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Abstract

The demand-led supermultiplier growth model proposes that business investment is induced by income while autonomous expenditures determine economic growth. The most known versions of the model are presented at high levels of abstraction, focusing on general analytical properties and dynamic stability conditions. Based on those versions, Nikiforos et al. (2021) argue that the supermultiplier model cannot generate business cycles compatible with the empirical observation. In this paper, we show that this conclusion is a consequence of the misspecification of the variable chosen to represent the investment share, which includes business and residential investment. As the separation of those expenditures is a central point in the supermultiplier theory, we estimate a VAR model for the US economy (1967-2020) using only the data on business investment share instead. This procedure re-establishes an important feature to the supermultiplier theory, the mechanism of capital stock adjustment, as the empirical results points to the business investment share generally lagging the cycle. Finally, we make some remarks on how to discuss the business cycle from the supermultiplier perspective. We argue that for the supermultiplier, the business cycle depends less on the mechanism of capital stock adjustment than on the behavior of the autonomous components of demand and changes in the multiplier components. As the latter two are influenced by political, social and institutional factors, each business cycle has its own narrative.

Keywords: Supermultiplier, Business cycles, Demand-led growth theory, Capital adjustment principle, non-capacity creating autonomous expenditures.

Resumo

Ciclos econômicos: empiria e a teoria do supermultiplicador

O modelo de crescimento liderado pela demanda do supermultiplicador propõe que o investimento das firmas é induzido pela renda enquanto os gastos autônomos determinam o crescimento econômico. As versões mais conhecidas deste modelo são apresentadas em um elevado nível de abstração, enfatizando propriedades analíticas gerais e condições de estabilidade dinâmicas. Baseando-se nestas versões, Nikiforos *et al.* (2021) argumentam que o modelo do supermultiplicador não consegue gerar ciclos econômicos compatíveis com a observação empírica. Neste artigo, mostramos que esta conclusão é decorrência da especificação incorreta da variável que representa a taxa de investimento, que inclui investimento das firmas e investimento residencial. Como a separação desses gastos é um ponto central na teoria do supermultiplicador, estimamos um modelo VAR para a economia dos EUA (1967-2020) utilizando apenas os dados do investimento das firmas no seu lugar. Esse procedimento reestabelece uma característica importante da teoria do supermultiplicador, o mecanismo de ajustamento do estoque de capital, posto que os resultados empíricos indicam que a taxa de investimento das firmas geralmente segue o ciclo. Por fim, fazemos algumas observações sobre como discutir o ciclo econômico na perspectiva do supermultiplicador. Argumentamos que para a teoria do supermultiplicador, o investimento depende menos no mecanismo de ajustamento do estoque de capital do que do comportamento dos componentes autônomos da demanda e de mudanças

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dos componentes do multiplicador. Como estes dois últimos são influenciados por fatores políticos, sociais e institucional, cada ciclo econômico tem a sua própria história.

Palavras-chave: Supermultiplicador, Ciclo econômico, Teoria do crescimento liderado pela demanda, Princípio do ajustamento do estoque de capital, Gastos autônomos não-criadores de capacidade.
JEL Codes: E11, E12, E22, E32.

1 Introduction

The demand-led supermultiplier growth model proposes that the trend rate of growth of the economy is driven by the expansion of autonomous components of demand, and changes in the average propensity to save accommodate changes in the investment share of output. (Serrano, 1995). The most known versions of the model have many simplifying assumptions and were modeled at very high levels of abstraction, generally dealing with closed economy with no public sector and only one variable for autonomous demand. This is the case because their main purpose is to discuss the general analytical properties of the stead state, the comparative statics and the dynamic stability conditions (Freitas; Serrano, 2015; Allain, 2015; Lavoie, 2014, 2016). Some recent research on the supermultiplier model has focused on empirical evidence and extensions of the model to encompass macroeconomic policies and determinants of the components of autonomous demand (see, for example, the recent symposium organized by Summa and Freitas, 2020). Very few works have analyzed the cyclical properties of the supermultiplier model.[4]

Recently, Nikiforos et al. (2021) criticized the supermultiplier model for its supposed incapacity to generate business cycles compatible with the empirical observation. According to Nikiforos et al. (2021, p. 4), "postwar US samples strongly indicate that the investment share leads the rate of utilization" in the cycle, while the "Sraffian supermultiplier theory predicts that the rate of utilization leads the investment share in a dampened cycle", raising "questions about the key mechanism underlying supermultiplier theory".

In this paper, we will show that the results obtained by Nikiforos et al. (2021), namely that investment leads the cycle, are a consequence of a misspecification of the variable denoting the investment share. Nikiforos et al. (2021) use in their econometric exercise the data on total private investment, which incorporates both business investment and residential investment, but a central point in the supermultiplier theory is that the capacity generating business investment must be separated from the residential investment (Serrano, 1995; Cesaratto; Serrano; Stirati, 2003). We show that the results change considerably by using the data of business investment share. We found that the changes in the degree of capacity utilization led to changes in the business investment share, that is, business investment share in general lagging the economic cycle, which is compatible with the idea of the adjustment of the capital stock present in the supermultiplier theory. Moreover, in addition to contributing to clarifying the results found by Nikiforos et al. (2021) from a supermultiplier perspective, our econometric exercise provides further evidence in favor of the supermultiplier view using data on the degree of capacity utilization, adding to the previous literature that usually estimates the relationship between business investment share and the growth rate of output or aggregate demand

(4) An exception is a recent paper by Fazzari and Gonzalez (2021) with a focus on empirical properties of the model and its adherence to the empirical facts of the US business cycle.

(Girardi and Pariboni, 2016, 2020; Braga, 2020; Pérez-Montiel and Erbina, 2020; Haluska et al., 2021).

We will thus seize the opportunity to clarify other misunderstanding about the supermultiplier theory relating to the possibility of 'unjustified' business investment in the short period (Cesaratto; Serrano; Stirati, 2003). We will also claim there are different formal specifications of the investment function and the mechanism of capital stock adjustment within the supermultiplier models. Finally, we will make some remarks on discussing the business cycle from the supermultiplier theory perspective.

The paper is articulated into five more sections. We discuss the supermultiplier theory in section 2. In section 3, we will discuss different specifications of the supermultiplier model. In section 4, we discuss the empirical evidence on the business cycles. In section 5, we discuss or econometric results and the differences with Nikiforos et al. (2021). In section 6, we discuss how to model business cycles from the supermultiplier perspective. We make our final remarks in section 7.

2 Supermultiplier theory, business investment and residential investment

In the demand-led supermultiplier growth model, the expansion of autonomous components of demand drives the trend rate of growth of the economy and changes in the investment share of output are possible due to changes in the average propensity to save (Serrano, 1995). This kind of model has its foundations on more general theoretical principles. In particular, it is essential to separate aggregate expenditures accordingly to two different criteria: whether they create (or not) capacity for the private business sector of the economy and if they are autonomous or induced. Induced demand is the share of aggregate demand that is systematically related to the production process and the level of output. On the contrary, autonomous demand is defined as the part of aggregate demand that is not systematically related to the output level (Serrano, 1995; Cesaratto; Serrano; Stirati, 2003).

Firms' current production decisions introduce purchasing power into the economy through contractual income (wages) paid to workers, which is spent in consumption goods. So, in the supermultiplier theory, part of consumption is seen as induced by the production process.

Also, for this theory, capacity-creating private business investment is seen as totally induced by effective demand since these expenditures, at the macroeconomic level, must be systematically related to the capacity requirements to attend the output levels over a longer time horizon. Following the capital-stock adjustment principle, business investment is seen as a derived demand, since it is related to firms' decision to produce in the future. Investment goods are purchased and added to the capital stock to increase productive capacity, allowing production to meet the expected trend of effective demand. In this view, competition forces firms to act in this way, as underestimating demand trends entails the risk of losing market share to rival firms and overestimation leads to costly levels of undesired excess capacity (Serrano, 1995; Summa, 2022).

The principle of adjustment of the capital stock thus establishes that are endogenous forces acting to adjust the productive capacity to the expected effective demand and output level through business investment. Business investment, however, at the macroeconomic level, is a result of the sum of investment decisions from firms of different sizes and operating in different activities in the economy, and ‘unjustified investment’ due to technical change, ‘animal spirits’ or the nature of competition may occur, but it triggers a process of correction according to the expansion of effective demand and considering the existing productive capacity (Cesaratto; Stirati; Serrano, 2003, p. 45). Thus, the supermultiplier is compatible with short-run business investment decisions not related with the current level or rate of growth of effective demand.

Among ‘non-capacity creating autonomous expenditures’, we find (at least part of) residential investment, consumption financed by credit, the discretionary consumption expenditures of the wealthy, government expenditures, and exports. These expenditures have multiple determinants that reflect social, political and institutional settings of specific economies and are influenced by their particular economic policy framework. Contrary to what happens to induced consumption and business investment, we have no *a priori* motive to establish a systematic relation between non-capacity creating autonomous expenditures and the production process.

Separating residential investment from business investment is not a novelty brought exclusively by the supermultiplier theory. Duesenberry (1958), for instance, states that it is not possible to have a theory of aggregate private investment. For him, it is clear there must be a different theory for each kind of private investment. The same point is shared with Matthews (1959) and Fair (2015). A more recent study stressing the differences on the behavior between business and residential investment is Blecker, Cauvel and Kim (2022). In this sense, Petrini and Teixeira (2021) discuss the idiosyncratic determinants of residential investment since there are multiple reasons to invest in housing: living in it, renting, or speculating with it. It is possible to separate long-term determinants, such as housing policies, urbanization processes, and population growth. Those change slowly and are essential in explaining the growth tendency of this expenditure. In addition, there are determinants more important in defining its cyclical behavior, such as mortgage interest rate and house price inflation. Households finance this expenditure mainly by credit and not by wages. Therefore, changes in house prices are very important in determining households´ net indebtedness, which is also a key aspect in considering this expenditure autonomy to current output. This is a source of finance independent of firms´ production decisions, fundamental to shaping the evolution of induced consumption or business investment.

Thus, from the supermultiplier perspective, it is very important, for theoretical reasons, to separate the explanation of the private business investment from the residential investment.

3 Supermultiplier models

The demand-led supermultiplier growth model is, like any model, a simplified framework constructed to explain some aspects of the economic process. This framework aims to analyze the implications of the Keynesian-Kaleckian principle of effective demand in a schematical way for the long-period analysis of capitalist economies by incorporating a multiplier-flexible accelerator mechanism (reflecting the principle of the capital stock adjustment) with autonomous expenditures. Freitas and Serrano (2015) presented one of the most known versions of this model – the one Nikiforos et al. (2021) chose to discuss its cyclical proprieties. We must recall that the model presented by Freitas and Serrano (2015) is a very baseline version of the supermultiplier, with many simplifying assumptions. They present a model built with high levels of abstraction – a closed economy with no public sector and only one variable for autonomous demand – with the main purpose to discuss its analytical properties for the long-period position to gravitate to the fully adjusted position. In this paper, also, the principle of the capital stock adjustment is modeled by considering that the propensity to invest (the business investment share[5]) reacts to deviations of the actual degree of utilization from the normal degree of utilization. This change on the investment share causes the convergence of the actual degree of utilization towards the normal one in a fully adjusted position. It is important to note that for them this rule is "the simplest for the purpose at hand, i.e., the elucidation of the adjustment of capacity to demand" (Freitas; Serrano, 2015, p. 266, footnote 12).

In fact, there are many versions of supermultiplier models. Fagundes and Freitas (2018) list three alternatives to Freitas and Serrano (2015) to modeling the adjustment mechanism of capital stock found in the supermultiplier literature: first, accumulation of capital depends on the difference between actual and normal utilization and the expected growth rate. The latter will also change depending on the difference between actual and normal utilization over the long period, as in Allain (2015) and Lavoie (2014, 2016). The second alternative follow the first group by relating capital accumulation to the difference between actual and normal utilization and the expected growth rate but proposes a different adjustment to the expected growth rate, according to an adaptive mechanism based on corrections regarding the actual growth rate in the long period, as Freitas and Dweck (2010) proposed. Third, the set of models in which the propensity to invest depends on the expected growth rate of effective demand, and the latter adjusts slowly following an adaptive mechanism based on corrections regarding the actual growth rate, as in Serrano (1995), Cesaratto et al. (2003), and we can add Serrano et al. (2019). To this list, we certainly can add a fourth different mechanism proposed by Fazzari et al. (2020) in which the propensity to invest depend both on a slowly adjusting target capital-output ratio and expected growth rate of effective demand, and the latter adjusts slowly following an adaptive mechanism based on corrections regarding the actual growth rate.

Anyway, we believe that specific models are constructed for different purposes, and to tackle them they can present different levels of abstraction. Emphasizing this point: Freitas and Serrano (2015) did not build a model to be directly applied to the empirical analyses of business cycles without any adaption – as Nikiforos et al. (2021) suppose. But supermultiplier models can be adapted and equipped to the task. A good example is Fazzari et al. (2020). Their version is modified to evaluate the model's empirical performance, showing that it produces results with good adherence to the observed US business cycle data (Fazzari; Gonzalez, 2021).

4 Empirical evidence

4.1 A quick look at the empirical literature on business cycle

One of the main contentions of Nikiforos et al. (2021) is that total private investment drives business cycles for the US economy. As discussed in section 2, the aggregation of business investment and residential investment in total private investment is conceptually inadequate if the aim is to use the result to criticize the supermultiplier theory. In this subsection, we show that the empirical

(5) We should recall that they abstract from residential investment, so all investment expenditure in this economy is business investment. Thus, investment share and business investment share are the same in this very specific model (Freitas; Serrano, 2015, p. 261).

literature on US business cycles provides evidence of the importance of dealing separately with these two kinds of investments, as they present very distinct behavior.

As we discussed in section 2, it is possible, within the supermultiplier approach, that short-run unjustified business investment leads economic cycles.[6] Despite this theoretical possibility, this does not seem to be the most common pattern found in historical business cycle experiences for the US economy. It is well documented for this economy that residential investment and business investment show significantly different patterns (Zarnowitz, 2007 [1992]). In general, residential investment (and durable consumption goods) seems to lead the business cycles while business investment lags them. This understanding is not exclusive to authors researching into supermultiplier lines, and on the contrary, researchers with very different theoretical affiliations have come to this conclusion.

Green (1997), for instance, states clearly that residential investment leads the business cycle, while business investment lags it, when analyzing the US economy from 1952 to 1992. Leamer (2007, 2015) finds similar results that US business cycles usually present the following pattern "[f]irst homes, then cars, and last business equipment" (Leamer, 2007, p. 8), meaning that the residential investment and durable consumption (a proxy to autonomous consumption) are the first movers in the business cycle, while business investment follows it. Kydland et al. (2016) and Huang et al. (2020) follow Leamer (2007, 2015) research line and support the results that residential investment and housing-related variables (such as house prices, mortgage rate, among others) lead US business cycles.[7]

Fiebiger (2018) and Fiebiger and Lavoie (2019) reach similar conclusions departing from a rather different theoretical perspective. Following a Luxemburg-inspired perspective on external markets, they present the relevance of residential investment (and autonomous consumption) in explaining US business cycles. Following their lead, Pérez-Montiel and Pariboni (2021) find the former explains both cycles and growth for the US economy. Perez-Montiel and Manera (2022) show that autonomous demand (in which residential investment is included) is in fact autonomous to output both in the short and in the long run for the US economy.

Although the previous authors pointed out the autonomy of residential investment by its relation to business cycles, others come to similar conclusions by investigating its determinants. Some of them indicate a prominent role to mortgage interest rate (McCArthy; Peach, 2002; Cauger; Coxwell Snyder, 2003; Fair, 2018), house prices (Arestis; González-Martínez, 2015, Kohlscheen et al., 2018), and other factors as migration (Kohlscheen et al. (2018), and banking credit (Arestis; González-Martínez, 2015). Petrini and Teixeira (2021) combine house prices and mortgage interest rate to calculate a real interest rate (houses´ own-rate of interest) specifically designed to explain residential investment growth rate behavior in the US economy and find econometric evidence supporting it. Generally, those authors do not find any role for disposable income in determining this expenditure in the US.

(6) Keynes (1936, p. 321) labeled as 'misdirected' this kind of investment and discussed its possible role during booms and bursts.

(7) Kydland et al. (2016) find analogous results for Canada.

Therefore, Nikiforos et al. (2021) empirical procedure of using the total private investment is not only contrary to the supermultiplier theory but also to a broader empirical set of literature on the behavior of the investment variables in the business cycle.

4.2 A quick look at the data

Figure 1 shows the behavior of the relation between total, business and residential investment share and capacity utilization in eight different periods, related to US business cycles from 1969 to 2020. It shows three figures per business cycle related respectively to total (row I), business (row II) and residential investment share (row III) in a plane with capacity utilization. The former appears at the horizontal axis, while investment share appears at the vertical axis. We segregate each cycle using the NBER dating procedure (peak-to-peak)[8] and dots' size increase over time for each cycle. We can see the different behavior of the business and residential investment in the cycles. Row I of Figure 1 shows the investment share calculated by Nikiforos et al. (2021), composed by the sum of business and residential investment. The two following rows show the private business (II) and residential (III) investment share of each cycle. There are also arrows indicating the start and the end of each business cycle for easy readability.

Figure 1 allow us to discuss how business and residential investment have a distinctive behavior along the business cycle. During economic recovery, residential investment grows faster than GDP, so its share increases. Consequentially, capacity utilization increases as well. As firms adjusts their productivity capacity according to the expected demand, business investment grows faster than GDP. As a result, capacity utilization decreases and so do the residential investment share (and other autonomous non-capacity creating share on GDP).

Business cycles B, C, D and G (Figure 1) strictly relate to what we should expect for a business cycle led by residential investment in a supermultiplier framework. When residential investment grows faster than other expenditures, its share of GDP increases and capacity utilization also increases, due to higher demand. Following the principle of capital adjustment, after some time lag, firms will accelerate their capital accumulation to adjust capacity to this higher demand. Business investment will grow temporarily faster than aggregate demand and, the degree of capacity utilization will first continue increasing. When the increased capacity starts to be used. the degree of capacity utilization and residential investment share decreases, while business investment share increases. In this sense, the residential investment vs. capacity utilization plane (B.III, C.III, D.III, and G.III) follows a clockwise pattern, displaying the autonomous behavior of the former expenditure. The plane business investment vs. capacity utilization (B.II, C.II, D.II, and G.II), in its turn, shows an anti-clockwise pattern, demonstrating the induced behavior of the former expenditure, as predicted by the supermultiplier theory. The planes with aggregate private investment do not offer a unique pattern precisely because it bundles expenditures with such a distinct behavior. The aggregation of residential and business investments behaving in such different ways can result in an anti-clockwise (C.I and D.I), a clockwise (G.I) or even an unclear pattern (B.I).

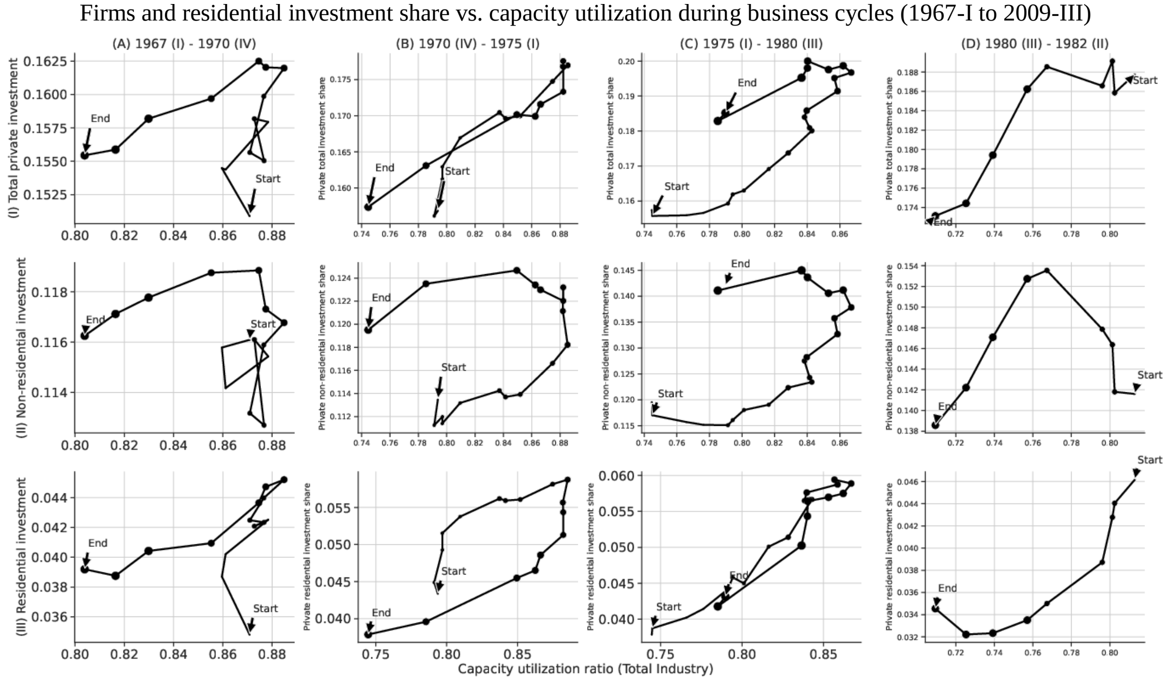
(8) We extended the first and the last business cycles to cover all data sample we use in the econometric research. Strictly following NBER dating, the former should be from 1969-IV to 1970-IV and the latter from 2009-II to 2020-I.

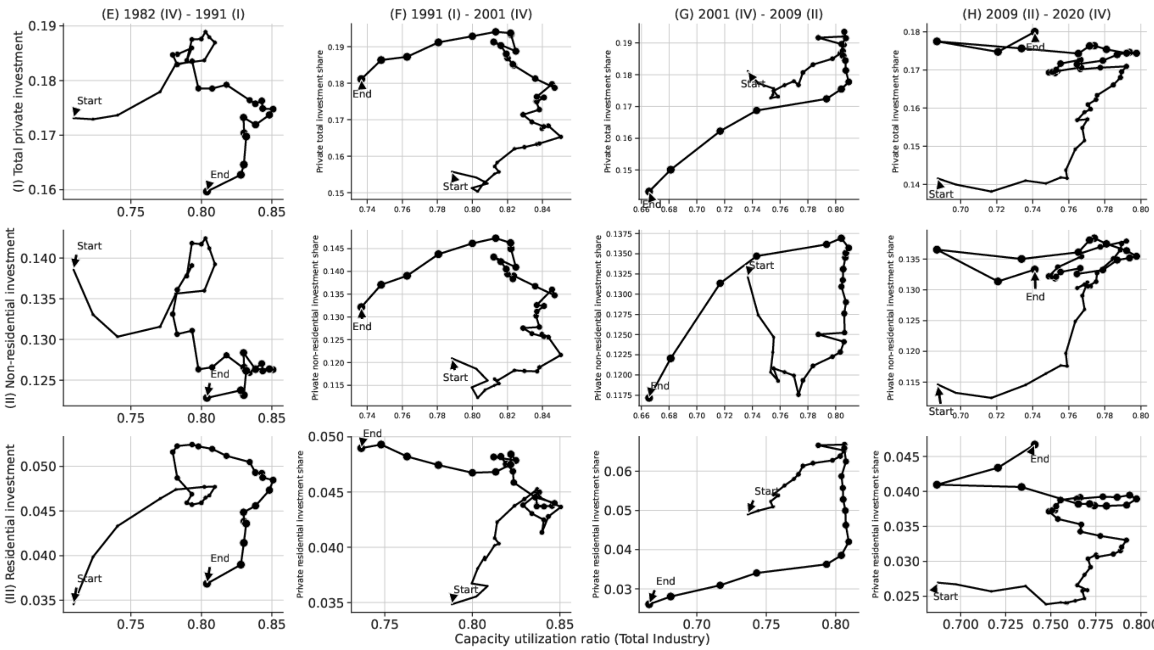
This analysis corresponds to the general validity of the capital adjustment principle and the induced behavior of business investment. However, there is room for ‘unjustified’ business investment according to the supermultiplier. This is the case of the dot-com business cycle (panel F, Figure 1), when residential investment did not lead the cycle, as already noted by Leamer (2007). In this episode, short-run ‘unjustified’ business investment seems to have played a role due to an innovative boom since its share in GDP started to increase after few quarters after the beginning of the cycle and since residential investment share presented an unclear pattern (F.III). However, the fall in capacity utilization and the consequently fall in business investment share after this business investment boom seems to be the pattern of the mechanism of correction expected by the principle of the capital stock adjustment.

It is not a problem for the supermultiplier theory that some business cycles do not follow precisely the same pattern, as in figures A, E and G. In addition to the fact that sometimes ‘unjustified investment’ booms can play a role in the upper phase of the cycles, in others some sort of sudden crisis can occur before the adjustment of capacity, which should take some time. The cycles A and D are examples of very short-run cycles (3 to 4 years) in which we should not expect to see the operation of the mechanism of capital stock adjustment. In the next section, we will econometrically analyze the cyclical behavior of business investment, which may help to show the general validity of the capital adjustment principle.

Figure 1

Firms and residential investment share vs. capacity utilization during business cycles (1967-I to 2009-III)





Note: All variables are seasonally adjusted. All figures have total capacity utilization index (TCU) on the x-axis. From top to bottom, y-axis variables are (BEA codes in parenthesis): total private investment (PNFI + PRFI) share on GDP; private nonresidential investment (PNFI) share on GDP; and private residential investment (PRFI) share on GDP. Dot size increases over time and is reset at each panel.

5 Econometric analysis

In this section we estimate the relationship between business investment share and capacity utilization. According to previous theoretical and empirical discussions, we calculate the investment share using only private nonresidential investment (i.e., business investment) data. This is our main divergence with Nikiforos et al. (2021) empirical methodology since they use total private investment (the sum of residential and nonresidential investment).

The business investment share variable (*h*) is calculated by private business investment (PNFI) divided by the GDP. The variable *u* is the degree of total industry utilization (TCU).[9] We use the natural logarithm of both series.[10] Our sample covers the same period as Nikiforos et al. (2021), from 1967-I to 2020-IV, quarterly seasonally adjusted data.[11, 12]

(9) Abbreviations in parenthesis indicates FRED's series code.

(10) We also estimated a model using natural logarithm only in business investment share variable. We did not find any qualitative distinction in the results.

(11) We estimated models with filtered and non-filtered data. Contrary to Nikiforos et al. (2021), we did not find any statistical advantage in using filtering procedures. Therefore, we only present the results for the non-filtered data estimations. Other estimations are available under request.

(12) Following Nikiforos et al. (2021), we also estimated an alternative model, using the log ratio of real GDP and real potential GDP as a measure for capacity utilization. The difference is our alternative model being the benchmark model for them and *vice versa*. We choose to present the model with TCU variable because it performed better in the post-estimation tests regarding homocedasticity and serial autocorrelation, although the alternative model exhibits the same overall results.

The analysis of the series does not indicate the presence of a cointegration relationship at a 5% significance level, suggesting the absence of a common long-run trend. Additionally, unit root tests indicate that those series are not stationary. See Tables 1 and 2 for results for both tests by the Johansen procedure. Thus, we follow a first difference VAR estimation. Equation 1 presents the short-run adjustment process:

$$\begin{bmatrix}\Delta u_t \\ \Delta h_t\end{bmatrix} = \begin{bmatrix}\delta_1 \\ \delta_2\end{bmatrix} + \sum_{i=1}^{N} \begin{bmatrix}\beta_{1,i} & \gamma_{1,i} \\ \beta_{2,i} & \gamma_{2,1}\end{bmatrix} \begin{bmatrix}\Delta u_t \\ \Delta h_t\end{bmatrix} + \begin{bmatrix}\varepsilon_{1,t} \\ \varepsilon_{2,t}\end{bmatrix} \quad (1)$$

where δ_{is} indicate linear constant; N indicates the number of lags adopted; β_{is} and γ_{is} are coefficients associated with lagged capacity utilization and investment share, respectively, and; ε_{is} are the residuals.

Table 1
Unit root test

	Ln Capacity utilization			Ln Business investment share		
	ADF	PP	KPSS	ADF	PP	KPSS
Statistic	0.058	0.118	0.03	2.127	0.385	1.362
p-value	0.660	0.716	0.100	0.990	0.776	0.082

Note: $^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$.
Source: Authors' elaboration.

Table 2
Johansen cointegration tests (number of coitegrating vectors (r))

Null hypoteshis	$r = 0$	$r \leq 1$
Maximum Eigenvalue Statistics	53.239***	12.68**
Trace Statistics	65.919***	12.68**

Note: $^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$.
For cointegration, r must be equal to one ($n - 1$). Rejecting the hypothesis of $r \leq 1$ implies no cointegration relationship since $r = n$.
Source: Authors' elaboration.

We estimate a VAR model with three lags due to the analysis of four information criteria (see Table 3). This lag order generates homoscedastic residuals without serial auto-correlation (see bottom of Table 4).

Table 3
Lag order selection

	AIC(n)	HQ(n)	SC(n)	FPE(n)
Lag	3	3	2	3

Source: Authors' elaboration.

As in Nikiforos et al. (2021), we consider two Cholesky decomposition scenarios. The first assumes that private business investment is an induced expenditure and lags final demand (represented by capacity utilization rate). The other considers the opposite, that private nonresidential investment precedes utilization; that is, private nonresidential investment leads the business cycle. For short we will call the first ordering "Ordering I" and is out benchmark model, while the second is referred to as "Ordering II" (the ordering preferred by Nikiforos et al., 2021). We report the results for the benchmark model in this section, while the "Ordering II" results are in Appendix A.2.

Table 4 presents the estimations results of our VAR model.[13] It is important to note that our estimation is robust and not sensitive to the lag order specification. Table A1 of Appendix A.1 shows the results for a re-estimation of the benchmark model according to SC indication (Table 3).

Table 4
Ordering I model results
Model specification

	Ordering I	
	Δ Ln (Capacity utilization)	Δ Ln (Investment share)
	(1)	(2)
L (Ln (Capacity utilization))	0.44***	0.55***
	(0.08)	(0.09)
L (Ln (Investment share))	0.06	0.30***
	(0.08)	(0.09)
L^2 (Ln (Capacity utilization))	−0.05	−0.01
	(0.09)	(0.10)
L^2 (Ln (Investment share))	−0.08	0.25***
	(0.08)	(0.08)
L^3 (Ln (Capacity utilization))	0.16*	0.02
	(0.08)	(0.09)
L^3 (Ln (Investment share))	−0.19***	0.05
	(0.07)	(0.08)
Constant	0.002	0.01***
	(0.002)	(0.002)
Post-estimation Serial correlation	Portmanteau	40.932
(system-wide)	Ljung-Box	43.204
	Breusch–Godfrey	15.111
Heteroskedasticity	ARCH-LM	132.447
	20.229	10.607
Normality	Jarque-Bera	233.368***
	228.083***	79.341***

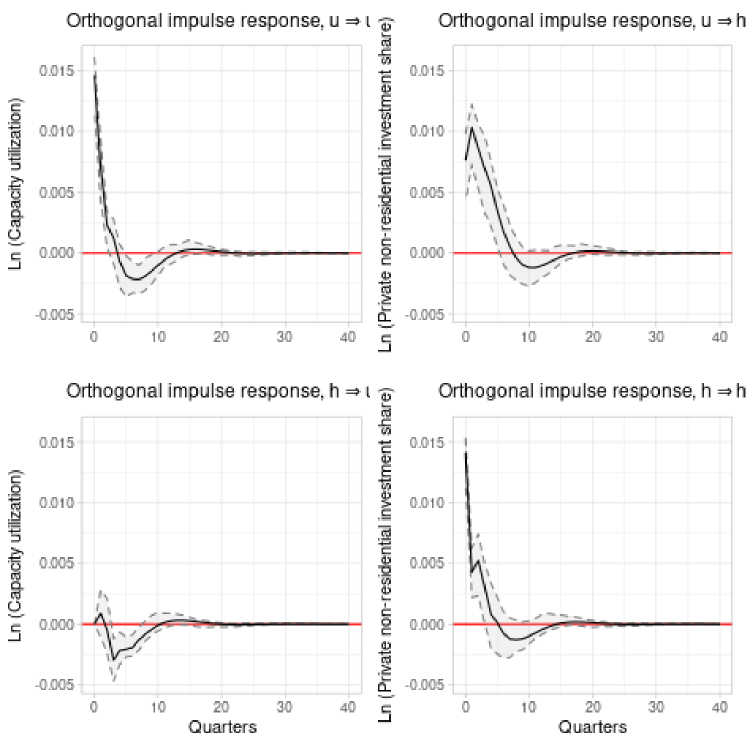
Note: *p<0.1; **p<0.05; ***p<0.01
Source: Authors' elaboration.

(13) We report no serial correlation at a 5% significance level according to Portmanteau, Ljung-Box and Breusch–Godfrey hypothesis tests. We also do not report system-wide nor equation-wide residual heteroscedasticity according to ARCH-LM test. However, as it is common in most empirical time series models, we do not report residual normality according to Jarque-Bera test.

The results show that capacity utilization and private nonresidential investment share positively correlate in the first lag. The positive and statistically significant capacity utilization parameter in the business investment share equation provides empirical support for the capital adjustment principle. We also report the negative effect of business investment share on capacity utilization after the second lag. We expect this result because nonresidential investment creates productive capacity only after some period[14].

We also evaluate the impulse response function (IRF) for the "Ordering I" model (Figure 2). Each panel shows an orthogonalized non-cumulative forty-period impulse response considering 95 percent bootstrapped confidence error bands. The main diagonal shows the model stability, which presents the exogenous shocks – in the statistical sense – of a variable on itself. The top right graph shows that a shock of one standard deviation increase in capacity utilization implies a positive and statistically significant increase in business investment share. The effect converges to zero after some period as expected. Considering now the symmetrically opposite case, an increase in business investment share positively affects capacity utilization (not statistically significant) and after some periods, the latter decreases. The interpretation of this result follows the notion of a dual character of investment: first, it affects aggregate demand, and only after some time creates new capacity (Mayer, 1960; Montgomery, 1995). Figure A1 (see Appendix A.1) reports similar findings for a different specification for the benchmark model and Figure A3 (see Appendix A.2) shows the results for the "Ordering II" model.

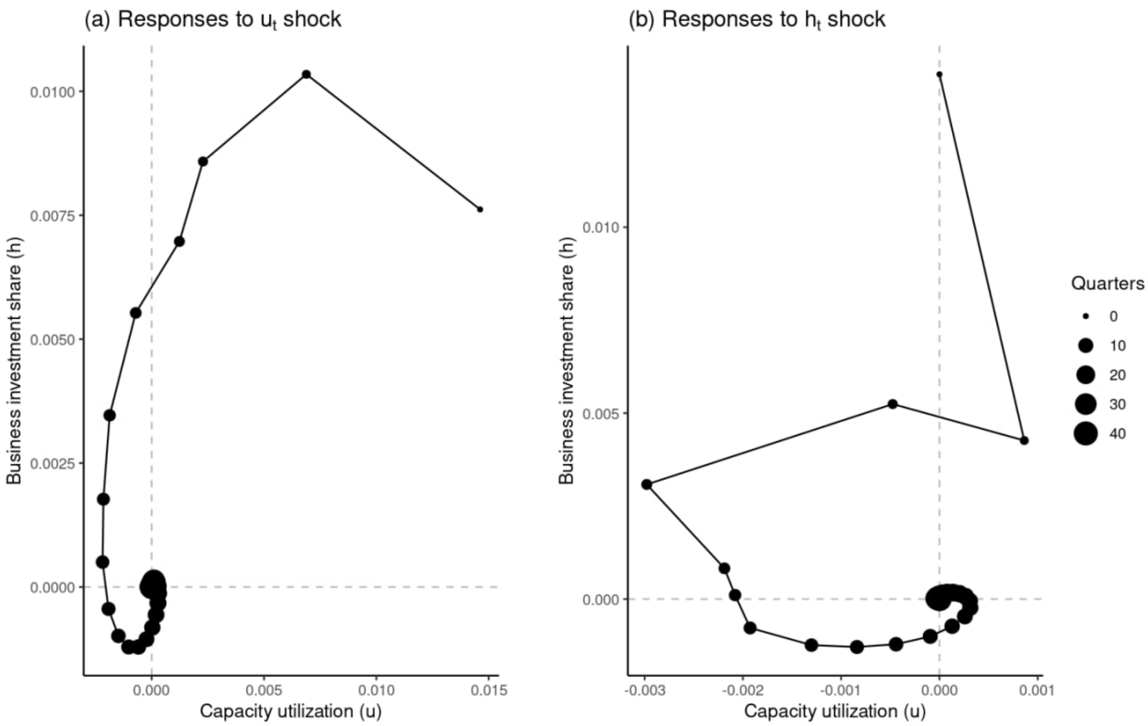
Figure 2
Orthogonal impulse response function (Benchmark model)



(14) It is important to note this model specification is just one among several possible. The capacity adjustment principle is a general proposition and not restricted to this functional form.

Like Nikiforos et al. (2021), we present the previous results in a business investment share/capacity utilization two-dimensional panel (see Figure 3). As the authors warn, this figure is just a visualization device, and it must be seen with caution since some observations are not statistically significant at 5% level. As discussed, from the supermultiplier perspective, business investment is expected to be an induced expenditure and reacts to aggregate final demand. Thus, we should expect business investment share and capacity utilization to present an anti-clockwise pattern (see the discussion in Section 4.2). Figure 3 shows this exact result, reflecting that using the appropriate investment data is sufficient to find results aligned to the supermultiplier theory – in opposition to Nikiforos et al. (2021) results.

Figure 3
Business investment share and capacity utilization cyclical pattern derived from VAR estimation
(dot size increases with time)

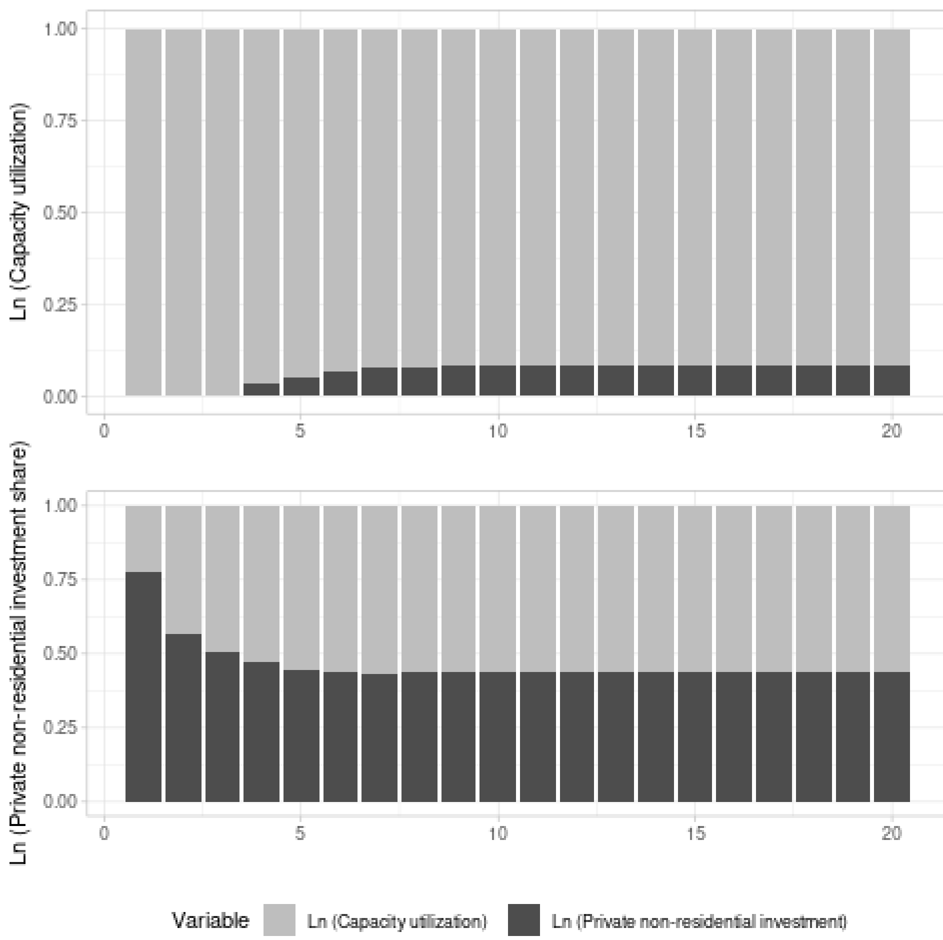


Source: Authors' elaboration inspired by Nikiforos et al. (2021) procedure.

We also report the forecast error variance decomposition (FEVD). Figure 4 and Figure A2 (see Appendix A.1) present the results for both benchmark ordering models. Following the supermultiplier theory, the rate of capacity utilization considerably explains the variance of business investment share in both models: more than fifty percent of the latter variability is explained by a shock on the former after the third quarter. On the other hand, a shock in business investment share does not explain a significant part of capacity utilization variability. This result reflects that a set of variables other than business investment explains capacity utilization – and economic activity as well – variability. According to the supermultiplier theory, this is the case for non-capacity creating autonomous expenditures already discussed by the literature (Girardi; Pariboni, 2016; Pérez-Montiel; Erbina, 2020).

The two variables (business investment share and capacity utilization) present a weaker relationship when considering the Ordering II (see Figures A3 and A4, Appendix A.2). When we simulate a structural shock in one of the variables, there is little repercussion in the other. Capacity utilization explains less than one-quarter of the variability of business investment share since this ordering treats the former as exogenous (in a statistical sense). In the opposite shock, the effect of business investment share on capacity utilization rate is also small (less than one quarter in the time span), meaning the main explanation of the former is outside the model: all the non-capacity creating autonomous expenditures. In summary, this means that the behavior of each variable is explained mainly by itself and does not explain the behavior of the other within the limitations of this econometric model.

Figure 4
Forecast error variance decomposition (FEVD)



The econometric estimations of the different models brought evidence that just by correcting the investment share variable one can find econometric evidence for the stylized facts of US business cycles presented in section 4 and supermultiplier theory (discussed in section 2). In the next section we will further discuss how to understand business cycles within this approach.

6 Discussion on cycles: accelerator or autonomous demand?

A more general theoretical criticism by Nikiforos et al. (2021, p. 13-14) on the possibility of the supermultiplier model in generating cycles is that this model can only "have a consistent story of the cycle with the long-run theory of growth (...) – where autonomous expenditure would drive both the cyclical fluctuations and long-run growth – (...) [if] resort to random shocks to autonomous expenditure".[15]

This kind of statement shows the importance of making some further clarifications on how to discuss business cycles within the supermultiplier approach. The principle of the capital stock – a fundamental component of this theory – can only generate dampened cycles since the propensity to spend is smaller than one and the flexible accelerator seems to operate slowly. This is a consequence of the theoretical stability conditions (Freitas; Serrano, 2015; Serrano; Freitas; Bhering, 2019), and is supported by empirical estimations (Haluska, Braga and Summa, 2021, for the US case). Thus, in the absence of new shocks, the actual productive capacity should converge to its desired level and the cyclical movements should fade away. In other words, the multiplier-accelerator mechanism within the supermultiplier cannot endogenously generate persistent cycles, but it propagates shocks coming from autonomous demand.

Nevertheless, this is a feature of a vast family of multiplier-accelerator models and not a particular characteristic of the supermultiplier model investigated by Nikiforos et al. (2021). For example, this kind of procedure is in line with the demand-led model proposed by Kalecki (1954). His multiplier-accelerator model also produced dampened cycles and he discusses the role of shocks in explaining the persistence of cycles in real economies. These shocks in Kalecki (1954) occur both on the parameters of the multiplier-accelerator model and also on the autonomous expenditures. Kalecki used to emphasize the role of investment spending in innovation to explain both the cycle and the trend, instead of capitalists' or workers' autonomous expenditures, or public and external demand (Kalecki, 1954, p. 119). Although the theoretical choices and assumptions made by Kalecki are somehow different from the supermultiplier, which presents a more prominent role for the non-capacity creating autonomous components of demand both for the cycle and the trend, the cyclical role of the multiplier-accelerator is very similar. Steindl ([1988] 2005, p.145) goes in the same line and suggests that "the macroeconomic system is like a machine which works up and transforms the disturbances which are fed into it from the outside in the course of time" and the demand shocks from changes in the macroeconomic policy stance are important to explain both to the cycle and the trend.

So, although this seems to be a first approach to studying cyclical fluctuations and trends within this approach, this is not the end of the story. On the contrary, as the multiplier-accelerator is

(15) According to them, the supermultiplier is similar to the Real Business Cycle (RBC) theory (Nikiforos et al, 2021, p.14). It seems quite clear for us that the supermultiplier and RBC models are not similar. On contrary, they present very opposite views on how the economy works. Just to list the most striking differences: (1) the former explains both the cycle and the trend from a demand-led perspective while the latter does it from a supply-side approach; (2) the former assumes slow adjustment of the variables while the latter instantaneous ones; (3) The latter sees the economy always in a full-employment equilibrium position, while the former sees actual capacity utilization in general different than normal position and no scarcity of labor; (4) more generally, the latter is based on the neoclassical principle of substitution between capital and labor, while the former is based on the surplus approach to prices and distribution. We think that pointing these striking differences are enough to show that this comparison is misleading, and we think that advance in this issue goes beyond the scope of this paper.

just a propagating mechanism, this model is open to accommodate the influence of history, institutional and policy factors on autonomous expenditures and the parameters. This must be seen as a positive quality of the model because there is no need to force it to generate cycles endogenously.[16, 17]

These expenditures and the supermultiplier parameters can (and should) be investigated in a more detailed way. We know that there can be changes in the propensity to consume due to changes in functional income distribution, changes in import coefficient due to changes in aggregate demand composition, and net tax rate changes due to changes in composition of demand and production and to policy decisions, for example. In fact, the empirical magnitude of the supermultiplier even for advanced and stable economies like US, Japan, Germany and Sweden are always changing in the recent decades (Morlin, Passos, and Pariboni, 2021).

Promising research already in progress can focus on the determinants of each of these autonomous components of demand in empirical and theoretical works. As Fiebiger (2018), Fiebiger and Lavoie (2019) and Skott (2019) show, the autonomous components of demand present cycles themselves. Teixeira and Petrini (2021), for instance, present a supermultiplier model in which residential investment leads growth and cycles, while Petrini and Teixeira (2021), Pérez-Montiel and Pariboni, (2021) and Goes (2021) empirically analyze this autonomous expenditure, stating its autonomy and relating its behavior to asset inflation and monetary policy.

There are also recent advances on incorporating autonomous consumption focusing on financial conditions and household indebtedness (Pariboni, 2016, Mandarino et al., 2020) and wealth-financed consumption (Brochier; Macedo e Silva, 2019); Government spending, transfers and taxation can be explained by electoral dynamics and changes in the economic policy stance (for an analysis of the public sector and policy rules into the Supermultiplier model see Freitas; Christianes, 2020, Freitas et al., 2021); and exports showing its role as an autonomous expenditure leading growth and in alleviating the external constraint (Morlin, 2022).

Those works, far from closing the subject, show the flexibility of the supermultiplier approach in taking into consideration changes that operate in real economies and are a starting point to further developments.

7 Concluding remarks

In this paper we discussed business cycles through the lens of the supermultiplier theory. According to this view, business investment is considered an induced expenditure, resulting from the capital adjustment principle while residential investment is seen as an autonomous expenditure. As there are theoretical and empirical reasons for separating business and residential investment, we check if Nikiforos et al. (2021) unexpected results are maintained if we use the data on business investment compatible with the supermultiplier theory. To achieve this objective, we used the same procedures and very similar econometric strategy, but we found opposite results, which are more aligned to the supermultiplier theory.

(16) Steindl ([1988] 2005) seems to disagree with the device of modeling non-linear relation with the variables to generate cycles as proposed by Goodwin.

(17) Steindl (1989) present similar reasoning in his positive assessment of Kalecki's business cycle theory.

Specifically, we found that the changes in the degree of capacity utilization led to changes in the business investment share, regardless of the lag order specification or the ordering imposed on these variables in the Cholesky decomposition. In summary, correctly separating private investment with different determinants (residential and nonresidential) provides evidence in favor of the general validity of the capital adjustment principle. In addition, this result adds to the previous empirical supermultiplier literature, that usually estimates the relation business investment share and the growth rate of output or aggregate demand, instead of the degree of capacity utilization (Girardi; Pariboni, 2016, 2020; Braga, 2020; Haluska et al., 2021; Pérez-Montiel; Erbina, 2020).

From the supermultiplier perspective, however, the multiplier-accelerator is just a propagating mechanism, and the cycles should also depend on the behavior of the components of autonomous demand. This open space to accommodate the influence of history, institutional and policy factors into the model, including other elements rather than the behavior of the business investment as the *causa causans* of trend and cycles. There is already some work in progress on the determinants and patterns of the autonomous demand and implications to the supermultiplier model, and certainly more work can be done to further investigate the theoretical and empirical role of non-capacity creating autonomous expenditures and changes in the parameters of the multiplier in explaining the business cycles.

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Appedix A. Additional models

A.1 Alternative lag order specification

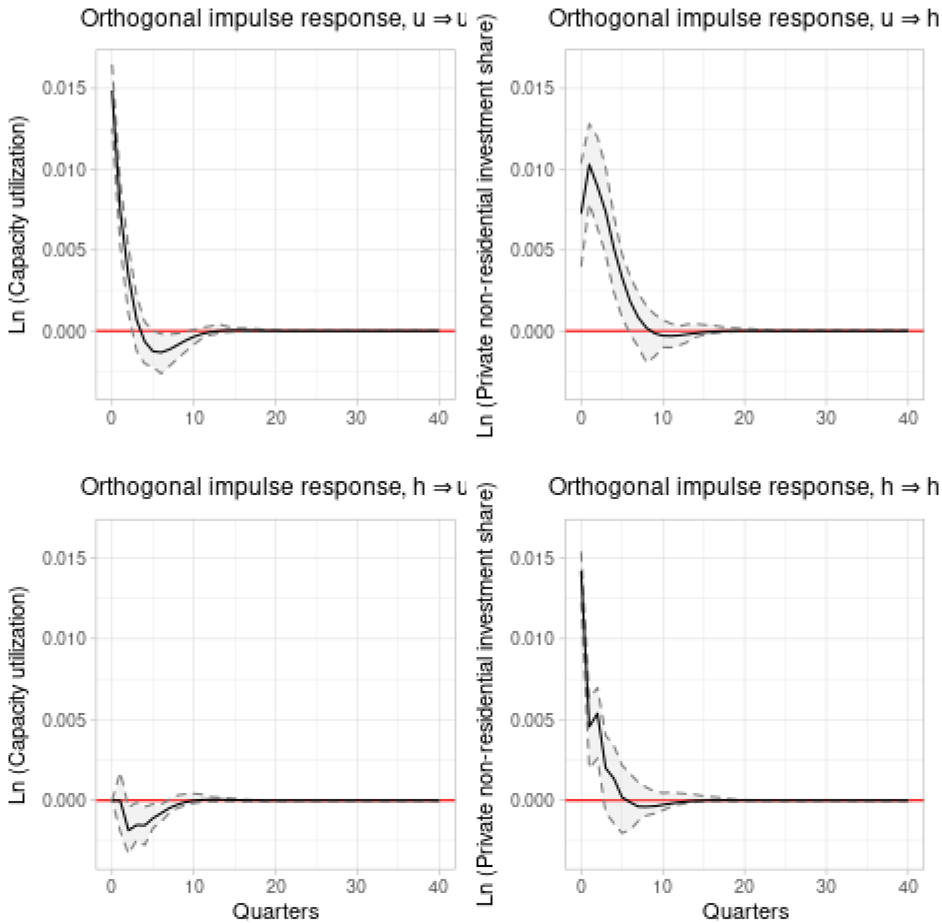
Table A1
Robustness model results

	Model specification	
	Ordering II with 2 lags	
	Δ Ln (Capacity utilization)	Δ Ln (Investment share)
	(1)	(2)
L (Ln (Capacity utilization))	0.50***	0.54***
	(0.08)	(0.09)
L (Ln (Investment share))	−0.001	0.32***
	(0.07)	(0.08)
L^2 (Ln (Capacity utilization))	0.05	−0.02
	(0.08)	(0.09)
L^2 (Ln (Investment share))	−0.13*	0.28***
	(0.07)	(0.07)
Constant	0.001	0.01***
	(0.002)	(0.002)
Post-estimation Serial correlation	Portmenteau	49.469
(system-wide)	Ljung-Box	51.805
	Breusch–Godfrey	29.489
Heteroscedasticity	ARCH-LM	152.221**
	15.304	10.363
Normality	Jarque-Bera	234.948***
	228.214***	77.746***

Note: *p<0.1; **p<0.05; ***p<0.01
Source: Authors' elaboration.

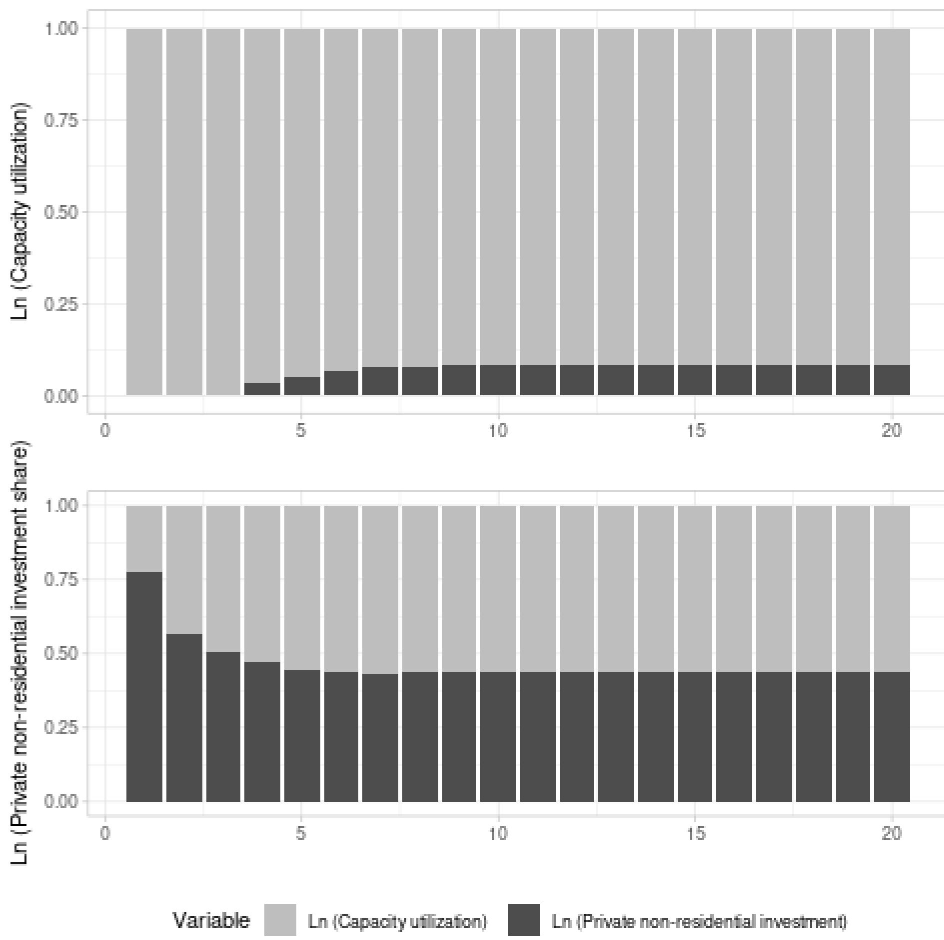
A.1.1 Alternative Impulse Response Function (IRF)

Figure A1
Impulse response function for robustness check



A.1.2 Forecast error variance decomposition

Figure A2
Forecast error variance decomposition (FEVD) for robustness check

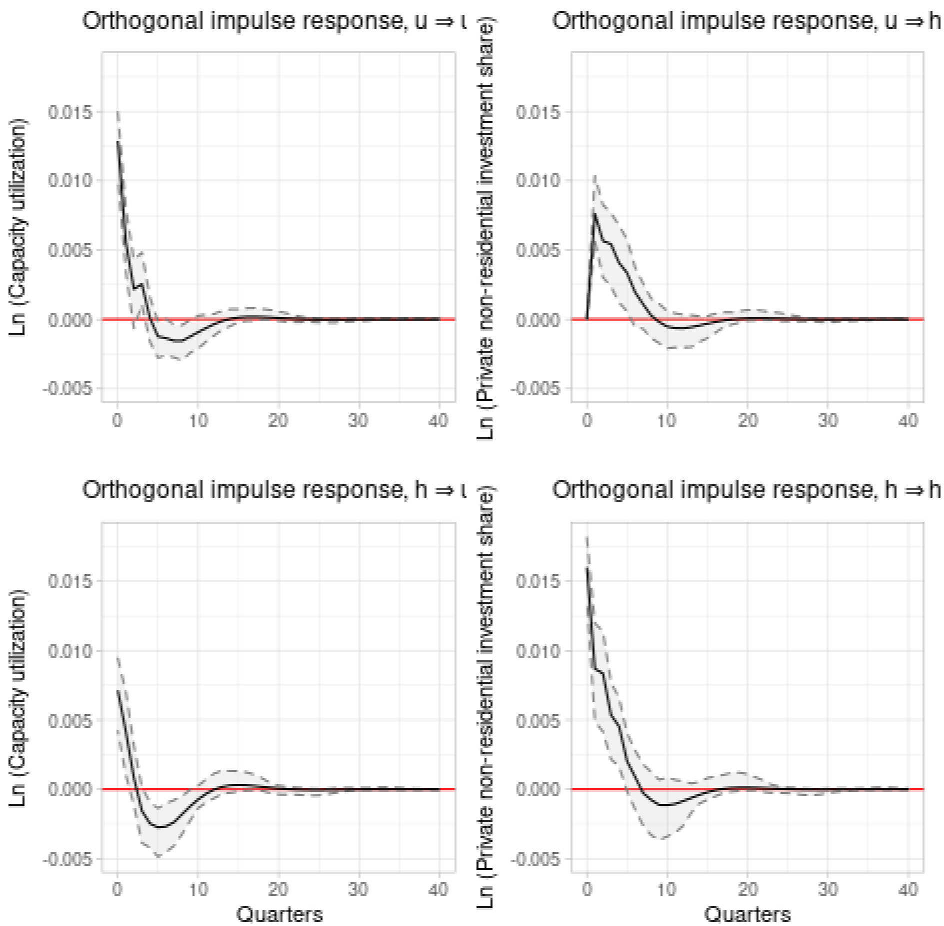


A.2 Ordering II results

In this subsection, we provide both IRF and FEVD results considering the Ordering II. To make main results comparable, we design our figures in the same manner.

A.2.1 Alternative impulse response function

Figure A3
Impulse response function (IRF) using Ordering II



A.2.2 Alternative forecast errors variance decomposition

Figure A4
Forecast error variance decomposition (FEVD) using Ordering II