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Growth, investment share and the stability of the Sraffian Supermultiplier model in the United States economy (1985-2017)

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Growth, investment share and the stability of the Sraffian Supermultiplier model in the United States economy (1985-2017)[1]

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Abstract

This paper constitutes an attempt to test the central hypothesis of the Sraffian Supermultiplier demand-led growth model empirically; videlicet, that the growth of demand induces the share of capacity creating investment in output. By evaluating the relationship between the propensity to invest and the rate of growth of demand for the case of the United States economy in the period from 1985 to 2017, our results provide empirical support for this relation, showing that movements in the output growth rate cause the movements in the induced investment ratio. Other significant result shows that the induced investment share presents a high degree of inertia from on period to another, while the effect of the lagged rate of growth of demand is low but statistically significant, suggesting a tendency for utilization to converge towards some exogenous normal level slowly. This feature, together with other estimated parameters of the model, suggest that the Sraffian Supermultiplier adjustment mechanism has been dynamically stable for the US data in the period under analysis.

Keywords: Economic growth, Sraffian Supermultiplier, Propensity to invest.

1 Introduction

The Sraffian Supermultiplier demand-led growth model posits that economic growth is led by autonomous expenditures that do not create productive capacity, while private capacity creating investment is supposed to be an induced expenditure. On fully adjusted positions, capacity tends to adjust to demand, and utilization converges to its normal level. For this adjustment to take place, the propensity to invest is required to be endogenously determined, playing the role of the adjusting variable that accommodates different growth rates (Serrano, 1995).

The wider acceptance of the Supermultiplier model after Lavoie (2014, 2016) also raised a debate about the dynamic stability of the model, that is, if the mechanism of adjustment of productive capacity to the long period level of effective demand proposed by the model will not face capacity constraints. As Freitas and Serrano (2015) show theoretically that the model is dynamically stable for some set of parameters, Skott (2017, 2019) believes that the values of the parameters necessary to stabilize the model are very implausible while Lavoie (2017) and Fazzari, Ferri and Variato (2019) are much more optimistic about the dynamic stability of the model calibrated for the real-world data.[2]

In this way, the contribution of the present paper to this debate will be to empirically check for the recent US data (1985-2017) what the evidences says about the stability of the sraffian supermultiplier mechanism. In order to do this stability assessment, we investigate if the investment share behaves in the way described by the model, expressly: 1) if the growth of demand induces the share of capacity creating investment in output;

[2] Serrano, Freitas and Bhering (2019) demonstrates that the Supermultiplier model is statically stable "because the reaction of induced investment to the initial imbalance between capacity and demand has, at some point during the disequilibrium process, a greater impact on the rate of growth of productive capacity than on the rate of growth of demand" (p. 273). In other words, the adjustment process goes in the right direction. The static stability is a necessary condition for the model to be dynamically stable, but not a sufficient one. The dynamic stability requires also that the intensity of the adjustment is not excessive. Therefore, we are assuming that static stability is ensured and restricting our discussion to the dynamic stability.

2) if this adjustment is sufficiently slow. We also estimate the main parameters of the model. The methodology adopted follows and updates the estimates of Braga (2006).

Besides this introduction, the paper has six more sections. Section two introduces the Supermultiplier model's primary results and the dynamic stability conditions for an open economy with the public sector. The empirical literature on the Sraffian Supermultiplier is reviewed in the third section. In the fourth section, the methodology for the construction of the data series is presented. The fifth section presents a descriptive analysis of the data while the econometric results and the assessment of the dynamic stability condition of the models for the estimated data is made in section 6. Concluding remarks are made in the last section.

2 The Supermultiplier model

The Sraffian Supermultiplier model posits that "growth is led by the autonomous components of demand that do not create capacity (autonomous consumption in the present case), productive investment is an induced expenditure and income distribution is exogenous" (Freitas and Serrano, 2015, p. 1-2) and capacity utilization converges towards an exogenous desired level on the long run under some specified conditions.[3]

Serrano (1995) defines autonomous expenditures as "all those expenditures (…) that are neither financed by the contractual (wage and salary) incomes generated by production decisions nor are capable of affecting the productive capacity of the capitalist sector of the economy" (p. 71). According to Cesaratto, Serrano and Stirati (2003), these expenditures include the totality of government spend (which comprehends consumption, investment and transfers made by the government), exports, autonomous consumption financed by credit or accumulated wealth, residential investment by households and business expenditures, which includes R&D expenditures. Although the portion of the investment that creates capacity for the private sector is seen as an induced expenditure, it does not mean that the entire investment should be treated as induced. What we mean by induced investment is firms' investment in equipment and structures. The idea of the induced investment is that capacity should be built to meet expected demand. Government investment is considered autonomous because a) public gross capital formation does not create productive capacity for the private sector, and b) it is submitted to political decisions, and it is not motivated to adjust capacity do demand. The investment made by households should be treated as an autonomous expenditure since a) it does not create productive capacity, and b) it depends on other factors besides current income, such as credit, accumulated wealth, and the income expected for the future.

[3] For a comparison with the Kaleckian and the Harrodian models, see, respectively, Serrano and Freitas (2017) and Serrano, Freitas, and Bhering (2019).

Finally, firms' investment in R&D should also be treated as autonomous because it does not create capacity.

To present the formal model, we assume that the product is homogeneous, being consumed by workers and capitalists, and also used as fixed capital. There is only one technique of production available with fixed coefficients of labor and capital. We presume that the relation between the stock of capital and normal output (which is the output obtained if utilization were equal to normal) is exogenous (normal capital-output ratio). Labor supply is infinitely elastic and does not constitute a restriction even in the long run, and the economy presents excess capacity. Wage and profit shares on income are determined by distributive conflict and institutional factors and do not depend on demand conditions.

Neglecting changes in inventories, output plus imports should be equal to aggregate demand:

$$Y + M = C + I + G + X \quad (1)$$

Where Y is output, M represents imports, C is household consumption, I represents investment, G is government consumption, and X stands for exports. Since part of the aggregate demand leak through imports, we define m as the share of import content on aggregate demand, assuming that the import coefficient is equal for all types of expenditure:

$$M = m(C + I + G + X) \quad (2)$$

Household consumption is composed by an autonomous portion (C^A) and an induced one, which depends on the propensity to consume (c) and on disposable income (Y^d):

$$C = cY^d + C_A \quad (3)$$

Disposable income is equal to total output minus personal taxes (T) plus current transfers made by the government (Tr), such as social security benefits and unemployment insurance $(Y^d = Y - T + Tr)$. Taxes, by its turn, are expressed by $T = tY$, where t represents the tax rate. Combining these two expressions with equation 3, we get to:

$$C = c(1-t)Y + cTr + C^A \quad (4)$$

It is worth noticing that transfers made by the government does not create demand directly, but only increases household disposable income, so its effect must be weighted by the propensity to consume. Although the consumption out of transfers is an induced expenditure, transfers are considered an autonomous expenditure. So, from the perspective of the economy as a whole, it must also be taken as autonomous.

Investment, by its turn, is divided between government investment (I_G), household investment (I_H), firms investment on R&D (I_F^A) and firms induced investment (I_F^I)[4] – Expressed in equation 5. Induced investment, by its turn, is given by equation 6, where h represents capitalists' propensity to invest.

$$I = I_G + I_H + I_F^A + I_F^I \quad (5)$$

$$I_F^I = hY \quad (6)$$

The model is presented in two stages, and for now, we suppose that h is given – this assumption will be modified later. Combining equations 1, 2, 4, 5 and 6, we determine the level of output according to the following expression:

$$Y = \left(\frac{1-m}{1-(1-m)[c(1-t)+h]}\right)Z \quad (7)$$

The term in parenthesis is the value of the supermultiplier, while Z calls for the total amount of autonomous expenditures that equal to:

[4] The superscripts A and I on firms' investment represents the autonomous and induced expenditures, respectively.

$$Z = cTr + C^A + I_G + I_H + I_F^A + G + X \tag{8}$$

Considering that m, c, t and h are given, the value of the supermultiplier is also exogenous, and the growth rate of output is determined by the growth rate of autonomous expenditures $(g = g_z)$. Induced investment growth rate (g_I^I) is also equal to g_z, and since this type of investment increases the productive capacity of the private sector, the growth trend of the stock of capital (g_k) depends on the growth of induced investment so that it will converge to the growth of autonomous expenditures too.[5]

The following equation expresses the growth rate of the stock of capital at any given period:[6]

$$g_k = \frac{(I/Y)u}{v} - \delta \tag{9}$$

Where u represents capacity utilization, v is the ratio between capital and normal output, and δ is the depreciation rate – we take the latter two as exogenous. Utilization is normalized at its normal degree so that $u_n = 1$. When output and productive capacity growth at the same pace, capacity utilization remains stable. This means that when $g_z = g_k$, we can calculate the value of capacity utilization using equation 9:

$$u^* = \frac{v(g_z + \delta)}{h} \tag{10}$$

When taking the propensity to invest as given, we can see that there is a positive relationship between the growth rate and capacity utilization. This occurs because when

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[5] When using the terms stock of capital, we are considering only the private capital that consists of productive capacity, in a way that it is compatible with the definition of induced investment.

[6] This equation is derived from:

$$g_k = \frac{I}{K} - \delta = \frac{I}{Y}\frac{Y}{Y^*}\frac{Y^*}{K} - \delta = \frac{hu}{v} - \delta$$

Where I is investment, K is the stock of capital, δ is depreciation rate, Y is actual output, Y^* is normal output, h is the propensity to invest, u is capacity utilization (defined as Y/Y^*) and v is normal capital-output ratio (K/Y^*).

the growth rate of autonomous expenditures increases, output and investment will grow at this new higher rate. However, the growth rate of the stock of capital converges to the growth rate of investment expenditures only after some lag, and initially, the stock of capital will be growing at the lower older rate, converging to the new growth rate slowly and only after some time. During this transitional period, the output will grow faster than productive capacity, and utilization will increase.

Let us move to the second stage of the model when we drop the assumption that h is exogenous and assume that it is endogenously determined instead. We consider that competition between capitalists will result in a tendency for the capacity to adjust do demand in order to reach normal capacity utilization.[7] The aggregate propensity to invest depends on the normal capital-output ratio, the depreciation rate and the expected growth rate of demand[8]:

$$h_t = v(\delta + g_t^e) \tag{11}$$

The expected growth rate by its turn is gradually adjusted to the effective growth, according to the following rule:

$$g_t^e = g_{t-1}^e + x(g_{t-1} - g_{t-1}^e) \quad or \quad g_t^e = (1-x)g_{t-1}^e + xg_{t-1} \tag{12}$$

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[7] According to Ciccone (1986, 1987), full capacity is determined by the peaks in demand expected during the economic lifecycle of the equipment, while normal utilization is determined by some conventional historical pattern of the ratio between average and peaks in demand. Capitalists aim to be able to meet peak levels in demand in order to maintain their market share. Inversely, firms do not want to keep excess capacity above the required to meet the maximum expected levels of demand, since it is costly to keep idle capacity.

[8] In some specifications of the Supermultiplier model, the propensity to invest might be expressed as a function of the expected growth, while the latter one is gradually adjusted according to actually observed growth. This specification can be found in Serrano (1995), Cesaratto, Serrano and Stirati (2003), Serrano, Freitas and Bhering (2019) and Garrido Moreira and Serrano (2019). Alternatively, the propensity to invest might adjust itself according to deviations between actual and normal utilization, a specification present in Freitas and Serrano (2015) and Serrano and Freitas (2017). As normal utilization is an unobserved variable, and since the purpose of this paper is to test empirically the propensity to invest function, we are presenting the model according to the former specification.

Where x represents the parameter of expectations adjustment and it is subjected to the restriction that $0 \leq x \leq 1$. It is more likely that the value of x is low, which means that expected growth adjusts slowly to changes in actual growth. The first justification for this is that firms are aware that demand is subjected to cyclical fluctuations and might not adjust their expectations immediately if growth increases for only one or a few periods. The second reason is that firms do not intend to adjust capacity to demand in each moment in time but rather for the whole economic life of the equipment. Our empirical work will focus on equations 11 and 12, trying to identify if the propensity to invest adjusts to the growth rate of output in the way described by the model.

Let us assume that the economy is initially on its fully adjusted position, where growth expectations are fulfilled, and utilization is equal to its normal level and simulate what happens when a persistent increase in the growth rate of autonomous expenditures takes place. As mentioned above, the growth rates of output, investment, and productive capacity will all increase to this new level. However, in this case, effective growth will surpass capitalists' expectations, and since capital stock growth increases only after some time lag, utilization will increase and remain above its normal level. In this case, capitalists will start to adjust their expected growth rate according to the observed growth, increasing their propensity to invest and enabling investment to grow faster than output, which will allow productive capacity to grow at a higher pace than demand and result in a decrease in utilization, converging towards its normal level. The same mechanism applies when there is a decrease in autonomous expenditures growth rate.

On fully adjusted positions, the growth rate of output, investment, and of the stock of capital remain determined by the growth rate of autonomous expenditures. However, utilization will converge towards its normal level and will not show any relation with growth rates. Under these conditions, we can calculate the value of the propensity to invest in fully adjusted position based on equation 9:

$$h^* = v(g_z + \delta) \tag{13}$$

This is an essential result of the Supermultiplier model: the propensity to invest is endogenous in the long run and depends positively on the growth rate, playing the role of the adjusting variable that enables capacity to adjust to demand.

The dynamic stability of the model requires that the propensity to spend stays below unity during the adjustment process. The stability condition for the present specification of the model is expressed in equation 14[9]:

$$(1-m)[c(1-t)+v(g_z+\delta)+vx+vxg_z]<1 \qquad (14)$$

The term $c(1-t)$ represent the propensity to consume already taking into account the taxes, $v(g_z+\delta)$ is the propensity to invest in long-run steady state, the term vx expresses that there must be some space for the adjustment to occur when the economy is outside the fully adjusted position and vxg_z represents an interaction term involving the two previous terms. The sum of all these items is multiplied by $(1-m)$, which is the share of domestic content in total demand, meaning that a higher import coefficient contributes to reducing the propensity to spend of the economy. The fulfillment of the above condition requires that the parameter x cannot be too high, indicating that the speed of adjustment of growth expectations must be slow, otherwise the system is only demand led for very low rates of growth of autonomous demand.

[9] This stability condition is based on Serrano, Freitas, and Bhering (2019).

3 Review of the empirical literature on the Supermultiplier

By reviewing the few papers that have already performed empirical tests for the Supermultiplier model, we can identify two different types of experiments performed by the authors. The first kind tries to identify if autonomous expenditures explain the level of output, while the second aims to test, in a broad sense, the investment function of the model, looking for a relationship between investment and growth rates. In some cases, the authors take into account the investment share, while in others, it is considered the investment level or growth. Additionally, in some situations, the growth rate of output is used, while in others, the data considered consists of the growth rate of autonomous expenditures. The first type of test can check if growth is led by autonomous expenditures but does not guarantee the existence of some mechanism that adjusts capacity to output. The second test aims to check if the investment share is sensitive to the growth rate, a condition required for actual utilization to converges towards its normal level.

Girardi and Pariboni (2016) focus on the United States, using quarterly data from 1947 to 2014. The first part of this study investigates the relation between autonomous expenditures and output, trying to check if autonomous expenditures cause output or if it is the other way around. The authors notice that the first years of the data series are very unstable and choose to consider only the period from 1960 to 2014. They also observe that the tests show better results when the consumption financed by credit is excluded from the autonomous expenditures. In this case, the latter has a positive effect on output, and there is no sign of reverse causality. However, the intensity of Z on Y is low, and the explanation suggested is that there might be some endogeneity on autonomous expenditures. To solve this problem it would be required some strategy to take into account the factors that explain the autonomous expenditures more appropriately.

Girardi and Pariboni (2016) also look for a relation between the propensity to invest and the growth of autonomous expenditures. It is important to notice that what the authors consider as induced investment comprehends the totality of firms' private investment, which also includes the expenditures in intellectual property products. As will be explained in more detail in the next section, this constitutes a difference from the classification of induced investment used to construct our series. As mentioned before, the first years of the data series present major volatility so the authors find better results when considering only the period from 1960 to 2014. In this case, autonomous expenditures seem to have a strong effect on the investment share and there is no evidence of reverse causality.

These two authors continue their empirical research in another paper (Girardi and Pariboni, 2018). In this case, they study a group of 20 OECD countries. The first part of their estimates uses quarterly data from 1960 to 2016 and search for the causality between the propensity to invest and the growth of autonomous expenditures. The interest rate and the profit share are included in the tests as control variables, in order to check if the causality going from g_z to h disappears when these series are taken into account. In this case, g_z continues to present a positive effect on h, although the effect of the control variables included is also statistically significant.

Girardi and Pariboni (2018) also try to deal with the endogeneity of the autonomous expenditures using instrumental variables approach. They use three instrument variables for autonomous demand: a) total imports from the US weighted by each country openness to trade with the US, b) weighted average of trade openness of the five most important destinations of each country exports and c) military spending. The basic idea is that the first two instruments influence the exports of each country, while the last one affects government expenditures, and that these instruments are not induced by each country output. Due to the availability of data, this exercise uses annual data from 1970 to 2015 and the US is excluded from the sample since the first instrument cannot be applied to them. The tests confirm the validity of the instruments and the results seem to show that the autonomous expenditures have a positive effect on the investment share.

Goes, Moraes and Gallo (2018) investigate the causality between autonomous expenditures and output for a group of ten European countries. The range of selected years varies for each country, starting as far as 1975 and ending in 2016. The authors find Granger causality from Z to Y in five of the ten countries. Instantaneous causality is confirmed for all countries, although this test does not specify the direction of causality between the two variables. They also calculate orthogonalized impulse-response functions between Y and Z. The results show that a positive shock in autonomous demand has a positive effect on output for all countries, although the size and the time lag of this response differ from one country to another. Since autonomous expenditures are not completely exogenous and present some degree of endogeneity, impulse-response function for the effect of a shock on Y on Z are expected to be positive. However, the results differ from one country to another, depending on the specificities of each nation.

Perez (2019) research focuses on a group of 16 selected European countries, using quarterly data from 1995 to 2017. The first part of the paper focuses on the relation between autonomous expenditures and output. Results point to a causality going from Z to Y but also to reverse causality from Y to Z. However, impulse response function shows that the effect on Z of a shock on Y tends to dissipate through time, while a shock on Z has a lasting effect on Y. Next, the author investigates the relationship between investment and growth. This experiment is composed of two parts. The first estimative is between investment and output growth rates, and the tests suggest that output Granger-cause investment, but investment does not Granger-cause output, a result that supports the hypothesis that investment is an induced expenditure. The second stage of the experiment consists in estimating the relation between investment share and autonomous demand growth rate. In this case, Perez finds a long-run causality from g_Z to h, while results for reverse causality from h to g_Z point to a positive short-run effect that tends to dissipate on the long run.

Braga (2018) estimates the relation between output and investment for the case of Brazil. The first empirical exercise consists in estimating the relation between GDP growth rate and the propensity to invest. Because of lack of availability of data that allow us to identify the type of investment by institutional sector, investment in equipment is used as a proxy for induced investment, using annual data from 1962 to 2015. Results indicate the existence of Granger causality from g to h, with structural breaks in 1973 (the year of the first oil crisis) and in 1995 (the first year of price stability), while causality going from h to g is not confirmed. The second part of the tests uses quarterly data from 1996 to 2017 and looks for a relation between the growth rate of final demand and of investment in equipment, with final demand being defined as the sum of all expenditures that to not create productive capacity for the private sector. Results also provide support to the Supermultiplier approach. The estimation of the parameters indicates the existence of a structural break in 2008 (the year of the global financial crisis), suggesting that from this year on, investment became more sensitive to changes in final demand.

Figure 1 contains a summary of the main characteristics of each of the mentioned empirical works, with the group of countries studied, time period, type of empirical exercise, and its results.

Figure 1: Summary of the empirical studies on the Supermultiplier model.

Paper	Countries	Period	Experiments	Results
Girardi and Pariboni (2016)	United States	1947-2014 (quarterly)	Relation between Z and Y. Relation between h and g_z.	Z has a low positive effect on Y g_z has a strong effect on h.
Girardi and Pariboni (2018)	20 selected OECD countries.	1960-2016 (quarterly) 1970-2015 (annual)	Relation between h and g_z, using Instrumental Variable to avoid endogeneity in g_z.	Tests point that the instrument is valid and that g_z has a positive effect on h.
Goes, Moraes and Gallo (2018)	10 selected European countries.	1975-2016 (annual)	Relation between Z and Y.	Z Granger causes Y in five countries. A positive shock in Z has a positive effect on Y in all countries.
Perez (2019)	16 selected European countries.	1995-2017 (quarterly)	Relation between Z and Y. Relation between g and g_I Relation between h and g_z	Z has a persistent positive effect on Y. g Granger causes g_I. Long run causality from g_z to h.
Braga (2018)	Brazil	1962-2015 (annual) 1996-2017 (quarterly)	Relation between h and g. Relation between g_I and growth rate of final demand.	Granger-causality goes from g to h. g_I is sensitive to the growth rate of final demand.

4 Methodology used to construct the data series

The methodology used to construct our data series will be presented in this section. As mentioned in the previous section, the empirical research on the Supermultiplier focuses on two relations: a) between autonomous expenditures and output, and b) between the propensity to invest and the output growth rate. The present paper is concerned about the second relation and our study is restricted to the United States.

As we mentioned in the second section, autonomous expenditures are defined as the expenditures that are not financed by the contractual incomes generated by production decisions neither alter the productive capacity of the private sector of the economy. Another way to put it is by saying that autonomous expenditures introduce new purchase power in the economy, either through government spending, exports, new credit for consumer or from accumulated wealth by capitalists. However, this does not mean that autonomous expenditures are completely exogenous neither that its growth rate does not change through time. Depending on the institutional arrangement, government spending might be procyclical, presenting a high degree of endogeneity. Credit is also procyclical, although banks are capable of creating new money whenever they want to. Since we are studying the case of the largest world economy which is also the country that issues the currency accepted to settle international payments, it is reasonable to assume that US exports – which are the imports of goods and services produced in the US from the rest of the world – depends on the income of the rest of the world, which by its turn also depend in some degree on the economic performance of the United States. Summarizing, there is no reason to assume autonomous expenditures to be completely independent from output and it is expected to find some degree of endogeneity in the former one, so we consider that studying the causality between autonomous expenditures and output might not bring definite conclusions, which is the reason why we are not studying the relation between booth.[10]

[10] Girardi and Pariboni (2018) recognize that autonomous expenditures are partially endogenous and as we mentioned on section three, the authors try to address the issue using instrumental variable approach, isolating some elements that are in fact utterly independent from current output – in their case, the

We can rewrite the investment share, by replacing equation 12 on 11, as:

$$h_t = v\delta + (1 - x)vg^e_{t-1} + vxg_{t-1} \tag{15}$$

From equation 11 we get that $h_{t-1} = v(\delta + g^e_{t-1})$. Reordering, we know that $vg^e_{t-1} = h_{t-1} - v\delta$. Replacing vg^e_{t-1} on equation 15 and reordering brings us to:

$$h_t = vx\delta + (1 - x)h_{t-1} + vxg_{t-1} \tag{16}$$

Our empirical study aims to test if the growth rate influences the propensity to invest and to estimate the parameters of our equation 16. This is also the same specification tested in Braga (2006).

As we mentioned in the previous section, most of the empirical studies on the Supermultiplier investigate the existence of a relation between the growth rate of autonomous expenditures and the propensity to invest. However, it is important to highlight that the theoretical model establishes a relation between the propensity to invest and the growth rate of **total** output. Although the model also establishes that output growth tends to be equal to autonomous demand growth, this is only true if all the other parameters that determine the value of the supermultiplier (propensity to consume, to invest, to import and tax rates) remains unaltered, a condition that is not satisfied for the period we are considering, since the value of the supermultiplier seems to have declined mainly due to an increase in the import coefficient. This means that considering the period as a whole, autonomous expenditures grew at a higher rate than output. Additionally, capitalists invest in order to meet the aggregate demand of the economy, not being concerned if this demand consists of autonomous expenditures, induced consumption or the induced investment itself.

With this in mind, we are constructing data series of h, g, g_{fd} (the growth rate of final demand) and g_z (the growth rate of autonomous expenditures). Final demand is defined

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instrument consists on US imports, trade openness of the most essential destinations of each country exports and military spending.

as the amount of expenditure that do not create capacity for the private sector, which is equal to total demand minus the induced investment. Although we consider that the most important relationship is between g and h, we believe that we can get a broader view on the issue if we perform Granger causality tests between the propensity to invest and each one of the growth rates (g, g_{fd} and g_z) separately, trying to determine if growth rates help to predict the propensity to invest and if there is some reverse causality going from the latter to the former ones. Next, when estimating the parameters of equation 16, we take into account only total output growth, since this is the relevant one to explain capitalists' investment decisions.

To construct the series for h, g, g_{fd} and g_z, the first task is to determine which expenditures are considered induced investment, induced consumption, autonomous expenditures and final demand. The categories of investment, according to the US National Accounts, are organized as follow: first, investment is divided between private and public. The private investment consists of fixed investment and change in inventories. The private fixed investment is composed of residential and nonresidential expenditures. Finally, the nonresidential investment is divided between investment in structures, equipment and intellectual property products (IPP). According to the discussion made in section two, we classify as induced investment firms' expenditures on structures and equipment. From now on, the propensity to invest we are taking into account consists of the ratio between the sum of these expenditures to GDP. On the other hand, we consider as autonomous expenditures: a) government investment b) residential investment, which corresponds to household investment, and c) nonresidential investment in IPP, which correspond to firms' investment that do not create capacity[11].

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[11] Intellectual property products include investments in R&D and software. Investment in R&D is an autonomous expenditure, but the investments in software should be taken as induced since it might be interpreted as a type of investment that does create capacity. However, this segment of investment presents a growth rate far above the average GDP growth and its share on output increases practically uninterruptedly from 0.6% in 1985 to 1.8% in 2017, which might represent some sort of structural change rather than an investment induced by demand. Additionally, its relative weight on the remaining segments of induced investment is low, so we opted to take it as autonomous and consider only investment in structures and equipment as induced.

We are ignoring the change in private inventories from our analysis, not classifying this component of demand in any type of expenditures. The reason for this decision is because: a) it is impossible to distinguish which part of the change in private inventories is planned by firms and which part is due to an error in predicted demand, and b) US National Accounts release only money values for this variable but not volume indexes.

According to our equation 8, autonomous expenditures are composed of: a) government consumption, b) government investment, c) exports, d) investment by households, e) firms' investment in intellectual property products, f) transfers made by the government and g) credit financed consumption by households. The first five components mentioned can be obtained directly from the National Accounts, while the other two require some special treatment. Since transfers made by the government only increases private sector disposable income but does not constitute direct demand for goods and services, its impact must be weighted by the household propensity to consume[12]. Credit financed consumption by households cannot be directly measured from the National Accounts, and to incorporate it into the analysis, we use the methodology suggested by Serrano and Braga (2006) and Freitas and Dweck (2013), who take durable household consumption as a proxy for autonomous household consumption. It is worth pointing out that consumer credit presents a high degree of endogeneity, leading Girardi and Pariboni (2016) to conclude that their estimates show better results when excluding this component from autonomous expenditures and considering it as induced consumption. Taking this into account, we estimate two alternative series for autonomous expenditures: one that includes durable goods consumption (called series "a" or g_z^a) and another one that excludes it (called series "b" or g_z^b).

[12] The effect of transfers on autonomous consumption is thus calculated by $c * Tr$, as presented in equation 8. Induced consumption (from households point of view) equals to cY^d. So c is given by:

$$c = \frac{Induced\ Consumption}{(1-t)Y + Tr}$$

Depending of the definition of autonomous expenditures, induced consumption might include only the sum of non-durable goods and services or the total household consumption. So depending on the specification of the model, c must be calculated accordingly.

Household consumption is divided between a) durable goods, b) non-durable goods and c) services. Depending on the definition of autonomous expenditures, the definition of induced consumption is also modified. When we classify durable goods consumption as an autonomous expenditure, induced consumption consists on the sum of non-durable goods and services. Alternatively, if we assume that durable consumption is induced by income, induced consumption is equal to total household consumption.

Final demand is used here in the specific sense of Garegnani (1962 (2015)) of aggregate demand minus the capacity generating investment by firms. Here it would be is defined as the sum of total household consumption, government consumption, government investment, investment by households, firms' investment in IPP and exports.

We assume that normal capital-output ratio and depreciation rate are given and remain unaltered. However, since these data enter into equation 16 which we are trying to estimate, we also calculate it in order to evaluate our estimates. In this case, we consider only its average values observed during the period we are considering, assuming that: a) the depreciation rate remained unchanged during those years and b) that effective capital-output ratio during some long period of time can be taken as a good proxy for normal capital-output ratio and that it also remained unaltered. The data on capital stock and depreciation of fixed capital is organized using the same classification of gross fixed investment, so we are considering only the stock of nonresidential private fixed assets in structures and equipment. The capital-output ratio (v) we are calculating here is equal to the sum of these assets divided by GDP, while the depreciation rate (δ) is equal to the amount of depreciation of structures and equipment of enterprises and nonprofit institutions divided by the total stock of these assets[13].

Information on quarterly data starts in 1947, but we selected the interval from 1985 to 2017. The year 1985 was chosen because from this time on growth rate presents a more

[13] The depreciation rate is calculated dividing the depreciation in t by the stock of capital existing at the end of the previous year $(t-1)$. It requires bringing the stock of capital of $t-1$ to the prices of t. Although BEA does not release price indexes for the stock of capital, it can be calculated from nominal values and quantity indexes, which are available.

stable path than during the previous period of the Golden Age (the 1950's and 1960's) and also the crisis that characterized its end (the 1970's and beginning of the 1980s). All the growth rates expressed were calculated between one quarter and the same quarter of the previous year.

5 Presentation of the data

We present here a brief description of the data series constructed before presenting the econometric tests. Figure 2 brings the time series of g, g_{fd}, g_z^a and g_z^b, while Figure 3 shows g and h, which are the main variables we are investigating. As we can see in the first Figure, all four series of growth presents a very similar behavior trough time. In the second image, we see that both the growth rate and the induced investment share present a declining trend during the period in the analysis. It is worth noticing that the inflections in g seem to precede the inflections in h by a few quarters, indicating that when the growth rate changes, capitalists start to adjust their expected growth rate and to change their propensity to invest accordingly.

Figure 2: g, g_{fd}, g_z^a and g_z^b

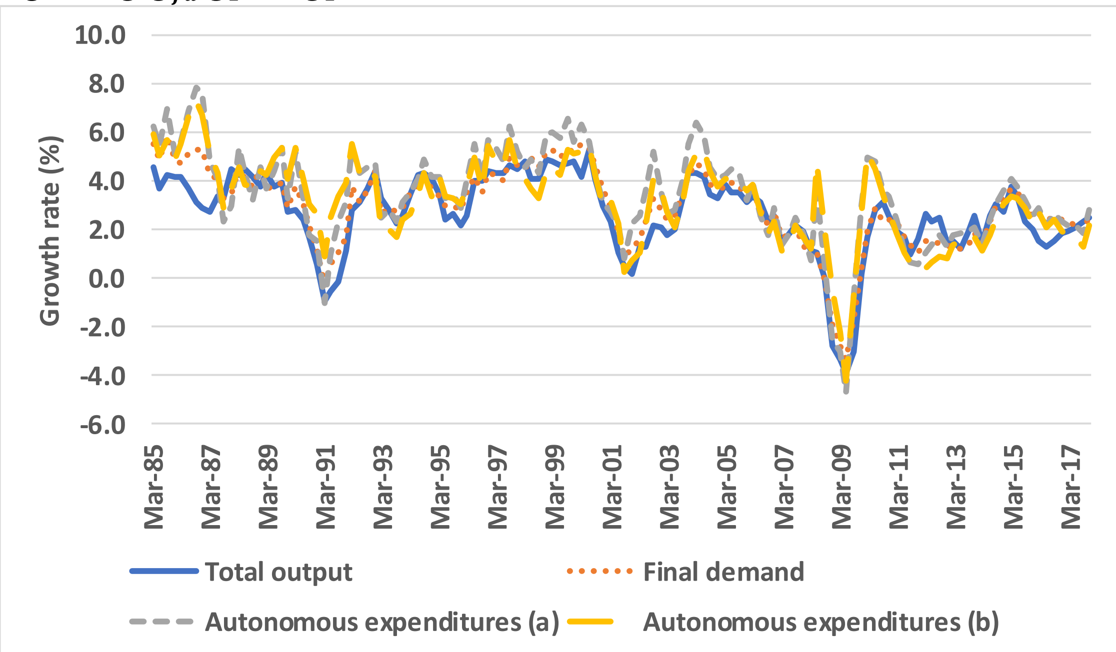
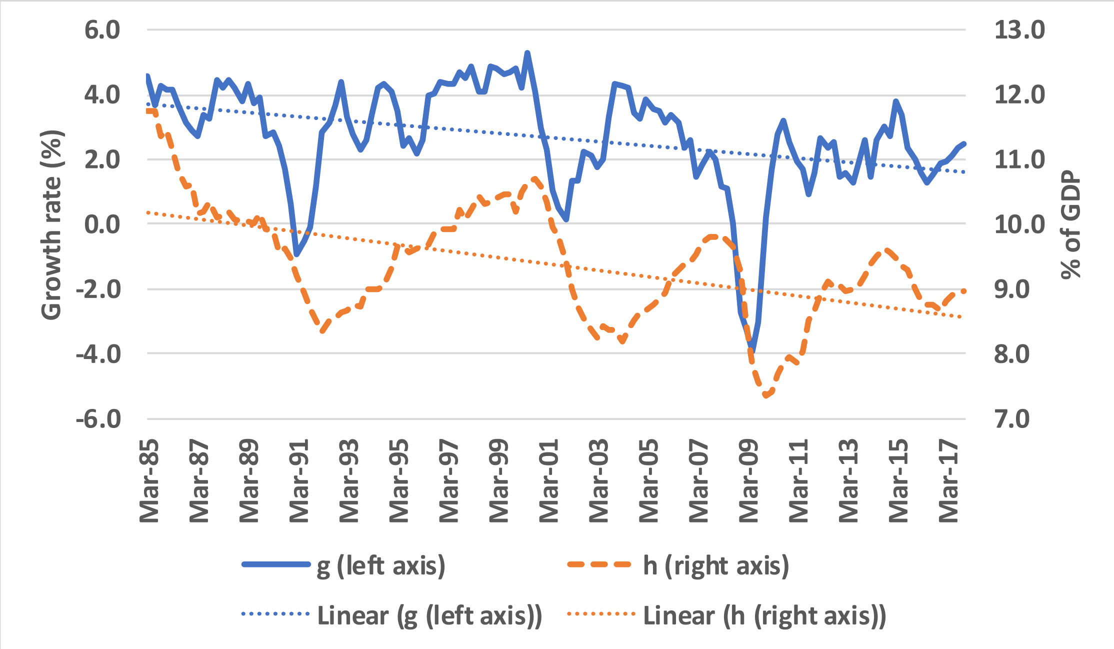


Figure 3: g and h



Next, we plot each one of the growth rate series vs the propensity to invest to see the empirical relation between them (Pictures 4 to 7). Although correlation does not imply causality, in all pictures, there is a clear positive relationship between growth rate and the induced investment share, a stylized fact expected according to the Supermultiplier approach.

Figure 4: g vs h

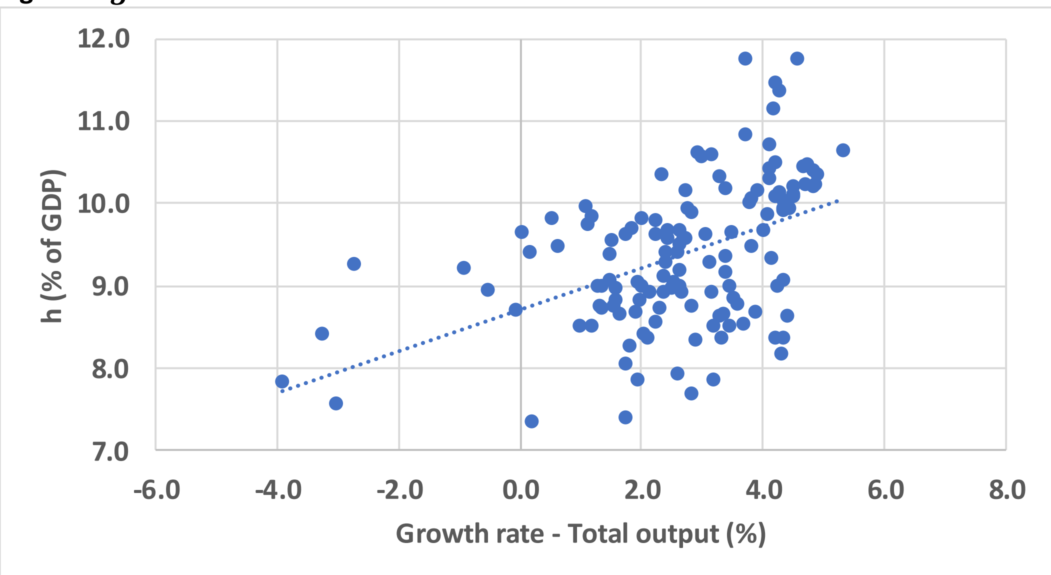


Figure 5: g_{fd} vs h

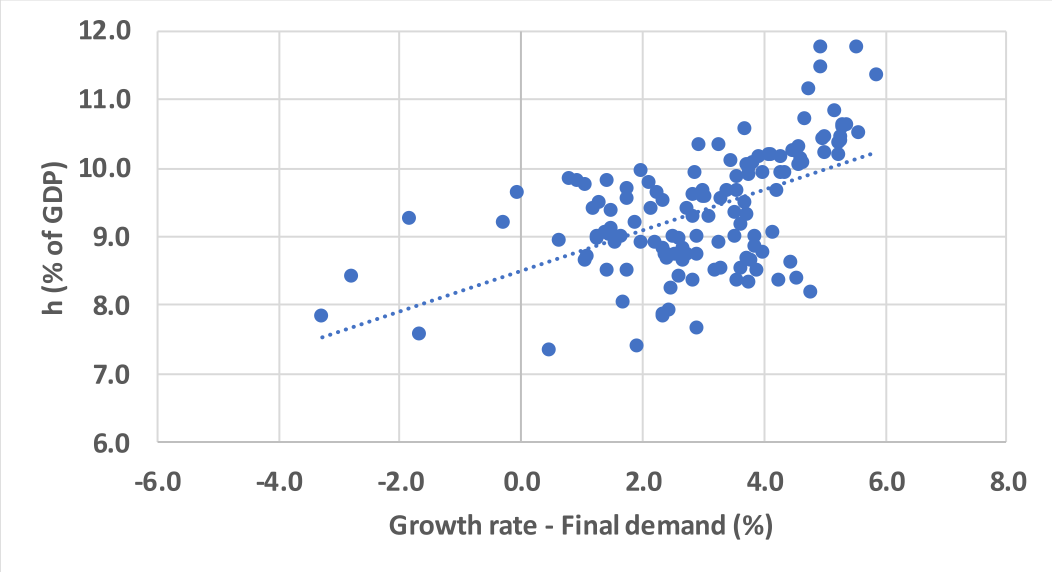


Figure 6: g_z^a vs h

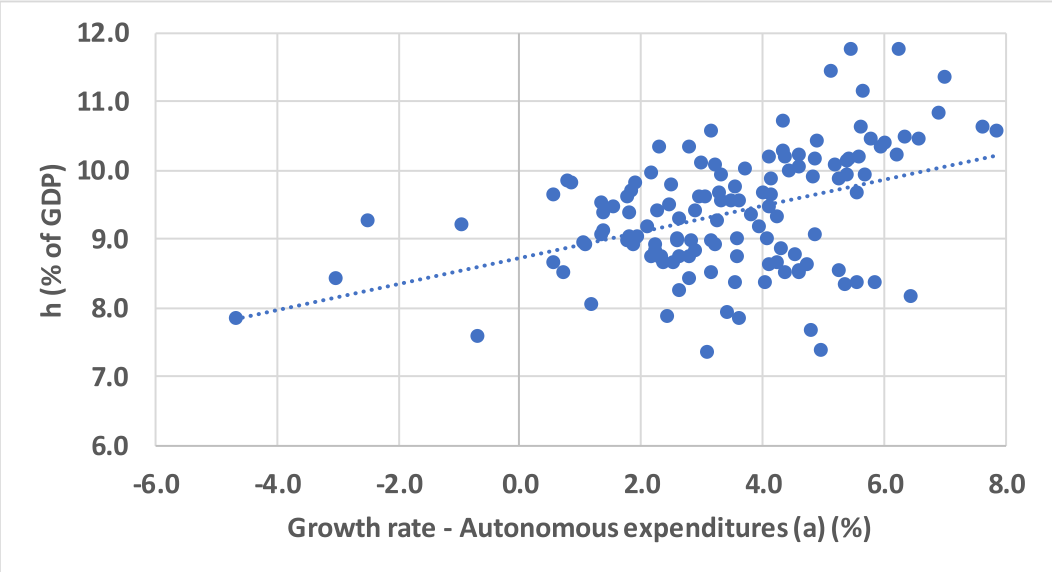
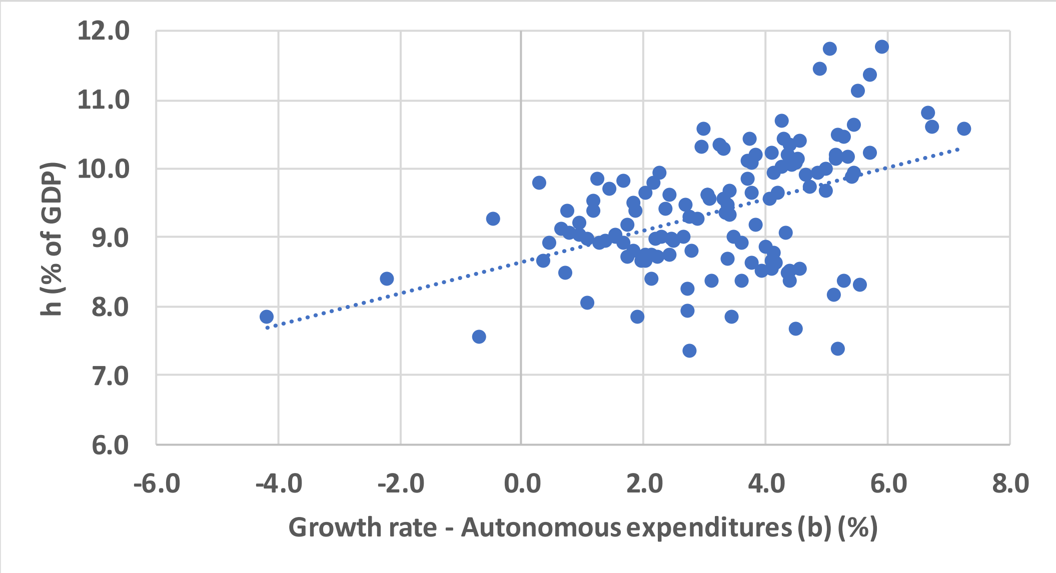


Figure 7: g_z^b vs h



6 Causality between growth and propensity to invest and estimation of the propensity to invest function

In this section, we check for the causality (in the econometric sense) between the growth rate and propensity to invest, and the estimation of the parameters of the propensity to invest function presented in equation 16. We present the results in the context of the discussion of the dynamic stability condition of the model.

We begin by performing unit root tests on the series of h, g, g_{fd}, g_z^a and g_z^b. Taking the 5% level as our criterion, it is not possible to reject the null hypothesis (of the existence of unit root) for neither of the five series so that we can consider all of them as non-stationary. Although we do not expect to see growth rates or investment share that increase or decline persistently, we saw on Figure 3 that during the period we are considering growth rates and the propensity to invest presented a declining trend, so this non-stationarity seems consistent for the sample window. Since the series present unit root, we perform cointegration tests before proceeding to the estimation of the VAR equations. Cointegration tests between each one of the growth rates and h reject the null hypothesis of no cointegration at least at the 5% level, as can be seen in Figure 8.

Figure 8: Cointegration tests

Cointegration	Are the series cointegrated?	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob
Between h and g	yes	0.1311	23.38	20.26	0.018
Between h and g(fd)	yes	0.1263	23.78	20.26	0.016
Between h and g(z)(a)	yes	0.1373	26.57	20.26	0.006
Between h and g(z)(b)	yes	0.1432	27.26	20.26	0.005

Our next step is to estimate a VAR between g and h, g_{fd} and h, g_z^a and h and g_z^b and h. In order to do so, we choose the number of lags using the lag order selection criteria[14]. In most of the cases, the number of lags selected is 5, and in only one case, we chose 7 as the optimal number of lags. After estimating all VAR equations, we test for causality between the variables. Since all the series considered are non-stationary, Granger

[14] To choose the number of lags, we take into account the LR, FPE, AIC, HD and SC criteria.

causality test does not apply, and we have to use Toda Yamamoto procedure to test for causality. The results of the test are reported in Figure 9.[15]

Figure 9: Toda Yamamoto tests

Variables	Number of lags (VAR)	Dependent variable: h		Dependent variable: g, d(fd), g(z)(a) or g(z)(b)	
		Is there causality?	Prob	Is there causality?	Prob
h and g	5	yes	0.000	yes	0.042
h and g(fd)	7	yes	0.000	no	0.310
h and g(z)(a)	5	yes	0.000	no	0.531
h and g(z)(b)	5	yes	0.001	no	0.667

As can be seen above, causality going from the growth rates to the propensity to invest is confirmed at the 1% level in all tests, providing empirical support to the Supermultiplier model. On the other hand, the existence of reverse causality must be interpreted with caution and deserves some commentaries. When we check for causality between the propensity to invest and total output growth, it is not possible to rule out the existence of reverse causality going from the induced investment share to the growth rate, although in this case causality is only present at the 5% level and it is not so undoubted as the one going from g to h. A possible explanation for this is the fact that the induced investment (which is the numerator of the ratio we are trying to explain - h) is included on total demand, so the variable we are taking as "exogenous"– the growth rate of output – in order to explain the induced investment ratio is in fact not completely exogenous.

Following the procedure used by Braga (2018), an alternative method to deal with this issue is to exclude the induced investment from the total output and consider only final demand (in the sense of Garegnani, 2015). In this case, the reverse causality going from the propensity to invest to the growth of final demand is completely ruled out, meaning

[15] There is autocorrelation in the VAR estimated between h and g_z^a. However, we re-estimated it using 7 lags, and in this case there is no autocorrelation present and Toda Yamamoto results remain basically the same. In the case of the VAR between h and g and between h and g_z^b, there is a weak autocorrelation that did not disappear when using a different number of lags.

that the former does not Granger-causes the latter. In this test, the p-value (chance of error when rejecting the null hypothesis of no causality) is 31%.

However, final demand includes the induced consumption, which is also an endogenous component of demand, so final demand is still not entirely exogenous. Our next step is to exclude the induced consumption from final demand, getting to non-capacity creating autonomous expenditures. First, we are discussing the scenario in which durable goods consumption is included in autonomous expenditures. In this case, causality going from h to g_z^a is also completely ruled out, and the p-value of the test is higher than in the previous one (53%), meaning that when excluding an endogenous part of demand, the existence of such causality becomes even more unlikely. At last, we exclude the consumption of durable goods from autonomous expenditures, since this is probably the component of autonomous demand that presents the highest degree of endogeneity, moving thus to our second specification of autonomous demand (g_z^b). As discussed in the fourth section, it does not mean that this variable is one hundred per cent independent of current output, but it represents the most exogenous portion of demand as possible. As expected, Toda Yamamoto test indicates that h does not Granger causes g_z^b, and the p-value is even higher than before (67%). We can conclude from these tests that to the extent that we exclude endogenous elements of demand, demand growth rates become more independent from the propensity to invest, ruling out the possibility of reverse causality.

Once we have discussed the causality relations between growth and the propensity to invest, we proceed to the task of estimating the parameters of this function. As discussed in section 4, the relevant variable to determine firms' investment is total demand, so we are leaving aside final demand and autonomous expenditures for now and considering only output growth. Our estimates are based on equation 16, and we begin estimating h using the generalized method of moments (GMM). The theoretical model states that the relevant variable to be considered is g_{t-1} (with a lag), and even though we estimated the parameters using g_t (without lags), g_{t-1} is taken into account in the instrument specification (we use six lags both for g and h). The results are reported in equation 17 below. The numbers in the parenthesis in the line below the equation represent the p-value of the parameters, expressing the chance of error in rejecting the null hypothesis that the values are different from zero.

$$h_t = 0.629 + 0.909h_{t-1} + 0.075g_{t-1} \qquad (17)$$

$$(0.000)\ (0.000) \qquad (0.000)$$

All the parameters are statistically different from zero at the 1% level. The propensity to invest present a high degree of inertia from one period to another, while the effect of the growth rate is low. As pointed out in equation 17, $vx = 0.075$. Assuming that $v = 1.07$ (which is the average capital-output ratio for the period 1985-2017), we calculate that $x = 0.070$. Using an average depreciation rate of $\delta = 6.7\%$ a year, the constant term calculated based on average values of v, δ and the estimated value of x would be $vx\delta = 1.07 * 0.070 * 6.7 = 0.500$, which is close to the estimated value of the constant term (0.629).

As discussed in the second section, for the adjustment of capacity to take place, the propensity to invest must be sensitive to the growth rate – i.e., x must be positive. At the same time, for the Supermultiplier model to be dynamically stable, it is required that the parameter x to be sufficiently low (see equation 14), meaning that when the economy is outside fully adjusted position the speed of adjustment cannot be too high, under the risk that the propensity to spend to be higher than one. The combination of a high degree of inertia and a low value of x obtained in our estimates suggest that there is some tendency for the capacity to adjust to demand and that the speed of this adjustment is slow, providing empirical support to the Supermultiplier approach.[16]

Still, according to the theoretical model, it would be expected that the sum of x and $(1 - x)$ to be equal to one. In order to investigate if the estimated equation is compatible

[16] Notice that Fazzari, Ferri and Variato (2019, appendix) found persistent expectations of growth rates (calculated from a survey of professional forecasters), meaning that the adjustment of expectations of growth rates on lagged growth rates is very small, about 0.10 as a benchmark, which presents some similarity with our result of $x = 0.070$.

with the theoretical model, we performed a test of restriction of the parameters to check if this condition is fulfilled. Since the parameters we estimated are $(1-x)$ and vx, and assuming that $v = 1.07$, we tested for the following restriction:

$$0.909 + \frac{0.075}{1.07} = 1 \tag{18}$$

The left side of the above equation is equal to 0.979, slightly below unity. However, since there is some confidence interval in the estimated values, the results show that this sum is not statistically different from one. The null hypothesis of the test is that the condition above holds, and the results show that the null hypothesis cannot be rejected even at the 10% level. The results of the Wald test are reported in Figure 10 below:

Figure 10: Wald test results for parameter restrictions – parameters obtained from estimates using GMM method.

Test Statistic	Value	df	Probability
t-statistic	-1.428	123	0.156
F-statistic	2.038	(1, 123)	0.156
Chi-square	2.038	1	0.153

In order to validate our calculations, we also estimated the propensity to invest function equation through the cointegration vector, including a term to capture deterministic trend, since we concluded that both g and h have a declining trend from 1985 to 2017. Results are reported in equation 19:

$$h_t = 0.603 + 0.909 h_{t-1} + 0.072 g_{t-1} \tag{19}$$

$$(0.002)\ (0.000) \qquad (0.000)$$

We can see that the parameters estimated are very similar to the ones obtained using the GMM method and that all values are different from zero at the 1% level. Taking $v = 1.07$, we obtain $x = 0.067$. The sum of the inertia coefficient $(1-x)$ plus x equals to 0.977 in this case. Although this sum is slightly below one (just like in the previous estimates) the Wald test for parameter restrictions indicates that this sum is not statistically different from one, suggesting again that our estimates are compatible with the model. The results of the test are reported in Figure 11.

Figure 11: Wald test results for parameter restrictions – parameters obtained from estimates using cointegration vector.

Test Statistic	Value	df	Probability
t-statistic	-1.264	126	0.209
F-statistic	1.597	(1, 126)	0.209
Chi-square	1.597	1	0.206

At last, after estimating all the parameters, we are able to discuss under which circumstances the US economy presents dynamic stability. Based on expression 14, which presents the stability condition for the model, we can calculate the maximum possible rate of growth that falls within the stability range:

$$g^{max} = \frac{1 - (1 - m)[c(1 - t) + v\delta + vx]}{(1 - m)v(1 + x)} \qquad (20)$$

Basing on our decomposition of the supermultiplier model for the US economy, we calculated the values for m, c, t, v and δ. The remaining variable is x, which we estimated on our econometric exercises, so we know all the parameters required to calculate the maximum rate of growth.[17]

Our objective here is to discuss the role of three variables that affect the determination of this ceiling for demand-led growth. The first one is taxes. The supermultiplier model establishes a positive relationship between growth rate and the induced investment share. In a hypothetical situation where the propensity to spend is equal to one, for the economy to grow at higher rates without triggering instability, it would be required that the share of induced consumption to decrease. For a given propensity to consume, a higher tax rate implies a lower share of induced consumption on total output, increasing the "space left" for investment, which means the economy can grow at a faster pace. The second variable

[17] In order to provide more conservative estimates for g^{max}, our calculations are made using the data from the second decomposition of the supermultiplier – called series "b", – that takes the total household consumption as induced by disposable income and consequently imply in a higher propensity to consume.

we are highlighting is imports: on an open economy, some fraction of demand leaks through imports, so it also contributes to reducing the induced demand for the goods and services produced domestically – independently if this demand consists on induced consumption or induced investment – contributing to increase the maximum rate of growth that does not trigger instability.

At last, it is also important to take into account the space required for the adjustment to occur when the economy is outside its normal capacity utilization level. If the speed of adjustment – represented by x – is fast, deviations of utilization from its normal level will lead to a strong reaction of capitalists' investment, resulting in a higher propensity to spend. So a faster speed of adjustment decreases the ceiling for growth.

In order to illustrate the effect of taxes and imports, we calculated the maximum rate of growth in three different ways: a) considering the hypothetical case of a closed economy without government, b) including taxes but excluding imports – also a hypothetical situation, – and c) including both taxes and imports, which renders us the actual ceiling for stable growth. To evidence the contribution of the space required for adjustment, we also calculate the maximum growth rate excluding this variable – i.e., considering that $x = 0$. These values are presented in Figure 12.[18]

[18] The hypothetical maximum rate of growth ignoring taxes and imports was calculated using the following expression: $g^{max} = \frac{1-[c+v\delta+vx]}{v(1+x)}$. The maximum rate of growth considering taxes but excluding imports is given by: $g^{max} = \frac{1-[c(1-t)+v\delta+vx]}{v(1+x)}$. Finally, the ceiling for growth, ignoring the space required for the adjustment to occur is obtained by the following expression: $g^{max} = \frac{1-(1-m)[c(1-t)+v\delta]}{(1-m)v}$.

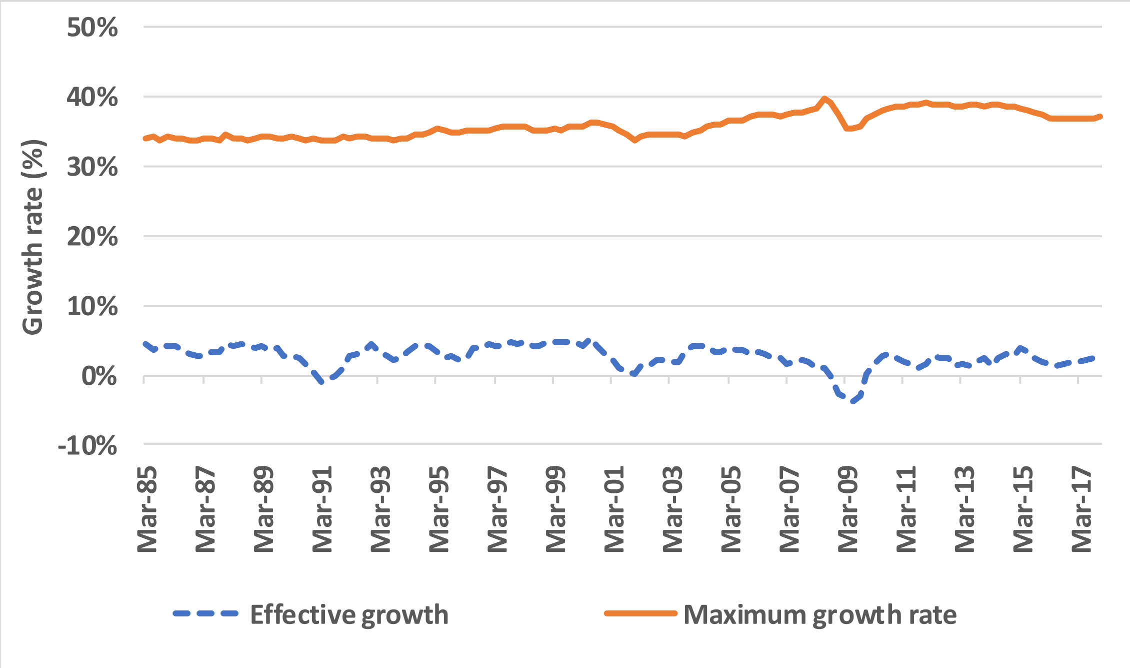
Figure 12: Parameters to calculate the maximum rate of growth

Parameters	Values (for 2017)
c	0.701
t	0.171
m	0.131
v	1.068
δ	6.7%
x	0.070
Evidencing the effect of taxes and imports	
Maximum growth (Excluding taxes and imports)	13.4%
Maximum growth (Including taxes and excluding imports)	23.9%
Maximum growth (Including taxes and imports)	37.0%
Evidencing the space required for the adjusment to occur	
Maximum growth (Ignoring the space required for the adjustment to occur)	46.6%
Maximum growth (Including the space required for the adjustment to occur)	37.0%

Figure 13 presents the series of effective growth and the maximum demand-led rate of growth that falls within the stability range. As can be seen, the maximum growth rate is currently around 37% and actual growth is always far below the upper limit, which suggests that a) the demand-led growth framework proposed by the Supermultiplier model is indeed very stable for a very large range of growth rates and b) during the period we are considering the US economy has never approached the stability limit. The upper limit has also increased since the early 2000's mainly due to the raise of penetration of imports.

Note that these limits are somewhat overestimated, to the extent that some of the components of autonomous demand that here are treated as totally exogenous might actually be partially endogenous. If some of those autonomous expenditures are found to be in part a function of output these upper limits would be reduced accordingly, but given the very high limit rates of growth estimated we think that including these effects would not change our basic conclusion that the maximum rate of demand led growth is indeed very high

Figure 13: Maximum rates of growth – the role of taxes and imports



7 Conclusion

In this paper, we tried to contribute to the debate about the Sraffian Supermultiplier demand led model by examining the specific case of the US Economy. Our results provide empirical support to the model, showing that (1) autonomous demand growth Granger-causes the propensity to invest (2) investment share presents a high degree of inertia from on period to another, while the effect of lagged growth is small but statistically significant, and (3) these results taken together suggest that there is a tendency for utilization to converge towards its normal level and that the speed of this adjustment is slow. Moreover, we combined the estimated value of the parameters with other US data to calculate the maximum rate of growth that fulfills the dynamic stability condition of the model. We find that (1) the range of growth rates compatible with dynamic stability is indeed extensive, allowing for very high growth rates of demand and (2) that the US economy has never approached the dynamic stability upper limit during the period we are considering.

Finally, it is important to make some comments about this limit for growth that we discussed. This ceiling represents simply the maximum rate of growth compatible with demand-led growth for a given distribution and taking into account the mechanism of adjustment of capacity to demand. However, there might be other kinds of constraints for demand-led growth that might arise before the economy reaches this limit. The first one relates to the balance of payments constraint. Although the US might not be subjected to this kind of constraint by issuing the world's currency, for other countries higher growth rates will probably entail a higher growth rate of imports, and a country might run short of foreign currency to pay for its imports and its external debt services. Second, faster economic growth induces a higher rate of growth of employment and reduces the unemployment rate, which can increase the bargaining power of the working class and lead to conflict inflation. This can be incompatible with policy rules or targets and lead to policy response from the monetary authority and the government; or in case of a strengthened distributive conflict can also lead to a stronger reaction from the ruling class by pressuring for change in the macroeconomic policy stance towards austerity in order to reduce growth and to get rid of wage inflation. This is why many recent papers dealing with the Sraffian Supermultiplier are focusing on these more important external and policy constraints to demand-led growth.

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