saw, should be integrated with other institutional, political economy and structural elements, with a prominent role for the macroeconomic policy stance, and complemented with further institutional and empirical research.

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Appendix

1. Data sources

Table 1: Data sources

Variable	Source
Main aggregates	
Aggregate income	Spanish national accounts
Consumption by households and non-profit institutions serving households	Spanish national accounts
Investment	Spanish national accounts
Government consumption	Spanish national accounts
Government investment	Operaciones no financieras de las Administraciones Públicas
Public companies' investment	Cuentas de las empresas públicas
Exports	Spanish national accounts
Imports	Spanish national accounts
Auxiliary - investment	
Total residential investment	Spanish national accounts
Government residential investment	Operaciones no financieras de las Administraciones Públicas
Investment in non-residential constructions by real estate services sector	El stock y los servicios del capital en España y su distribución territorial y sectorial
Private investment in R&D	Spanish national accounts
Net acquisition of valuable objects	Spanish national accounts
Auxilliary - consumption	
Consumer credit	Bank of Spain's Statistical Bulletin
Transfers to households	Spanish national accounts
Public wage bill	Spanish national accounts
Parameters	
Average effective tax rate on wages	AEAT's tax collection statistics
Average effective tax rate on value added	AEAT's tax collection statistics
Adjusted wage share	AMECO Database

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Bank of Spain's Statistical Bulletin, Database of the Bank of Spain, URL: https://www.bde.es/webbde/en/estadis/infoest/bolest.html

Cuentas de las empresas públicas, database of the Spanish Finance Ministry's Comptroller General of the State (*Intervención General de la Administración del Estado, IGAE), URL: https://www.igae.pap.hacienda.gob.es/sitios/igae/es-ES/Contabilidad/ContabilidadNacional/Publicaciones/Paginas/empresaspublicas.aspx*

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2. Estimation of incomplete and real series

2.1. Estimation of incomplete series

There are two series for which data is not available either in the first years and/or in the last years of our period (consumption credit and investment by public companies). Missing values have been filled by extrapolating these series using other series ("consumption of durable goods" and "government investment" respectively), which are both economically related and statistically correlated, as references. Statistical correlation is checked on growth rates for the years data is available for both series, at a level of confidence of 0.95. Denoting *A* the incomplete series and *B* the complete and correlated

series, we run a linear regression of the growth rate of the incomplete series ($\dot{A}$) on the growth rate of the complete one ($\dot{B}$) as specified below (equation 1), where dots denote growth rates. The nomenclature is clarified in (equation 2). Finally, we use the coefficient b obtained in the regression to extrapolate recurrently the incomplete series backwards (equation 3) and/or forwards (equation 4).

$$\dot{A}=a+b\cdot\dot{B} \quad (1)$$

$$\dot{A}_t = \frac{A_t - A_{t-1}}{A_{t-1}} \quad (2)$$

$$A_{t-1} = \frac{A_t}{(1+b\cdot\dot{B}_{t-1})} \quad (3)$$

$$A_{t+1} = (1+b\cdot\dot{B}_{t+1})A_t \quad (4)$$

For consumption credit, data previous to 2003 is not available. We have extrapolated the series backwards using consumption of durable goods as reference (R^2=0.82). In the case of investment by public companies data is only available between 2002-2017. We have, hence, extrapolated the series both backwards and forwards with the values of govern investment (R^2=0.53).

2.2. Estimation of real series

To estimate series in real terms we use, when available, the volume indices at constant euros of 2015 from the Spanish national accounts. For the remaining series, we use the deflators specified in Table 2 below. The durable goods deflator is obtained by calculating the weighted average of volume indices for the following items, according to the Classification of Individual Consumption According to Purpose (COICOP): 4.3 Maintenance, repair and security of the dwelling; 5.1 Furniture, furnishings, and loose carpets; 5.3 Household appliances; 7.1 Purchase of vehicles; 9.1 Recreational durables; and 9.2 Other recreational goods. In turn, the deflator for non-durable goods and services is calculated in the same way using the remaining items.

Table 2: Deflators used for the estimation of real series

Variable	Deflator	Source
Government investment	Gross fixed investment	REMSDB Database
Investment by public companies	Gross fixed investment	REMSDB Database
Public residential investment	Residential investment	Spanish national accounts
Private investment in R&D	Investment in R&D	Spanish national accounts

Consumer credit	Consumption of durable goods	Own calculation from Spanish national accounts (as described above)
Transfers	Consumption of non-durable goods and services	Own calculation from Spanish national accounts (as described above)
Public wages	Consumption of non-durable goods and services	Own calculation from Spanish national accounts (as described above)
Private wages	Consumption of non-durable goods and services	Own calculation from Spanish national accounts (as described above)

3. Growth decomposition results considering households' autonomous consumption out of public income as part of the private sector

Table 3: Growth decomposition

	1998-2007	**2008-2013**	2008-2009	2010-2013	**2014-2019**	**1998-2019**
GDP	**3.83%**	**-1.32%**	-1.44%	-1.26%	**2.60%**	**2.09%**
Public expenditures[1]	**1.26%**	**-0.35%**	1.50%	-1.27%	**0.27%**	**0.55%**
Private expenditures	**2.01%**	**-1.48%**	-1.55%	-1.44%	**1.47%**	**0.91%**
Consumer credit	0.43%	-0.52%	-1.12%	-0.21%	0.41%	0.17%
Government wages[2]	0.21%	-0.11%	0.36%	-0.34%	0.15%	0.11%
Transfers[2]	0.45%	0.24%	1.14%	-0.22%	0.52%	0.41%
Private residential investment	0.87%	-1.08%	-1.98%	-0.63%	0.35%	0.20%
Other autonomous investment	0.05%	-0.01%	0.05%	-0.04%	0.04%	0.03%
Exports	**1.73%**	**0.55%**	-1.80%	1.73%	**1.55%**	**1.36%**
Supermultiplier parameters	**-1.17%**	**-0.05%**	0.41%	-0.28%	**-0.68%**	**-0.73%**
Private wage share	-0.37%	-1.02%	0.22%	-1.64%	0.00%	-0.45%
Propensity to consume	0.45%	1.15%	-1.66%	2.56%	-0.72%	0.32%
Propensity to invest	0.25%	-0.62%	-2.28%	0.22%	0.47%	0.08%
Import content of demand	-1.47%	1.12%	3.74%	-0.20%	-0.59%	-0.52%
Wage taxation	0.01%	-0.15%	0.09%	-0.28%	0.11%	0.00%
Value added taxation	-0.04%	-0.53%	0.30%	-0.94%	0.03%	-0.16%
Net contributions						
Public sector	**1.23%**	**-1.03%**	1.90%	-2.49%	**0.41%**	**0.39%**
Private sector	**2.34%**	**-1.96%**	-5.28%	-0.30%	**1.22%**	**0.86%**
External sector	**0.25%**	**1.67%**	1.94%	1.53%	**0.96%**	**0.83%**

[1] Includes government wages as government consumption, but not as income financing households' consumption.

[2] Contribution to growth through their spending by households in consumption.

4. The supermultiplier growth decomposition formula

The supermultiplier growth accounting methodology (Freitas and Dweck, 2013) consists of decomposing the rate of growth of GDP on the basis of the supermultiplier theoretical framework. The rate of growth of GDP is expressed in terms of the supermultiplier and the rate of growth of each variable. To reach that expression, we use an iterative process, based on rearranging the basic decomposition of GDP in increments of each variable. We depart from the basic decomposition of GDP between autonomous and induced demand minus imports:

$$Y = D - M = (1-m)D + mW_G = (1-m)(Z + C_I + I_I) + mW_G$$

Defining $Y' = Y - W_G$ and $Z' = Z - W_G$ we obtain:

$$Y' = (1-m)(Z' + C_I + I_I)$$

In turn, we define $\gamma = c(1-t_{VA})(1-t_w)\omega'$ and express each component but the autonomous one in terms of *Y'*:

$$Y' = (1-m)(Z' + \gamma Y' + hY')$$

Hence, we can express the increase in *Y'* as:

$$\Delta Y' = (1-m_1)(Z'_1 + \gamma_1 Y'_1 + h_1 Y'_1) - (1-m_0)(Z'_0 + \gamma_0 Y'_0 + h_0 Y'_0)$$

We rearrange the expression as

$$\begin{aligned}\Delta Y' = {} & \left[(1-m_1)Z'_1 - (1-m_0)Z'_0\right] \\ & + \left[(1-m_1)\gamma_1 Y'_1 - (1-m_0)\gamma_0 Y'_0\right] + \left[(1-m_1)h_1 Y'_1 - (1-m_0)h_0 Y'_0\right]\end{aligned}$$

and we operate to express each of the three elements on the right side of the equation in terms of increases in *Z'* and *Y'* by adding and subtracting $(1-m_1)Z'_0$, $(1-m_1)\gamma_1 Y'_0$ and $(1-m_1)h_1 Y'_0$:

$$\begin{aligned}\Delta Y' = {} & \left[(1-m_1)\Delta Z' - Z'_0 \Delta m\right] + \left[(1-m_1)\gamma_1 \Delta Y' + ((1-m_1)\gamma_1 - (1-m_0)\gamma_0)Y'_0\right] \\ & + \left[(1-m_1)h_1 \Delta Y'_0 + ((1-m_1)h_1 - (1-m_0)h_0)Y'_0\right]\end{aligned}$$

Solving *ΔY'*:

$$\begin{aligned}\Delta Y' = {} & \frac{1}{1-(1-m_1)}(\gamma_1 + h_1)\left[(1-m_1)\Delta Z' - Z'_0 \Delta m\right. \\ & \left. + \left[(1-m_1)\gamma_1 - (1-m_0)\gamma_0 + (1-m_1)h_1 - (1-m_0)h_0\right]Y'_0\right]\end{aligned}$$

We add and subtract $(1-m_1)\gamma_0 Y'_0$ and $(1-m_1)h_0 Y'_0$ inside the right-sight parenthesis to express the two last elements in terms of $\Delta\gamma$ and Δh. Regrouping we obtain:

$$\Delta Y' = \frac{1}{1-(1-m_1)(\gamma_1+h_1)}\left[(1-m_1)\Delta Z' + (1-m_1)Y'_0\Delta\gamma + (1-m_1)Y'_0\Delta h - (Z'_0+\gamma_0 Y'_0+h_0 Y'_0)\Delta m\right]$$

Rearranging the expression in terms of the supermultiplier $\alpha = \frac{(1-m)}{1-(1-m)(\gamma+h)}$

we obtain:

$$\Delta Y'_0 = \alpha_1\left[\Delta Z' + Y'_0\Delta\gamma + Y'_0\Delta h - \frac{1}{(1-m_1)}(Z'_0+\gamma_0 Y'_0+h_0 Y'_0)\Delta m\right]$$

Adding ΔW_G on both sides and dividing by Y_0 we can express the equation in terms of the growth rate of Y:

$$\frac{\Delta Y}{Y_0} = \dot{Y} = \alpha_1\left[\frac{\Delta Z'}{Y_0} + (1-\frac{W_G}{Y_0})\Delta\gamma + (1-\frac{W_G}{Y_0})\Delta h - \frac{1}{(1-m_1)}[Z'_0 + (\gamma_0+h_0)(1-\frac{W_G}{Y_0})]\Delta m\right] + \frac{\Delta W_G}{Y_0}$$

We replace γ for its expression:

$$\dot{Y} = \alpha_1\left[\frac{\Delta Z'}{Y_0} + (1-\frac{W_{G0}}{Y_0})[c_1(1-t_{VA1})(1-t_{w1})\omega'_1 - c_0(1-t_{VA0})(1-t_{w0})\omega'_0] + (1-\frac{W_{G0}}{Y_0})\Delta h - \frac{1}{(1-m_1)}[\frac{Z'_0}{Y_0} + (1-\frac{W_{G0}}{Y_0})(c_0(1-t_{VA0})(1-t_{w0})\omega'_0 + h_0)]\Delta m\right] + \frac{\Delta W_G}{Y_0} \quad (27)$$

We develop the second term inside the big brackets repeating iteratively the same strategy used previously to express it in terms of increases in ω', t_w, t_{VA} and c. First, adding and subtracting $c_1(1-t_{VA1})(1-t_{w1})\omega'_0$:

$$c_1(1-t_{VA})(1-t_{w1})\omega'_1 - c_0(1-t_{VA0})(1-t_{w0})\omega'_0 = c_1(1-t_{VA1})(1-t_{w1})\Delta\omega' + \left[c_1(1-t_{VA1})(1-t_{w1}) - c_0(1-t_{VA0})(1-t_{w0})\right]\omega'_0 \quad (28)$$

Adding and subtracting $c_1(1-t_{VA1})(1-t_{w0})$, taking into account that $\Delta(1-t_w) = (1-t_{w1}) - (1-t_{w0}) = -\Delta t_w$ we obtain that:

$$c_1(1-t_{VA1})(1-t_{w1}) - c_0(1-t_{VA0})(1-t_{w0}) = -c_1(1-t_{VA1})\Delta t_w + \left[c_1(1-t_{VA1}) - c_0(1-t_{VA0})\right](1-t_{w0}) \quad (29)$$

Adding and subtracting $c_1(1-t_{VA0})$

$$c_1(1-t_{VA1}) - c_0(1-t_{VA0}) = -c_1\Delta t_{VA} + (1-t_{VA0})\Delta c \quad (30)$$

Replacing 30 in 29, 29 in 28 and 28 in 27 we obtain:

$$\begin{aligned}\dot{Y}=\alpha_1\Bigg[&\frac{\Delta Z'}{Y_0}+c_1(1-t_{VA1})(1-t_{w1})(1-\frac{W_{G0}}{Y_0})\Delta\omega'\\&-\omega_0'c_1(1-t_{VA1})(1-\frac{W_{G0}}{Y_0})\Delta t_w-\omega'_0(1-t_{w0})c_1(1-\frac{W_{G0}}{Y_0})\Delta t_{VA}\\&+\omega_0'(1-t_{w0})(1-t_{VA0})(1-\frac{W_{G0}}{Y_0})\Delta c+(1-\frac{W_{G0}}{Y_0})\Delta h\\&-\frac{1}{(1-m_1)}[\frac{Z_0}{Y_0}+(1-\frac{W_{G0}}{Y_0})(c_0(1-t_{VA0})(1-t_{w0})\omega'_0+h_0)]\Delta m\Bigg]+\frac{\Delta W_G}{Y_0}\end{aligned} \tag{31}$$

We develop now the increase in Z' in the first term inside the brackets:

$$\Delta Z'=\Delta C_{Cr}+\Delta C_{Tr}+\Delta C_{W_G}+\Delta I_{Res}+I_{OA}+\Delta(G-W_G)+\Delta X \tag{32}$$

We use the same iteration to develop each of these components.

$$\Delta C_{Cr}=(1-t_{VA1})Cr_1-(1-t_{VA0})Cr_0=(1-t_{VA1})\Delta Cr-Cr_0\Delta t_{VA} \tag{33}$$

$$\begin{aligned}\Delta C_{Tr}&=c_1(1-t_{VA1})Tr_1-c_0(1-t_{VA0})Tr_0\\&=c_1(1-t_{VA1})\Delta Tr+[c_1(1-t_{VA1})-c_0(1-t_{VA0})]Tr_0\\&=c_1(1-t_{VA1})\Delta Tr-c_1Tr_0\Delta t_{VA}+(1-t_{VA0})Tr_0\Delta c\end{aligned} \tag{34}$$

$$\begin{aligned}\Delta C_{W_G}&=c_1(1-t_{VA1})(1-t_{w1})W_{G1}-c_0(1-t_{VA0})(1-t_{w0})W_{G0}\\&=c_1(1-t_{VA1})(1-t_{w1})\Delta W_G+[c_1(1-t_{VA1})(1-t_{w1})-c_0(1-t_{VA0})(1-t_{w0})]W_{G0}\end{aligned} \tag{35}$$

Taking into account that $\Delta(1-t_w)=(1-t_{w1})-(1-t_{w0})=-\Delta t_w$, we continue the iteration by adding and subtracting $c_1(1-t_{VA1})(1-t_{w0})$:

$$\begin{aligned}\Delta C_{W_G}&=c_1(1-t_{VA1})(1-t_{w1})\Delta W_G\\&\quad+\left[-c_1(1-t_{VA1})\Delta t_w+[c_1(1-t_{VA1})-c_0(1-t_{VA})](1-t_{w0})\right]W_{G0}\\&=c_1(1-t_{VA1})(1-t_{w1})\Delta W_G\\&\quad+\left[-c_1(1-t_{VA1})\Delta t_w+[-c_1\Delta t_{VA}+(1-t_{VA0})\Delta c](1-t_{w0})\right]W_{G0}\\&=c_1(1-t_{VA1})(1-t_{w1})\Delta W_G-c_1(1-t_{VA1})W_{G0}\Delta t_w\\&\quad-c_1(1-t_{w0})W_{G0}\Delta t_{VA}+(1-t_{VA0})(1-t_{w0})W_{G0}\Delta c\end{aligned} \tag{36}$$

Introducing 33, 34, 35 and 36 in equation 32, and 32 in 31 we obtain:

$$\begin{aligned}\dot{Y}=\alpha_1\Bigg[&(1-t_{VA1})\frac{\Delta Cr}{Y_0}-\frac{Cr_0}{Y_0}\Delta t_{VA}+c_1(1-t_{VA1})\frac{\Delta Tr}{Y_0}-c_1\frac{Tr_0}{Y_0}\Delta t_{VA}\\&+(1-t_{VA0})\frac{Tr_0}{Y_0}\Delta c+c_1(1-t_{VA1})(1-t_{w1})\frac{\Delta W_G}{Y_0}-c_1(1-t_{VA1})\frac{W_{G0}}{Y_0}\Delta t_w\\&-c_1(1-t_{w0})\frac{W_{G0}}{Y_0}\Delta t_{VA}++(1-t_{VA0})(1-t_{w0})\frac{W_{G0}}{Y_0}\Delta c+\frac{\Delta I_{Res}}{Y_0}+\frac{\Delta I_{OA}}{Y_0}\\&+\frac{\Delta(G-W_G)}{Y_0}+\frac{\Delta X}{Y_0}+c_1(1-t_{VA1})(1-t_{w1})(1-\frac{W_{G0}}{Y_0})\Delta\omega'\\&-\omega'_0c_1(1-t_{VA1})(1-\frac{W_{G0}}{Y_0})\Delta t_w-\omega'_0(1-t_{w0})c_1(1-\frac{W_{G0}}{Y_0})\Delta t_{VA}\\&+\omega'_0(1-t_{w0})(1-t_{VA0})(1-\frac{W_{G0}}{Y_0})\Delta c+(1-\frac{W_{G0}}{Y_0})\Delta h\\&-[\frac{Z'_0}{Y_0}+(c_0(1-t_{VA0})(1-t_{w0})\omega'_0+h_0)(1-\frac{W_{G0}}{Y_0})]\frac{1}{(1-m_1)}\Delta m\Bigg]+\frac{\Delta W_G}{Y_0}\end{aligned}$$

Grouping terms in terms of increases in each variable:

$$\begin{aligned}\dot{Y}=\alpha_1\Bigg[&(1-t_{VA1})\frac{\Delta Cr}{Y_0}+c_1(1-t_{VA1})\frac{\Delta Tr}{Y_0}+c_1(1-t_{VA1})(1-t_{w1})\frac{\Delta W_G}{Y_0}\\&+\frac{\Delta I_{Res}}{Y_0}+\frac{\Delta I_{OA}}{Y_0}+\frac{\Delta(G-W_G)}{Y_0}+\frac{\Delta X}{Y_0}+c_1(1-t_{VA1})(1-t_{w1})(1-\frac{W_{G0}}{Y_0})\Delta\omega'\\&+[(1-t_{VA0})\frac{Tr_0}{Y_0}+(1-t_{VA0})(1-t_{w0})(\frac{W_{G0}}{Y_0}+\omega'_0(1-\frac{W_{G0}}{Y_0}))]\Delta c\\&-c_1[(1-t_{VA1})(\frac{W_{G0}}{Y_0}+\omega'_0(1-\frac{W_{G0}}{Y_0}))]\Delta t_w\\&-[\frac{Cr_0}{Y_0}+c_1\frac{Tr_0}{Y_0}+c_1(1-t_{w0})(\frac{W_{G0}}{Y_0}+\omega'_0(1-\frac{W_{G0}}{Y_0}))]\Delta t_{VA}+(1-\frac{W_{G0}}{Y_0})\Delta h\\&-\frac{1}{(1-m_1)}[\frac{Z'_0}{Y_0}+(c_0(1-t_{VA0})(1-t_{w0})\omega'_0+h_0)(1-\frac{W_{G0}}{Y_0})]\Delta m\Bigg]+\frac{\Delta W_G}{Y_0}\end{aligned}$$

Finally, we can express each element in terms of the growth rate of the corresponding variable by multiplying and dividing them by that variable in time=0, obtaining the full supermultiplier growth-decomposition formula. Time=0 corresponds to the previous year's value at current prices and time=1 to the current year's value at previous year's prices.

$$\begin{aligned}\dot{Y}=\alpha_1\Bigg[&(1-t_{VA1})\frac{Cr_0}{Y_0}\dot{Cr}+c_1(1-t_{VA1})\frac{Tr_0}{Y_0}\dot{Tr}+c_1(1-t_{VA1})(1-t_{w1})\frac{W_{G0}}{Y_0}\dot{W}_G\\&+\frac{I_{Res0}}{Y_0}\dot{I}_{Res}+\frac{I_{OA}}{Y_0}\dot{I}_{OA}+\frac{(G-W_G)}{Y_0}(\dot{G-W}_G)+\frac{X}{Y_0}\dot{X}\\&+(1-t_{VA0})[\frac{Tr_0}{Y_0}+(1-t_{w0})(\frac{W_{G0}}{Y_0}+(1-\frac{W_{G0}}{Y_0})\omega'_0)]c_0\dot{c}\\&+c_1(1-t_{VA1})(1-t_{w1})(1-\frac{W_{G0}}{Y_0})\omega'_0\dot{\omega}'-c_1(1-t_{VA1})(\frac{W_{G0}}{Y_0}+(1-\frac{W_{G0}}{Y_0})\omega'_0)t_{w0}\dot{t}_w\\&-[\frac{Cr_0}{Y_0}+c_1\frac{Tr_0}{Y_0}+c_1(1-t_{w0})(\frac{W_{G0}}{Y_0}+(1-\frac{W_{G0}}{Y_0})\omega'_0)]t_{VA0}\dot{t}_{VA}+(1-\frac{W_{G0}}{Y_0})h_0\dot{h}\\&-\frac{1}{(1-m_1)}[\frac{Z_0-W_{G0}}{Y_0}+(c_0(1-t_{VA0})(1-t_{w0})\omega'_0+h_0)(1-\frac{W_{G0}}{Y_0})]m_0\dot{m}\Bigg]+\frac{W_{G0}}{Y_0}\dot{W}_G\end{aligned}\quad(37)$$

Defining

$$\begin{aligned}&\beta_{Cr}=\beta_{Tr}=(1-t_{VA1})\\&\beta_c=(1-t_{VA0})\left[\frac{Tr_0}{Y_0}+(1-t_{w0})(\frac{W_{G0}}{Y_0}+(1-\frac{W_{G0}}{Y_0})\omega'_0)\right]\\&\beta_{\omega'}=c_1(1-t_{VA1})(1-t_{w1})(1-\frac{W_{G0}}{Y_0})\\&\beta_{t_w}=c_1(1-t_{VA1})\left[\frac{W_{G0}}{Y_0}+(1-\frac{W_{G0}}{Y_0})\omega'_0\right]\\&\beta_{t_{VA}}=\frac{Cr_0}{Y_0}+c_1\frac{Tr_0}{Y_0}+c_1(1-t_{w0})\left[\frac{W_{G0}}{Y_0}+(1-\frac{W_{G0}}{Y_0})\omega'_0\right]\\&\beta_m=\frac{1}{(1-m_1)}\left[\frac{Z_0-W_{G0}}{Y_0}+(1-\frac{W_{G0}}{Y_0})[c_0(1-t_{VA0})(1-t_{w0})\omega'_0+h_0]\right]\end{aligned}$$

and replacing in equation 37, we obtain the version of the growth-decomposition formula presented in section 2 (equation 22 in table 2):

$$\begin{aligned}\dot{Y}=\alpha_1\Bigg[&\beta_{Cr}\frac{Cr_0}{Y_0}\dot{Cr}+\beta_{Tr}\frac{Tr_0}{Y_0}\dot{Tr}+\beta_{W_{Pub}}\frac{W_{G0}}{Y_0}\dot{W}_G+\frac{I_{Res0}}{Y_0}\dot{I}_{Res}+\frac{I_{OA0}}{Y_0}\dot{I}_{OA0}+\frac{G-W_G}{Y_0}(\dot{G-W}_G)\\&+\frac{X}{Y_0}\dot{X}+\beta_c c_0\dot{c}+\beta_\omega\omega'_0\dot{\omega}'-\beta_{t_w}t_{w0}\dot{t}_w-\beta_{t_{VA}}t_{VA0}\dot{t}_{VA}+h_0\dot{h}-\beta_m m_0\dot{m}\Bigg]+\frac{W_{G0}}{Y_0}\dot{W}_G\end{aligned}$$

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