Long-run effective demand and residential investment: a Sraffian supermultiplier based analysis

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In this paper, we build a fully specified parsimonious Sraffian supermultiplier stock-flow consistent model (SSM-SFC) with two non-capacity creating autonomous expenditure: residential investment and debt-financed consumption. Our model represents a closed and without government economy with workers and capitalist households and only the latter are not not credit constrained. The introduction of residential investment implies that our SSM-SFC model has two real assets: firms' productive capital and households' real estate. The numerical simulation experiments report the main standard Sraffian supermultiplier growth models results: (i) income distribution affects growth rate only during the traverse; (ii) autonomous expenditures alone affects long-term growth rate and; (iii) utilization rate moves towards the normal one. As a particular result, an increase of residential investment growth rate increase implies a decrease of real estate share in total real assets. Therefore, this model introduces both housing and asset bubbles on Sraffian supermultiplier agenda and extends the range of autonomous expenditures alternatives.

# Introduction

Sraffian supermultiplier growth model (SSM) establishes an important role to non-capacity creating (NCC) autonomous expenditures. textcite:serranolong1995 — and also more recent papers Freitas and Serrano (2015) — presents the SSM model in a rather parsimonious way as an alternative closure within the demand-led growth model agenda Serrano and Freitas (2017). In summary, SSM describes a demand-led growth pattern led by NCC autonomous expenditures.

More recently, SSM has been introduced to broader Post-Keynesian audience by textcite:allaintackling2015 and textcite:lavoieconvergence2016. Different NNC autonomous expenditures have been included in this framework: debt-financed cites:pariboniautonomous2015,fagundesrole2017,mandarinofinancing2018 and financial wealth-financed consumption Brochier and Macedo e Silva (2019); government expenditures Allain (2015) and; exports Nah and Lavoie (2017). Nevertheless, housing — another NCC autonomous expenditure — has been systematically neglected. Despite its absence in theoretical models, there is a growing empirical literature highlighting its macrodynamic relevance cites:leamerhousing2007,jordagreat2014,fiebigersemi-autonomous2018,fiebigertrend2017. One way to connect residential investment with the SSM model is through houses' own interest rate proposed by textcite:teixeiracrescimento2015. This particular real interest rate is the relevant one for house investors (households) and allow us to include asset bubble in a SSM-friendly framework.

In this paper, we include residential investment into the the Sraffian supermultiplier model within a SFC framework. Section ref:sec:Review reviews heterodox growth models with NCC autonomous expenditures and highlight the lack of residential investment as an autonomous expenditure. In Section ref:sec:empirical we will introduce some stylized facts on the relation between dwelling investments and macroeconomic dynamics. In Section ref:sec:Model we present our SSM-SFC model with two real assets: firms' capital and household' real estate. Next, in Section ref:sec:Experiments, we evaluate both traverse and steady-state dynamics through numerical simulations. The experiments are: decrease in wage-share (Section ref:sec:Exp1; increase in real estate inflation (Section ref:sec:Exp2) and; a increase in interest rate ref:sec:Exp3). Section ref:sec:Conclusion offers some concluding remarks while Appendix ref:append:Solution provides the analytical solution in order to assess stability condition and Appendix ref:append:Data presents simulation's parameters values.

# Empirical Motivation

A current trend among empirical research on demand-led growth is about the role of non-capacity creating autonomous expenditures. textcite:freitaspattern2013 present a growth accounting decomposition for the Brazilian economy. Their work show the importance of those expenditures in explaining Brazilian GDP growth between 1970 and 2005. textcite:bragainvestment2018 shows evidence that economic growth and firms investment are explained by unproductive expenditures in Brazilian economy from 1962 to 2015. For the USA, textcite:girardilong-run2016 show that autonomous expenditures do cause long run effects on the growth rate. textcite:girardiautonomous2018 bring evidence that autonomous expenditures determine the investment share on GDP for twenty OECD countries.

Nevertheless, there still is a lack of studies on the role of residential investments specifically. With the exception of textcite:leamerhousing2007, most of those studies were published after the Great Recession 2008-2009 — which made it clear how important this particular expenditure is to USA economic dynamics. Leamer (2007, 2) shows the central role in explaining US business cycles in the post-war period. Accordingly to Leamer, US business cycles have the pattern ``*[f]irst homes, then cars, and last business equipment*'' (Leamer 2007, 8).

\begin{figure}[htb]  
 \centering  
 \caption{Residential Investments as share of GDP\\\centering quarterly moving average}  
 \label{Investo\_Resid\_GDP}  
 \includegraphics[width = 0.7\textwidth]{./figs/housing\_gdp.png}  
 \caption\*{\textbf{Source:} Federal Reserve Bank of St. Louis, authors’ elaboration}  
\end{figure}

Figure ref:InvestoResidGDP shows how the behavior of residential dynamics can help to predict recessions. Recessions are anticipated by a reduction of residential investment share of GDP, while the expansion of those expenditures precedes economic recovery. The fall of dwellings expenditures in 1966-67 are an exception because the increase of military expenditures because of Vietnam War offset an eventual economic downturn (Leamer 2007, 20). Another exception is the dot-com bubble 2000 crisis that was not caused by residential investment. The Great Recession 2008-2009 is the one in which this pattern is the most evident.

Figure ref:fig:cycles depicts the relevance of business cycles in an alternative way[[1]](#footnote-22). Each cycle is represented in a different panel. The vertical axis represents residential investment-GDP ratio and the horizontal axis represents the rate of capacity utilization as a proxy for business cycle. Economic recovery is generally characterized by a growth rate of residential investment greater than GDP rate of growth — with the 1991-2000 period being a particular case. The result is a bigger residential investment-GDP ratio and an also bigger rate of capacity utilization. As firms investment follows the capital stock adjustment principle the accumulation rate increase with the goal to adjust the effective rate of capacity utilization to the normal/planned one. The increase of firms investment growth rate causes the GDP to grow faster than residential investment, therefore reducing the latter share on GDP and also reducing the rate of capacity utilization[[2]](#footnote-23). Therefore its is possible to see the stylized fact about the relation among residential investment and economic cycle.

\begin{figure}[htb]  
 \centering  
 \caption{Share of residential investment and capacity utilization during business cycles\\\centering (Dots size grow in time)}   
 \includegraphics[width = 0.65\textwidth]{./figs/cycles.png}  
 \label{fig:cycles}  
 \caption\*{\textbf{Source:} Federal Reserve Bank of St. Louis, authors’ elaboration.}  
\end{figure}

There is also an indirect relation between housing and aggregate demand. Accordingly to textcite:teixeirauma2011, real estate is one of the most commons means of wealth to US households and it serves as collateral to borrowing. textcite:zezzau.s.2008 and textcite:barbarising2009 show that credit-financed consumption was one of the main drivers of economic growth before 2008 subprime crises. Households would increase their indebtedness as houses prices went up as a way to ``realize'' capital gains without selling their homes during the house bubble of the 2000s Teixeira (2015).

In order to analyze the relation between residential investment, real estate inflation and interest rates, textcite:teixeiracrescimento2015 introduced houses' own interest rate (). It is a real interest rate, estimated by deflating interest rate on mortgages by real estate inflation. This particular real interest rate is the most relevant for households since it is the real cost in real estate from buying real estate (Teixeira 2015, 53). Figure ref:propriainvesto shows how this procedure is more adequate than to deflate by a general price index — as Fair (2013, 143–6) does — to describe the housing dynamics. It is worth noting that during a housing bubble period, it is real estate inflation that governs own's interest rate dynamics. Therefore, the lower this rate is, the greater the capital gains (in real estate) for speculating with real estate will be. This negative relation between houses' own interest rate and residential investment is shown in Figure in which this particular real interest rate has been gradually decreased over the real estate boom (2002-5).

\begin{figure}[htb]  
 \centering  
 \caption{Residential investment growth rate vs. Houses Own interest rate}  
 \label{propria\_investo}  
 \includegraphics[width=.8\textwidth]{./figs/Own\_gI}  
 \caption\*{\textbf{Source:} U.S. Bureau of Economic Analysis, Authors' elaboration}  
\end{figure}

Despite shedding light on some relevant relationships, Teixeira (2015)'s (2015) proposition was not presented in a numerical simulation model and this will be done in Section . Understood how important is residential investment to economic dynamics (specially to the US economy), in the next section we will present and compare different heterodox models of economic growth with special focus on how they incorporate non-capacity creating autonomous expenditures.

# The absence of residential investment in demand-led growth models

Recently, there is an effort to include SSM in Post-Keynesian strands cites:allaintackling2015,lavoieconvergence2016. Some authors started to explore the consequences of introducing different NCC autonomous expenditures through modifications in the canonical Kaleckian model in the long-run[[3]](#footnote-25). In this Section, we will analyze which NCC has been included and its consequences.

textcite:allaintackling2015 considers tax-financed government consumption growing at an exogenous rate as NCC autonomous expenditure. In this model, tax rate adjusts endogenously so government budget remains balanced. textcite:heinautonomous2018 argues that textcite:allaintackling2015 does not explores the implications for government deficits/debt dynamics. Thus, embeds Allain (2015)'s (2015) contribution in a SFC framework in which government expenditures is now financed by credit creation/high powered money, keeping up with the canonical neo-Kaleckian investment function. This model has one result in conflict with SSM: non-convergence of utilization rate to the normal one. This is a consequence of traditional neo-Kaleckian investment function, so NCC autonomous expenditures plays a leading role only temporally.

textcite:brochiersupermultiplier2018 was the first effort to introduce SSM model in a fully specified SFC framework. They present a non-parsimonious model in which wealth-financed consumption plays the leading role. The results are at odds with the standard SSM model: income distribution affects fully-adjusted position growth rate. In other words, paradoxes of thrift and costs are held despite convergence of utilization rate to the normal one. Although causal mechanisms are not clear — considering the complexity of this model — it is a possible exception to what has been presented so far.

textcites:duttmaturity2006,palleyinside2010,heinfinance-dominated2012 present a model in which debt-financed consumption under standard neo-Kaleckian assumptions. Thus, stability is reached only if NCC autonomous consumption grows at the same rate of capital accumulation which means that this expenditure is not really autonomous. textcite:pariboniautonomous2015 presents an SSM alternative in which this causality is reversed so accumulation gradually converges towards debt-financed growth rate. textcite:mandarinofinancing2018 also build a debt-financed-led growth model in a SFC framework and reports both SSM standard results and paradox of debt.

textcite:nahlong-run2017 — similar to textcite:dejuanhidden2017 — introduce exports as the main driver of growth. Despite reporting standard SSM results as well, their model has different accumulation regimes (profit-led or wage-led) depending on how real exchange rate reacts to changes in income distribution.

Even though these works highlight the relevance of some NCC autonomous expenditures, residential investment has been systematically neglected. To be fair, textcite:zezzau.s.2008 — and latter textcite:nikolaidisecuritisation2015 — includes housing in a SFC growth model. However, as a result of neo-Kaleckian investment specification, residential investment only plays a secondary role on dynamics. textcite:teixeiracrescimento2015 includes residential investment in a SSM alternative. To do so, describes its growth rate by the so-called houses' own interest rate. This particular real interest rate depicts debt service and capital gains effects in households' net worth simultaneously. Teixeira (2015, 53) argues that this is the relevant real interest rate for households since it stands for the real cost in real estate from buying real estate. Therefore, houses' own interest rate allows us to include both asset bubbles and residential investment growth rate specification in SSM model, which motivates building the model in the third section.

From this literature review, we report an absence of residential investment-led growth models, despite its relevance to macroeconomic dynamics as shown by empirical literature cites:leamerhousing2007,jordagreat2014,fiebigersemi-autonomous2018,fiebigertrend2017. The next section will present a first attempt to fill this gap: a fully specified parsimonious SSM-SFC residential investment-led model which its growth rate is described by Teixeira (2015)'s (2015) own interest rate.

# A Sraffian supermultiplier SFC model with residential investment

## General equations

Our model is the most parsimonious as possible: a closed capitalist economy without government sector. Output () is determined by a fixed combination of a homogeneous labor () input with homogeneous fixed capital (). For simplicity, we put technological progress, depreciation and goods inflation aside so investment is presented in gross terms and all variables — except for houses — are measured in real terms. Assuming a Leontief production function and that growth is not constrained by labor scarcity, capacity output () is determined by firms' capacity creating capital stock ():

\begin{equation}  
\label{\_Leontieff}  
 Y\_{FC} = \min (Y\_L, Y\_K)  
\end{equation}  
\begin{equation}  
\label{\_YFC}  
 Y\_{FC} = \frac{K\_{f\_{-1}}}{v}  
\end{equation}  
\begin{equation}  
\label{\_u}  
 u = \frac{Y}{Y\_{FC}}  
\end{equation}

where is exogenous capital-output ratio and is utilization rate.

We further assume a ``Kaleckian'' economic structure composed by both workers (denoted by ) and capitalists (denoted by ) households and only the latter are not not credit constrained. Since we consider a closed without government economy, demand-determined level of output () is the sum of consumption () and both households and firms investment ( and respectively) and only the latter creates capacity:

\begin{equation}  
\label{\_It}  
 I\_t = I\_f + I\_h  
\end{equation}  
\begin{equation}  
\label{\_Y}  
 Y = \overbrace{[C + I\_h]}^{\text{Households}} + \overbrace{[I\_f]}^{\text{Firms}}  
\end{equation}

In other words, from institutional sectors perspective, household expenditures have two components (consumption and residential investment) and firms just one (non-residential investment). Only non-residential investment creates productive capacity. So, the novelty of this model is the inclusion of a second investment component all made by household sector and held by capitalists households for simplicity. Therefore, this economy produces two types of real assets: firms productive capital () and households housing ():

\begin{equation}  
 \label{\_K}  
 K = K\_f + K\_h  
\end{equation}

Denoting the houses share in total real assets as , we can rewrite equation as:

\begin{equation}  
\label{\_k}  
 k = \frac{K\_h}{K}  
\end{equation}  
$$  
K = (1-k)\cdot K + k\cdot K  
$$

Following both Sraffian and Kaleckian strands, we assume exogenous functional income distribution so wage-share () is defined as follows:

\begin{equation}  
 \omega = \overline{\omega}  
\end{equation}

which allows us to define total wages () as:

$$  
\overline{\omega} = \frac{W}{Y}  
$$  
\begin{equation}  
\label{\_W}  
 W = \overline{\omega}\cdot Y  
\end{equation}

Table presents the balance sheet matrix for all institutional sectors. Capitalists households hold financial wealth as bank deposits () and residential investment is financed by mortgages (). Capitalists' total net wealth () is the sum of their net financial wealth () and real assets (*i.e.* housing, ). Furthermore, capitalist consumption () is fully autonomous and financed by loans () while workers consumption () is fully induced by their wages. As usual, we assume that workers expend what they earn while capitalists earn what they expend, so workers financial and real wealth are both null. Firms finance their investment primarily by undistributed profits () and the residual by bank loans () — thus they do not hold deposits. Banks create credit *ex nihilo* and then collect the deposits, paying the same interest rate that they charge.

\begin{table}[H]  
\centering  
\caption{Balance Sheet matrix}  
\label{Matriz\_Estoques}  
\begin{tabular}{lccccc}  
\hline  
\hline  
 & Workers & Capitalists & Firms & Banks & $\sum$ \\ \hline  
  
Deposits & & $+M$ & & $-M$ & 0\\  
Loans& &$-L\_{hk}$ &$-L\_f$& $+L$ & 0\\  
Mortages & &$-MO$& & $+MO$ & 0\\\hline  
$\sum$ Net Financial Wealth &--- &$V\_{hk}$&$V\_f$&$V\_b$& $0$\\\hline  
Capital & & &$+K\_f$& & $+K\_f$\\  
Houses & &$+K\_{hd}$& & & $+K\_h$\\\hline  
$\sum$ Net Wealth &---&$NW\_{hk}$&$NW\_f$&$NW\_b$& $+K$\\  
\hline  
\hline  
\end{tabular}%  
\caption\*{\textbf{Source:} Authors' Elaboration}  
\end{table}

Table presents both transactions flows and the flow of funds matrix. This table shows all economic relations between institutional sectors ensuring that there is no ``black holes'' so all financial and real transaction are explicit Macedo e Silva and Dos Santos (2011).

\begin{table}[H]  
\centering  
\caption{Transactions flow matrix and flow of funds  
}  
\label{Matriz\_Fluxos}  
\resizebox{\textwidth}{!}{%  
\begin{tabular}{lccccccc}  
\hline  
\hline  
& Workers  
& \multicolumn{2}{c}{Capitalists}  
& \multicolumn{2}{c}{Firms}   
& Banks & Total \\ \cline{3-4}\cline{5-6}  
& &  
Current & Capital &   
Current & Capital &   
& $\sum$ \\   
Consumption &$-Cw$&$-C\_k$& & $+C$& & & 0\\  
Non-residential Investment & & & &$+I\_f$&$-I\_f$ & & 0\\  
Residential Investment & & &$-I\_h$&$+I\_h$& & & 0\\  
\textbf{{[}Output{]}} & & & &{[}$Y${]}& & & {[}$Y${]}\\  
Wages &$+W$&& &$-W$& & & 0\\  
Profits & &$+FD$& &$-FT$&$+FU$& & 0\\  
Deposits interest rate & &$+r\_m\cdot M\_{-1}$& && &$-r\_m\cdot M\_{-1}$& 0\\  
Loans interest rate & &$-r\_l\cdot L\_{k\_{-1}}$& &$-r\_l\cdot L\_{f\_{-1}}$& &$+r\_l\cdot L\_{-1}$& 0\\  
  
Mortages interest rates & &$-r\_{mo}\cdot MO\_{-1}$& && &$+r\_{mo}\cdot MO\_{-1}$& 0\\\hline  
\textbf{Subtotal} &---&$+S\_h$&$-I\_h$& &$+NFW\_f$&$+NFW\_b$& 0\\\hline  
Change in deposits & &$-\Delta M$& & & &$+\Delta M$& 0\\  
Change in mortgages & & &$+ \Delta MO$& & &$-\Delta MO$& 0\\  
Change in loans & &$+\Delta L\_{hk}$&&$+\Delta L\_f$& &$-\Delta L$& 0\\  
\textbf{Total} & & 0 & 0 & 0 & 0 & 0 & 0\\  
\hline  
\hline  
\end{tabular}%  
}  
\caption\*{\textbf{Source:} Authors' Elaboration}  
\end{table}

## Firms

In order to produce, firms purchase capital goods ( in capital account) and hire workers, whom total remuneration is the economy wage bill. Their total profits () are a residual between sales () and total wages (). Firms retain part () of profits net of interest payments () — to reinvest — and distribute the rest to capitalists ():

\begin{equation}  
\label{\_FT}  
 FT = Y - W  
\end{equation}  
\begin{equation}  
 FU = \gamma\_F\cdot (FT - r\_l\cdot L\_{f\_{-1}})  
\end{equation}  
\begin{equation}  
 FD = (1-\gamma\_F)\cdot (FT - r\_l\cdot L\_{f\_{-1}})  
\end{equation}

Firms (non-residential) investment is fully induced by the level of effective demand Freitas and Serrano (2015), and its growth rate changes accordingly to the capital stock adjustment principle. This implies that firms react to the discrepancies between actual and normal utilization rates. As mentioned above, only firms investment creates productive capital stock.

\begin{equation}  
\label{\_If}  
 I\_f = h\cdot Y  
\end{equation}  
\begin{equation}  
\label{\_h}  
 \Delta h = h\_{t-1}\cdot \gamma\_u\cdot (u - \overline{u}\_N)  
\end{equation}  
\begin{equation}  
 \Delta K\_f = I\_f  
\end{equation}

where is (endogenous) marginal propensity to invest and must be sufficiently small in order to the adjustment be gradual[[4]](#footnote-29).

Firms finance part of investment that exceeds undistributed profits by bank loans, charged by interest rate. We assume an elastic supply of credit for investment. Moreover, tables and show firms net wealth () and net financial balance () explicitly:

\begin{equation}  
 \Delta L\_f = I\_f - FU  
\end{equation}  
$$  
r\_g = \frac{\pi\cdot u}{v}  
$$  
$$  
r\_n = r\_g - r\_l\cdot\frac{L\_{f\_{-1}}}{K\_f}  
$$  
\begin{equation}  
 NFW\_f = FU - I\_f  
\end{equation}  
\begin{equation}  
 NW\_f = K\_f - L\_f  
\end{equation}

where and denotes gross and net profit rate respectively.

## Banks

As in most part of SFC literature, banks do not have an active role in our model. They create money as credit is demanded and just after they collect deposits Le Bourva (1992). Firms finance part of their investment with credit () and capitalists households finance all their residential investment by mortgages () and consumption by loans (), as already mentioned. Each operation has its own interest rate defined by a spread over deposits interest rate () exogenously determined by banks. For simplicity, we assume null bank spreads so interest rate on mortgages and on loans are the same as on deposits. Banks net balances () are defined by interests received net of interests payments. As those interests are the same, banks net wealth is necessarily zero (see table ) and deposits are residuum:

\begin{equation}  
L = L\_f + L\_{hk}  
\end{equation}  
\begin{equation}  
 r\_l = (1+\sigma\_l)\cdot r\_m  
\end{equation}  
\begin{equation}  
 r\_{mo} = (1+\sigma\_{mo})\cdot r\_m  
\end{equation}  
\begin{equation}  
 r\_m = \overline r\_m  
\end{equation}  
\begin{equation}  
 NFW\_b = r\_{mo}\cdot MO\_{-1} + r\_l\cdot L\_{-1} - r\_m\cdot M\_{-1}  
\end{equation}  
$$  
NFW\_b = \Delta MO + \Delta L - \Delta M  
$$  
\begin{equation}  
 NW\_b = V\_b \equiv 0  
\end{equation}  
\begin{equation}  
\label{\_M}  
 \Delta M = \Delta L + \Delta MO  
\end{equation}

## Households

### Workers

As mentioned before, we assume that workers expend () what they earn (). For simplicity, we consider that wages are the only source of income workers' disposable income () and do not have access to consumption loans, so worker' saving () are null. Therefore, accordingly to our hypothesis, workers' do not hold both net financial and total wealth.

\begin{equation}  
C\_w = W  
\end{equation}  
\begin{equation}  
YD\_w = W  
\end{equation}  
\begin{equation}  
S\_{hw} = YD\_w - C\_w  
\end{equation}  
$$  
S\_{hw} = 0  
$$  
\begin{equation}  
NFW\_{hw} = S\_{hw} = 0  
\end{equation}  
\begin{equation}  
V\_{hw} = 0  
\end{equation}

### Capitalists

This is the most complex institutional sector of our model. We assume consumption () is fully-autonomous and financed by loans (). Disposable income () is the sum of distributed profits and received interests on deposits, net of interests payments on both mortgages and loans. Capitalists savings () are disposable income net of consumption. At odds with SFC literature, savings are not equal to net balance () since we have included residential investment.

\begin{equation}  
\Delta L\_{hk} = C\_w  
\end{equation}  
\begin{equation}  
 \label{EqYD}  
 YD\_k = FD + \overline r\_m\cdot M\_{-1} - r\_{mo}\cdot MO\_{-1} - r\_{l}\cdot L\_{hk\_{-1}}  
\end{equation}  
\begin{equation}  
 \label{EqSh}  
 S\_{hk} = YD\_k - C\_k  
\end{equation}  
\begin{equation}  
\label{NFWh}  
 NFW\_{hk} = S\_{hk} - I\_h  
\end{equation}

In order to fulfill our goals, we employ Freitas and Cavalcanti (2019)'s (2019) procedure in which NCC autonomous expenditure () composition () remains unchanged so we express capitalists and total consumption as follows:

\begin{equation}  
 \label{EqMO}  
 \Delta MO = I\_h  
\end{equation}  
\begin{equation}  
\label{\_Z}  
Z = C\_k + I\_h  
\end{equation}  
$$  
\frac{C\_k}{Z} + \frac{I\_h}{Z} = R + (1-R)  
$$  
\begin{equation}  
\label{\_Ck}  
 C\_k = R\cdot Z  
\end{equation}  
\begin{equation}  
\label{ConsumoTotal}  
C = C\_w + C\_k  
\end{equation}  
$$  
C = C\_w + R\cdot Z  
$$

As households are the only institutional sector realizing residential investment, its supply () and demand () are equal and the same applies to houses stock.

\begin{equation}  
 I\_{hs} = I\_h  
\end{equation}  
\begin{equation}  
 K\_{hs} = K\_{hd}  
\end{equation}  
\begin{equation}  
 \Delta K\_{hs} = \Delta K\_{hd} = I\_{hs} = I\_h  
\end{equation}

where and denote supply and demand respectively. Accordingly to our hypothesis, nominal () and real net wealth () are defined as follows:

\begin{equation}  
V\_{hk} = K\_{hd}\cdot p\_h + M - L\_{hk} - MO  
\end{equation}  
\begin{equation}  
V\_{hkr} = K\_{hd} + M - L\_{hk} - MO  
\end{equation}

Finally, we present residential investment growth rate () as determined by houses own interest rate (, equation ) as introduced by textcite:teixeiracrescimento2015 and discussed in section ref:sec:empirical.

\begin{equation}  
 I\_h = (1 + g\_{I\_h})\cdot Ih\_{-1}  
\end{equation}  
\begin{equation}  
\label{g\_Z\_own}  
g\_{I\_h} = \phi\_0 - \phi\_1\cdot own  
\end{equation}  
$$  
\pi = \frac{\Delta p\_h}{p\_{h\_{t-1}}}  
$$  
\begin{equation}  
\label{\_own}  
own = \left(\frac{1+r\_{mo}}{1+\pi}\right) -1  
\end{equation}

where stands for real estate inflation, represents long-term determinants (*e.g.* demographic factors, housing and credit policies, etc.) while captures the demand for real estate arising from expectations of capital gains resulting from speculation with the existing dwellings stock. This particular real interest rate is the most relevant for households since the holders of an asset take their price into account in the decision-making process since its variation can generate capital gains/losses (Teixeira 2015, 114).

# Short and long-run equilibria

In this Section, we present the analytical solution of our model in order to analyse both short and long-run (denoted by ) relationships.

## Short-run good market equilibrium

In our no-government closed economic system, real output (equation ) is the sum of household consumption (equation ) and both types of investment (equation ref:It). If we replace equations ref:W and ref:If into ref:Y and considering equation ref:Z we get the short-run GDP level:

\begin{equation}  
 \label{AnaliticaNivel}  
 Y = \left(\frac{1}{1-\omega - h}\right)\cdot Z  
\end{equation}

Next, dividing equation ref:AnaliticaNivel by ref:YFC and presenting firm's capital stock in terms of , we get the short-run equilibrium utilization rate (Eq ref:shortu)

ut =

## Fully-adjusted position

# Numerical Simulations

In this Section, we present the results of the following experiments[[5]](#footnote-38): (i) wage-share decrease; (ii) real estate inflation and; (iii) deposits interest rate increase. Since we use a SFC framework — similar to Brochier and Macedo e Silva (2019) and Mandarino (2018) — first shock assess whether or not income distribution affects fully-adjusted position growth rates. Real estate increase shock is motivated by recent US experience while the last one aims to evaluate indebtedness stability. Table in Appendix presents the parameters of simulation and Table compare each result to baseline. Figures ref:fig:results1 and ref:fig:results2 reports all shocks.

## Wage-share decrease

A wage-share decrease has a negative impact both in growth rate and utilization rate (see Figure ref:fig:results1). As a consequence GDP level decrease, firms' investment growth rate and marginal propensity to invest decline as well. Since autonomous expenditure growth rate remains unchanged, this negative effect is followed by a increase in productive investment growth rate because firms react to the discrepancies between actual and normal utilization rates. Additionally, wage-share decrease also changes supermultiplier so autonomous expenditures share on GDP increases. In summary, we report standards SSM model results: (i) marginal propensity to invest decrease is temporally and returns to baseline level; (ii) utilization rate moves towards normal one; (iii) supermultiplier decreases and autonomous expenditure share increases due to GDP decline and; (iv) since autonomous expenditure growth rate does not change, distribution effects are temporally.

Despite temporary effects in growth rate, wage-share decrease has a permanent effect in house share on total capital stock (see Equation ref:kstar and Figure ref:fig:results2). This result stems from the initial lower accumulation rate as residential investment growth rate remains constant. Another persistent effect is the higher capitalists' indebtedness despite the profit-share increase. This result stems from the decline in profit level as a consequence of the negative effect on GDP and subsequent decrease in capitalists' disposable income. In other words, we report a paradox in capitalists attempt to increase their profits — due to markup changes and subsequent increase in profit-share — since it generates a negative effect on net profits.

Finally, we also report a persistent effect on firms' balance sheet due to wage-share decrease. The negative level effect on GDP implies an already mentioned temporally decrease in marginal propensity to invest. As a consequence, firms require less external funding — as profits distribution policy remains the same — so its indebtedness decreases. Therefore, gross and net profit rate remains persistently close to each other (see Figure ref:fig:results2)

## Real estate inflation

Real estate inflation implies a higher residential investment growth due to houses own interest rate increase. As a result, both GDP growth rate and capacity interest rate increase as well. Since firms react to discrepancies between actual and normal utilization rates, capacity creating investment growth rate is temporally higher than GDP growth rate (positive overshooting) due to marginal propensity to invest adjustment. Furthermore, capitalists' disposable income also increases as a result of the already mentioned higher GDP growth rate. Since loans interest remains unchanged, capitalists' indebtedness ratio decreases. During the traverse, gross and net profit rate are temporally close to each other as a result of profits level increase, so firms' indebtedness decreases as well. Therefore, similar to textcites:heinautonomous2018,mandarinofinancing2018, we also report paradox of debt.

In summary, we report standard fully-adjusted position results: (i) GDP growth rate converges to NCC autonomous expenditure growth rate; (ii) Marginal propensity to invest remains persistently higher compared to baseline and; (iii) utilization rate moves gradually towards the normal one. As mentioned before, our model distinctiveness is the existence of two types of capital stocks since households invest as well. Besides the usual SSM results, we report some particularities regarding real assets composition. The most distinct result is real houses share **decreases** on total capital stock as a result of residential investment growth rate **increase**.

Although counterintuitive, this result is in line with SSM literature. Firms investment follows capital stock adjustment principle, so a higher firms investment growth rate implies that GDP grows faster than residential investment, reducing both the latter share on GDP and also the utilization rate. In other words, both autonomous expenditures share on GDP — higher supermultiplier — and Houses share on real assets (see Equation ref:partialpi) decline as a result of the already described firms' positive overshooting reaction. Finally, it worth noting that real estate increase also has permanent effects over stock/flow ratios due to capital gains.

## Interest rate increase

A increase in deposits interest rate — increasing the other interest rate respectively — has a persistent effect on long-run growth rate since houses own interest rate increases as well. Firms' investment growth rate decreases (negative overshooting) as a result of residential investment growth rate permanent decline, so houses share on real assets increases. In summary, this shock has opposite effects on long-run growth rates, NCC autonomous expenditure share on GDP, utilization rate and marginal propensity to invest than the previous one (see Figure ref:fig:results1).

In particular, we report a stronger negative effect over both capitalists' and firms' balance sheet than wage-share decrease (compare figures and ). This result stems from the stronger (and temporary) decline of GDP growth rate compare to NCC autonomous expenditure growth rate (). Thus, capitalists' disposable income decrease — as a result of profits level decrease due to lower GDP growth rate — is higher than debt-financed consumption growth rate decrease. This mechanisms alone is enough to capitalists' indebtedness level to increase, however its followed by loans interest rate increase, so the overall effect is stronger than wage-share decrease shock. Regarding firms' balance sheet, we report a decrease in both gross and net profit rate and a permanent increase in the gap between them due to increase in external funding and decrease in profits level. Therefore, we find a stable debt dynamics for both capitalists and firms (other parameters remaining unchanged).

\begin{table}[H]  
 \centering  
 \caption{Shocks summary (compared to baseline)}  
 \label{ResumoChoques}  
 %\resizebox{\textwidth}{!}{%  
 \begin{tabular}{c|c|c|c|c||c|c|c|c}  
 \hline\hline  
 \multirow{2}{\*}{} & \multicolumn{4}{c||}{\textbf{Medium-run ($h \neq h^\*$)}} & \multicolumn{4}{c}{\textbf{Long-run ($h = h^\*$)}} \\ \cline{2-9}   
 & \textbf{$\Uparrow \phi\_0$} & \textbf{$\Uparrow \pi$} & \textbf{$\Downarrow \omega$} & \textbf{$\Uparrow rm$} & \textbf{$\Uparrow \phi\_0$} & \textbf{$\Uparrow \pi$} & \textbf{$\Downarrow \omega$} & \textbf{$\Uparrow rm$} \\ \hline  
 \textbf{$g$} & + & + & - & - & + & + & 0 & - \\ \hline  
 \textbf{$g\_Z$} & + & + & 0 & - & + & + & 0 & - \\ \hline  
 \textbf{$u$} & + & + & - & - & 0 & 0 & 0 & 0 \\ \hline  
 \textbf{$h$} & + & + & - & - & + & + & 0 & - \\ \hline  
 \textbf{$k$} & - & - & + & + & - & - & + & + \\ \hline  
 \textbf{$\frac{Z}{Y}$} & - & - & + & + & - & - & + & + \\ \hline  
 \textit{$\frac{(r\_{mo}\cdot MO\_{-1} + r\_l\cdot L\_{k\_{-1}})}{YD\_k}$} & - & - & + & + & - & - & + & + \\ \hline\hline  
 \end{tabular}%  
 %}  
 \caption\*{\textbf{Source:} Authors' Elaboration}  
\end{table}

\begin{figure}[htb]  
 \centering  
 \caption{Experiments simulations (I)}  
 \label{fig:results\_1}  
 \includegraphics[width=.8\textwidth]{./figs/Compared\_Shocks\_1.png}  
 \caption\*{\textbf{Source:} Authors' elaboration}  
\end{figure}

\begin{figure}[htb]  
 \centering  
 \caption{Experiments simulations (II)}  
 \label{fig:results\_2}  
 \includegraphics[width=.8\textwidth]{./figs/Compared\_Shocks\_2.png}  
 \caption\*{\textbf{Source:} Authors' elaboration}  
\end{figure}

## Plugging real data

\begin{figure}[htb]  
 \centering  
 \caption{Real Data Experiments simulations (II)}  
 \label{fig:results\_2}  
 \includegraphics[width=.8\textwidth]{./figs/Real\_Shocks\_2.png}  
 \caption\*{\textbf{Source:} Authors' elaboration}  
\end{figure}

# Concluding Remarks

This paper contributes to demand-led growth agenda, taking in consideration recent efforts of embedding it in a SFC framework. Our novelty is twofold: (i) inclusion of residential investment and (ii) determination of its growth rate by houses' own interest rate. Residential investment was included due to recent empirical works showing its relevance for macroeconomic dynamics. Houses' own interest rate allowed us to include asset bubbles in a Sraffian strand. As far as we know, none works have described this expenditure with this particular real interest rate.

Our model reports standard results of Sraffian supermultiplier: (i) utilization rate converges to the normal one through changes on firms' marginal propensity to invest; (ii) GDP growth rate converges to NCC autonomous expenditure growth rate and; (iii) income distribution affects growth rate only during the traverse. A particular feature of our model is the dual composition of capital stock: firms' capacity creating and real estate. The most distinct result is the decrease of houses share on capital stock due to the increase of residential investment growth rate. Although counterintuitive, this occurs because firms react to the discrepancies between actual and desired utilization rates. In other words, for capacity utilization converges to the normal one, firms' investment needs to grow temporarily faster than residential investment, changing the ratio between houses and total capital stock at the fully adjusted position.

Finally, it worth noting that this is a first step of a wider research agenda on the role of residential investment for economic growth and business cycles. Future research should increase the complexity of this model in order to understand some recent dynamics (such as increases of mortgages share on banks' balance sheet). In regarding residential investment, some extensions are: exploring other determinants of its growth rate and its effects on banks' net financial wealth. This emerging ``housing agenda'' should also moves towards empirical grounds. For example, future research could assess whether or not houses' own interest rate describes residential investment growth rate econometrically.

# Acknowledgments

# Disclosure statement

No potential conflict of interest was reported by the authors.

# References

# Analytical Solution

# Numerical Appendix

\begin{table}[H]  
\caption{Parameters of variables}  
\centering  
\label{tab:param}  
\input{./tabs/parameters.tex}  
\caption\*{\textbf{Source:} Authors' elaboration}  
\end{table}

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1. A similar depiction of business cycles can be found in Fiebiger (2018). [↑](#footnote-ref-22)
2. The works of Fiebiger (2018) e Fiebiger and Lavoie (2018) also report residential investment as an important determinant of economic cycles. Those works associate economic instability to the behavior of (at least some) autonomous expenditures in spite of the behavior firms investment — as it follows capital stock adjustment principle. textcite:dejuanhidden2017 and textcite:teixeiracrescimento2015 find similar results. [↑](#footnote-ref-23)
3. This modifications in the canonical Kaleckian growth model are related to critiques regarding both its non-convergence to normal utilization rate on the long-rung and the partial solution of Harrodian instability cites:dalleryconflicting2011,skotttheoretical2012,heinharrodian2012. [↑](#footnote-ref-25)
4. The size of this parameter guards a fundamental relation to the stability of the model, as shown by textcite:freitasgrowth2015. [↑](#footnote-ref-29)
5. Simulation scripts are available under request. It worth noting that our experiments are simulated using *pysolve3* package available at <https://github.com/gpetrini/pysolve3>. Implementation and improvement requests are all welcome. [↑](#footnote-ref-38)