Stock-flow ratios and the paradox of debt in canonical neo-kaleckian and supermultiplier models

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30 September 2019

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[Work in progress]

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Abstract

The paper addresses the features of stock-flow consistent (SFC) canonical versions of neo-kaleckian and supermultiplier models that introduce the accumulation of debt of households and firms. The aim of this comparison is twofold: (i) to analyze under which conditions the paradox of debt emerges in the household and firms sector in each model; (ii) to evaluate the extent in which these conditions differ due to each models' specific closure. Preliminary results suggest that the paradox of debt in firms' sector is not a necessary result of supermultiplier models. As for households sector, the paradox of debt is a feature of the canonical supermultiplier model, yet there may be episodes of rising debt-to-income ratios and financial crisis as precipitated by policy decisions.

Keywords: Paradox of debt, neo-Kaleckian model, Supermultiplier model, autonomous expenditures, SFC

JEL classification codes: E11, E12, O41.

1 Introduction

In supermultiplier models, non-capacity creating autonomous expenditures lead growth and private business investment endogenously adjusts to the deviation of capacity utilization from a desired rate in the long-run (Freitas and Serrano, 2015; Allain, 2015; Lavoie, 2016). The model closure has been targeted with some criticism as it allegedly reflects the model's inability to address financial phenomena such as financial crisis and episodes of rising debt-to-income ratios (Nikiforos, 2018).

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Underlying these critical remarks there seems to be a misconception of what autonomous expenditures are. Autonomous expenditures in the supermultiplier literature are those expenditures that are not directly connected to the circular flow of income (Serrano, 1995) or to the income accruing from firms production decision (Freitas and Serrano, 2015). Nowhere in this definition there is a hint that points to the belief that they are to be necessarily considered as *exogenous* or that they are not affected by other economic variables. Autonomous expenditures have determinants that can be explicitly addressed in a theoretical model.

That said, in canonical models it is a common practice to assume as a matter of simplification that some variables are not explained within the model. The supermultiplier model in that respect is no different than the canonical neo-Kaleckian model that assumes autonomous investment is explained by animal spirits, which in turn are not explained by the model. But few in the non-mainstream field of economics would say that in reality aggregate demand or income has no role to play in the entrepreneurs' drive to invest. In the supermultiplier canonical model, autonomous expenditures are exogenous as a means of simplifying the analysis of a growth scenario.

Besides that, saying that a kind of expenditure is autonomous in theory should not be mixed up with saying that there are no political and policy constraints for the working of an expenditure as such. Specially considering the high level of abstraction in which canonical models are situated.

In what concerns the real-financial linkages in this approach, there have been some initial efforts to address household debt accumulation (Pariboni, 2016; Fagundes, 2017; Mandarino, 2018) and to make financial determinants of autonomous expenditures endogenous (Brochier and Macedo e Silva, 2018) employing the stock-flow consistent (SFC) methodology. Those papers that focus on household debt already take into account the negative effect that debt service payments or debt amortization might have on an economic system in which household credit-based consumption leads growth. Household debt accumulation becomes unstable if the negative rate of amortization of loans exceeds the growth rate of autonomous expenditures (Fagundes, 2017; Pariboni, 2016). This condition can be interpreted as saying that rate of expansion of the autonomous expenditures (and thus of capital accumulation and income in the long run) must be higher than the rate at which households roll over their debt principal.

Brochier and Macedo e Silva (2018) also show that by making non-capacity creating autonomous expenditures endogenous to the supermultipler model, in their case consumption out of household wealth, changes in the propensities to spend and in income distribution may have permanent effects on the long run growth rate of the economy, not

only on the average growth rate.

Yet as has been the case for other non-mainstream growth models in their early development years, the supermultiplier approach has a long way to go in exploring the role finance can play in the model. In turn, the neo-Kaleckian literature has been dealing with financial issues for at least 30 years. Since both approaches are in different stages of development, it only seems fair to compare the implications of a debt accumulation process in variants of canonical models under these approaches.

Building on this, the paper addresses the features of stock-flow consistent (SFC) canonical versions of neo-kaleckian and supermultiplier models that introduce the accumulation of debt of households and firms. The aim of this comparison is twofold: (i) to analyze under which conditions the paradox of debt emerges in the household and firms sector in each model; (ii) to evaluate the extent in which these conditions differ due to each models' specific closure.

Besides this introduction, the paper is organized as follows. Section 2 presents a benchmark model with the institutional and financial assets structure employed to compare the Supermultiplier and the neo-Kaleckian models. This section also defines the behavioral equations of consumption and investment that are specific to each models' closure. In section 3, we discuss the process of firms' debt accumulation in each model, addressing (i) the effects debt might have on the capacity utilization rate and on growth; (ii) the conditions for a Minsky or Steindl debt regime to happen in firms' sector; and (iii) the partial stability conditions of firms' debt-to-capital ratio. Following this, in section 4 we deal with household debt accumulation adopting the same procedure of section 3. At last, in section 5, we present our conclusions based on the comparison made throughout the paper.

2 Framework of SFC Supermultiplier and neo-Kaleckian canonical models

In order to compare the results of canonical neo-Kaleckian and Supermultiplier models that take explicitly into account the process of debt accumulation we adopt the same institutional and asset structure for both of them. We build a benchmark SFC model with both household and firms debt, however to keep matters as simple as possible, we analyze each sectors debt accumulation process separately. We do that by adopting the specification that household (firms) debt and the related parameters are zero when analyzing firms'(households') debt and vice-versa.

In what concerns neo-Kaleckian models, there have been several efforts to extend its canonical version to deal with firms' debt (Lavoie, 1995; Dutt, 1995; Hein, 2006; Taylor, 2004; Ryoo, 2013) or with household debt (Dutt, 2006; Kim, 2012; Setterfield et al., 2016). The latter have emerged mainly in the context of the 2007-08 *subprime* crisis. There are also more elaborate versions of the neo-Kaleckian model that combine both household and firms debt, such as Isaac and Kim (2013) and van Treeck (2009).

For addressing household debt in the neo-Kaleckian model, we adopt a variant of Kim (2012)'s and Hein (2012)'s models in which household debt is as a function of workers' desire to emulate capitalists' consumption. For dealing with firms' debt we adopt a variant of Lavoie (1995); Dutt (1995); Taylor (2004) models that add the debt service as an argument of the investment function. If we were to address both households and firms debt accumulation at the same time, the model would become a variant of Isaac and Kim (2013)'s model.

As for the Supermultiplier model, we adopt a variant of Fagundes (2017)'s and Pariboni (2016)'s models that extend the canonical Supermultiplier model (Serrano, 1995; Freitas and Serrano, 2015; Lavoie, 2016) to address the process of household debt accumulation. To deal with firms' debt, we simply add firms' debt into the canonical model in a similar vein that is usually done in neo-Kaleckian models: firms' take on loans to finance the part of investment demand that is not covered by retained earnings.[1]

In the next paragraphs we present the models' basic accounting framework and their behavioral assumptions. As for the latter, unless said otherwise they will be the same for both models. We assume a pure credit closed economy with no government sector. Table 1 presents the balance sheet of the three institutional sectors: households, firms and banks. We further suppose that both households and firms take on debt for consumption and investment purposes respectively. For the sake of simplicity, we assume that banks do not profit and that interests paid on households deposits and on households and firms loans are the same.

Table 1: Balance sheet matrix

Assets	Households	Firms	Banks	$\sum$
1. Deposits	$+M$		$-M$	0
2. Loans	$-L_h$	$-L_f$	$+L$	0
3. Fixed capital		$+K$		$+K$
4. Equities	$+p_eE$	$-p_eE$		0
5. Net worth	V_h	V_f	0	$+K$

[1]For Supermultiplier models that take firms' debt explicitly into account see Brochier and Macedo e Silva (2018); Mandarino (2018).

Table 2: Transactions and Flow of Funds matrix

	Household	Firms		Banks	$\sum$
		Current	Capital		
1. Consumption	$-C$	$+C$			0
2. Investment		$+I$	$-I$		0
3. Wages	$+W$	$-W$			0
4. Firms' Profit	$+FD$	$-F$	$+FU$		0
5. Deposits interest	$+iM$			$-iM$	0
6. Loans interest	$-iL_h$	$-iL_f$		$+iL$	0
7. Subtotal	S_h	0	S_f	0	0
8. Change in Deposits	$-\dot{M}$			$+\dot{M}$	0
9. Change in Loans	$+\dot{L}_h$		$+\dot{L}_f$	$-\dot{L}$	0
10. Change in Equities	$-p_e\dot{E}$		$+p_e\dot{E}$		
11. $\sum$	0	0	0	0	0

Table 2 shows the transactions between institutional sectors in its first part and the flow of funds in the second part. At this point we can describe the transactions of each sector and the behavioral assumptions.

Households earn wage and financial income (interests on deposits and distributed profits) (1). Wage income will be defined as a consequence of firms' mark-up rule which sets the profit share (2). Behavioral assumptions in what concerns household consumption will be different in neo-Kaleckian (NK) and Supermultiplier (SM) models (equations 5 and 7).

$$Y_h = W + FD + iM \tag{1}$$

$$W = (1 - \pi)Y \tag{2}$$

In the Supermultiplier model, if households take on loans ($L_h > 0$), autonomous consumption (Z) can be interpreted as workers' consumption financed by credit, otherwise ($L_h = 0$) autonomous consumption could be interpreted as capitalists' autonomous consumption based on habits (see Fagundes (2017); Dutt (2019)). We come back to these alternative specifications in the next sections. Since we are dealing with a closed economy with no government, autonomous consumption that grows at an exogenously given rate (g_z) will be the non-capacity creating autonomous expenditure that leads growth in the long run (3) in the Supermultiplier model. Households take on new loans to finance autonomous consumption (4) and banks grant all loans demanded by households for consumption purposes. Besides autonomous consumption, poorer households consume a

fraction (α_1) of their wage income after interest payments on loans and richer households consume a fraction (α_2) of their financial income (5).

$$Z = Z_0 e^{g_z} \tag{3}$$

$$\dot{L}_h = Z \tag{4}$$

$$C = \alpha_1(W - iL_h) + Z + \alpha_2(FD + iM) \tag{5}$$

As for the neo-Kaleckian model, poorer households take on loans to emulate richer households' consumption (see Kim (2012); Ryoo and Kim (2014); Setterfield et al. (2016)) as denoted by equation 6. The parameter η represents poorer households' willingness to emulate richer households' consumption and at the same time banks' willingness to grant credit to these households (Dutt, 2006; Lavoie, 2014). Poorer households also consume a fraction of their wage income (α_1) after debt service payments and richer households consume a fraction (α_2) of their financial income (7). Following Fagundes (2017) and differently from most of the models that deal with emulation effects, we do not assume that households consume all their wages, since in the aggregate this is not a necessary condition for indebtedness to take place in the household sector.[2] As should be clear by now, we abstract from household debt amortization in the NK and the SM model.

$$\dot{L}_h = \eta[\alpha_2(FD + iM)] \tag{6}$$

$$C = \alpha_1(W - iL_h) + \eta[\alpha_2(FD + iM)] + \alpha_2(FD + iM) \tag{7}$$

For both models, changes in households' net wealth will be given by households' savings (since there are no capital gains in these models), which is also equivalent to the changes in deposits (assets) less changes in loans (liabilities) (8). Deposits, which represent households' gross wealth, are an increasing function of new loans and households' savings (9).

$$\dot{V}_h = S_h = \dot{M} + p_e\dot{E} - \dot{L}_h \tag{8}$$

$$\dot{M} = S_h + \dot{L}_h - p_e\dot{E} \tag{9}$$

[2]There may coexist workers that consume all their income and incur into debt to finance the consumption pattern they desire with workers that save part of their income and do not take on loans. Depending on the proportion of each group in total workers, the marginal propensity to consume may be lower or higher than one (Fagundes, 2017).

As for the **firms** sector, in both models they finance investment (I) through retained earnings (FU) and any additional demand for funds is covered by banks loans (10). As was the case for households, firms are not credit constrained. Firms retain a fraction of their profit (s_f) discounting the payment of interest on loans (11) and distribute the rest of profits to households (12). The mark-up (μ) on costs defines income distribution. Real output is the sum of households' consumption and business investment (14).

$$\begin{cases} \dot{L_f} = I - FU, & \text{if } L_f > 0 \\ p_e \dot{E} = I - FU, & \text{if } L_f = 0 \end{cases} \tag{10}$$

$$FU = s_f(\pi Y - iL) \tag{11}$$

$$FD = (1 - s_f)(\pi Y - iL) \tag{12}$$

$$\pi = \frac{\mu}{1 + \mu} \tag{13}$$

$$Y = C + I \tag{14}$$

In the Supermultiplier approach, firms' investment behavior is based on the flexible accelerator principle. Aggregate investment of firms is induced by income (15) and the marginal propensity to invest (h) will endogenously react to the discrepancies between the actual (u) and the normal utilization rate (u_n) according to the sensitivity parameter (γ) (16) (Freitas and Serrano, 2015; Lavoie, 2016; Allain, 2015). Investment decisions are not directly affected by firms' indebtedness, only indirectly through the capacity utilization rate.

$$I = hY \tag{15}$$

$$\dot{h} = h\gamma(u - u_n) \tag{16}$$

$$g_k = g_I = \frac{hu}{v} \tag{17}$$

There are several variants of a neo-Kaleckian investment function. We adopt a variant of the functions presented in Lavoie (1995); Dutt (1995); Taylor (2004), that take into account the negative effect debt service might have on investment demand. Thus firms

base their investment decisions on "animal spirits" or the expected trend growth rate of sales that is represented by the exogenous parameter (β_0), on the capacity utilization rate (β_1) (18) and, negatively, on the leverage ratio (β_2) .

$$I = K(\beta_0 + \beta_1 u - \beta_2 il_f) \tag{18}$$

$$g_k = g_I = \beta_0 + \beta_1 u - \beta_2 il_f \tag{19}$$

In both models, the actual utilization rate will be given by the ratio of output to full-capacity output (20) and full-capacity output is determined by a ratio of the capital stock to the given capital-output ratio (21). Besides that, since we abstract from capital depreciation for simplicity, in both cases the capital accumulation rate will be given by the investment growth rate (17 and 19).

$$u = \frac{Y}{Y_{fc}} \tag{20}$$

$$Y_{fc} = \frac{K}{v} \tag{21}$$

At last, since banks grant all loans demanded by households and firms and do not profit, it follows from the accounting framework that the total amount of the deposits will match firms' or households loans (depending on the adopted specification) or the sum of both sectors loans.

3 Growth, demand and firms' debt dynamics

In this section we compare the features of firms' debt dynamics in the NK and the SM models. Specifically we analyze (i) firms' debt ratio impact on capacity utilization (and growth in the case of the NK model) to check whether demand is debt-led or debt-burdened in the terminology of Taylor (2004); (ii) the impact of demand and growth on firms' debt ratio to establish the conditions for a Steindlian or a Minskyian regime to happen in firms' sector (Lavoie, 2014); (iii) and finally debt dynamic stability conditions in each model.

For this purpose, we adopt the following specification of the model: (i) we assume households do not take on loans ($L_h = 0$); (ii) firms distribute part of their profits to richer households ($0 < s_f < 1$); and (iii) that loans have a directly negative impact on

investment demand in the NK model ($\beta_2 > 0$).

Assuming $L_h = 0$ in the Supermultiplier model leads us to interpret the autonomous consumption component as richer households consumption and thus it seems redundant also to include an induced component for consumption out of financial income. Therefore we consider the consumption function takes the form of equation 22. As for the neo-Kaleckian model, when there is no household debt, that means poorer households' consumption no longer depends on richer households consumption: the emulation parameter (or banks' willingness to lend to households) is zero ($\eta = 0$) in equation 7, so that the consumption function is given by equation 23.

$$C_{SM} = \alpha_1 W + Z \tag{22}$$

$$C_{NK} = \alpha_1 W + \alpha_2 (FD + iM) \tag{23}$$

That said we can obtain the short run capacity utilization rate and the equilibrium growth rate (in the NK model) and compare the effects debt might have on the level of activity in each model.

3.1 Firms' leverage ratio impact on growth and demand

Substituting equations 15 and 22 and equations 18 and 23 into equation 14, respectively for the SM and for the NK model, and normalizing it by the capital stock, we get the short-term equilibrium capacity utilization rates (equations 24 and 25). Where z denotes the autonomous consumption normalized by the capital stock in equation 24 and l_f firms' debt ratio in equation 25. From these equations and assumptions, it is clear that the terminology of a debt-led or debt-burdened demand regime does not apply to the supermultiplier model.

As for the neo-Kaleckian model, assuming the Keynesian stability condition is satisfied (and therefore the denominator of equation 25 is positive), if we take the derivative of u with respect to l_f, we notice that firms' debt to capital ratio has an ambiguous effect on the capacity utilization rate as in Taylor (2004); Lavoie (2014). Through distributed profits, a higher loans to capital ratio reduces retained earnings and has a net positive effect on households' consumption. On the other hand, firms' leverage ratio has a negative impact on investment. The economy will be debt-led (debt-burdened) if the positive (negative) effect on consumption (investment) more than compensates the negative (positive) effect on investment (consumption)(see table 3). It is also important to notice that

the ambiguous effect of debt on demand arises from the investment function specification that firms' leverage ratio have a direct impact on investment demand. Otherwise, firms' debt ratio would only have a positive effect on consumption. This is what would happen also in the supermultiplier model if we were to include the induced component of richer households' consumption into the current specification of the model.

These rather unrealistic results – that firms' debt could have an unambiguously positive effect on household consumption just by taking debt out of the investment function – are related to a common simplifying assumption of the first (and many) SFC models. Namely that banks do not profit and as such it follows from the accounting framework that deposits will equal loans. If deposits are not equivalent to loans, it is easy to see that interest payment on these assets would have separate effects on demand. In that case, firms' leverage ratio would have an unambiguously negative effect on the level of activity through the reduction of distributed profits and thus on households' consumption out of financial income.

For the NK, if we substitute equation 25 into equation 19, we get the capital accumulation growth rate (26). Where x is the inverse of the multiplier. Taking the derivative of g^* with respect to l_f, we notice that the condition for growth to be debt-led is more restrictive than the condition for demand to be debt-led, depending also on the multiplier. The higher the multiplier (the lower x) the more likely growth will debt-led and vice-versa.

3.2 Growth and demand impacts on firms' leverage ratio

So far we have talked about how firms' debt ratio might affect the level of activity, but we can also investigate the conditions under which a faster pace of accumulation will lead to a reduction of firms' debt ratio constituting a Steindl regime – or the paradox of debt (Steindl, 1952) – or to an increase of firms' debt ratio, constituting a Minsky regime.

We start by finding the differential equation that describes the evolution of firms' debt to capital ratio through time. For the SM model, we substitute equation 15 into 10, normalize it by the capital stock and then substitute 17 into the resulting equation. After some mathematical manipulation, we get the differential equation for firms' debt ratio in the SM model (27). Taking the derivative of $\dot{l}_f$ with respect to u, we get the conditions for demand to have a positive or negative effect on the evolution of firms' leverage ratio (see table 4).

$$\dot{l}_f = (h - s_f\pi)\frac{u}{v} + (s_f i - \frac{hu}{v})l_f \tag{27}$$

Table 3: Firms' debt effect on demand and growth

		Capacity utilization rate	Debt demand regimes
Specification 1: $L_h = 0; \eta = 0;$ $p_e E = 0;\ L_f > 0; \beta_2 > 0$	SM	$u_{sm} = \dfrac{vz}{1-\alpha_1(1-\pi)-h}$ (24)	–
	NK	$u_{nk} = \dfrac{v[\beta_0 + (\alpha_2 s_f - \beta_2) il_f]}{1-\alpha_1(1-\pi)-\alpha_2(1-s_f)\pi - \beta_1 v}$ (25)	Debt-led: $\alpha_2 s_f - \beta_2 > 0$ Debt-burd: $\alpha_2 s_f - \beta_2 < 0$
		Growth rate	Debt growth regimes
	SM	g_z	–
	NK	$g^* = \beta_0 + \beta_1 \left(\dfrac{v[\beta_0 + (\alpha_2 s_f - \beta_2) il_f]}{x} \right) - \beta_2 il_f$ (26)	Debt-led: $\alpha_2 s_f - \beta_2(1+x) > 0$ Debt-burd: $\alpha_2 s_f - \beta_2(1+x) < 0$

In the short or medium run, the likelihood of a Minskyian regime for firms' sector to happen increases the lower the leverage ratio and the lower the retained share of profits in relation to firms' propensity to invest. The opposite holds true for a Steindlian regime: the paradox of debt in firms' sector is likely to emerge the higher firms' leverage ratio and the higher the retained profit share in comparison to firms' propensity to invest. Therefore, a scenario in which a higher level of activity leads to an increase in "financial fragility" as represented by a higher leverage ratio in firms' sector according to the main view of Minsky's Financial Instability Hypothesis can also happen in the SM model.

In the case of the SM model, we can also easily calculate the impact the growth rate of autonomous expenditures will have on the steady growth firms' debt to capital ratio and, therefore, define Minskyian and Steindlian regimes in terms of growth. In the long run, all stock and stock-flow ratios converge to their steady growth values ($\dot{l}_f = 0$), that is, all variables grow at the same rate, g_z, and firms' have adjusted their investment behavior so that the capacity utilization converges to the normal utilization rate ($\dot{h} = 0$). Given these steady growth conditions, the long run firms' debt to capital ratio will be given by equation 28. Taking the derivative of l_f^* with respect to g_z, we notice that for a Minskyian debt regime to happen the normal profit rate ($r_n = \frac{\pi u_n}{v}$) has to be higher than the interest rate and for a Steindlian regime to happen, the interest rate paid on loans and deposits has to exceed the normal profit rate.

$$l_f^* = \frac{g_z - s_f \pi \frac{u_n}{v}}{g_z - s_f i} \tag{28}$$

For the NK model, firms' debt ratio differential equation can be written as in (29). Since the conditions for Minsky or Steindl regimes in terms of demand have been explored elsewhere for the NK model, we simply present the results for our variant of a NK model in table 4. In what concerns the debt regime associated with the growth rate, to get the ultimate effect of growth on steady growth debt to capital ratio we would have to solve equation 29 for l_f, considering both the effects of l_f on u and g which leads to a very long second degree polynomial equation. To keep the discussion within limits, we won't pursue this avenue. We will content ourselves with a partial solution of equation 29 for l_f that we obtain by substituting (25) into (29) (equation 30).

$$\dot{l}_f = g_I(1 - l_f) - s_f(\frac{\pi u}{v} - i l_f) \tag{29}$$

$$l_f^* = \frac{(s_f \frac{\pi}{x} - 1)g_I}{s_f i(1 - s_f \frac{\pi \alpha_2}{x}) - g_I} \tag{30}$$

From the derivative of l_f^* with respect to g_I we get some partial conditions for each regime to emerge (see table 4). These conditions say that a Minskyian regime for growth is more likely to emerge with a medium-range multiplier. That is, if the inverse of the multiplier is somewhere between firms' retained profit share and this same share multiplied by households propensity to consume out of financial income. If the inverse of the multiplier is lower than the term $\alpha_2 \pi s_f$ and thus the multiplier is higher than in the previous case or if the inverse of the multiplier is higher than the retained profit share and thus the multiplier is lower than in the previous case, a Steindlian regime is more likely to emerge.

We observe that the conditions for each debt regime in response to demand to arise in both models are quite similar in intuition. They diverge in one aspect: while in the SM the regimes depend on total investment (since it's completely induced) in the NK they depend only on the induced part of investment. As for the growth effect on firms' steady growth debt ratio, while in SM there are only two scenarios that depend exclusively on the relative size of profit and interest rates; in the NK, the relative size of the multiplier in relation to the retained profit share and the leakage share of household consumption out of distributed profits seems to play a role in the debt regime, with a Minskyian regime possibly emerging in-between a lower and a higher multiplier.

In the next section we discuss the dynamic stability conditions for firms' debt ratio in both models.

3.3 Dynamic stability conditions

To analyze dynamic stability of firms' debt ratio in the SM, it will be helpful to define an alternative equation for the capacity utilization that explicitly takes the growth rate of autonomous expenditures into account. Assuming that we have partial equilibrium (a constant z ratio), namely, that the capital accumulation rate is given by autonomous expenditures growth rate in equation 17 and solving for u^*, we get an alternative definition for the capacity utilization rate (31).

$$u^* = \frac{v g_z}{h} \tag{31}$$

Table 4: Steindl and Minsky debt regimes in NK and SM models

	Steindl regime (demand)	Minsky regime (demand)
SM	$\frac{\partial \dot{l}_f}{\partial u} < 0$, if $\frac{s_f \pi}{h} + l_f - 1 > 0$	$\frac{\partial \dot{l}_f}{\partial u} > 0$, if $\frac{s_f \pi}{h} + l_f - 1 < 0$
NK	$\frac{\partial \dot{l}_f}{\partial u} < 0$, if $\frac{s_f \pi}{\beta_1 v} + l_f - 1 > 0$	$\frac{\partial \dot{l}_f}{\partial u} > 0$, if $\frac{s_f \pi}{\beta_1 v} + l_f - 1 < 0$
	Steindl regime (growth)	Minsky regime (growth)
SM	$\frac{\partial l_f^*}{\partial g_z} < 0$, if $\frac{\pi u_n}{v} - i > 0$	$\frac{\partial l_f^*}{\partial g_z} > 0$, if $\frac{\pi u_n}{v} - i < 0$
NK (partial)	$\frac{\partial l_f^*}{\partial g_I} < 0$, if $\alpha_2 \pi s_f < x < \pi s_f$	$\frac{\partial l_f^*}{\partial g_I} > 0$, if $x < \alpha_2 \pi s_f < \pi s_f$ $\alpha_2 \pi s_f < \pi s_f < x$

Substituting (31) into (27), we get the following dynamic equation for firms' debt ratio:

$$\dot{l}_f = g_z \left(1 - \frac{s_f \pi}{h}\right) + (s_f i - g_z) l_f \tag{27A}$$

For firms' debt ratio to stabilize it is a necessary and sufficient condition that the growth rate exceeds the interest rate multiplied by the retention rate (since firms' do not save all their net profit). A similar partial stability condition applies to the NK model (we adopt the same procedure of section 3.2.). While in the SM a sustainable debt accumulation process depends on the growth rate of autonomous consumption that is defined in the household sector and, therefore, is completely outside of firms' sector control; in the NK model it depends on the investment growth rate that is partially decided within firms' sector.

Table 5: Firms' debt ratio dynamic stability conditions

SM model	NK model
Necessary and sufficient condition	Necessary condition
$\frac{\partial \dot{l}_f}{l_f} < 0$ $g_z - s_f i > 0$	$\frac{\partial \dot{l}_f}{l_f} < 0$ $g_I - s_f i > 0$

So far we have not talked about the household sector, however some comments are in order. From the accounting framework one can observe that households' net wealth is equivalent to firms' loans. That means whenever a Minskyian debt regime is observed in firms' sector, households' wealth ratio increases as a result of a stronger level of activity and vice-versa. Therefore, even if we cannot talk about financial fragility in households' sector, we can say its relative net wealth is decreasing when firms experience a Steindl debt regime for both the SM and the NK model. In what concerns the long run (growth) Steindl debt regime in the SM model, since it requires a fairly high interest rate to happen as one can notice attributing values to the condition presented in table 4, it seems more likely that it will fall into an unstable debt dynamics zone in comparison to the long run Minsky debt regime.

Even if both models seem to be able to account for a rising firms' debt ratio during the transition from one steady growth state to the other and, consequently, for a rising financial fragility in its main interpretation (Minsky, 1982, 1986; Taylor and O'Connell, 1985), it is important to acknowledge that there have been some relevant work that highlight the possibility that financial fragility at the micro level does not necessarily add up to a higher aggregate debt to capital ratio (Lavoie and Seccareccia, 2001). In addition to this, more recently some researchers have also questioned the relevance of aggregate debt ratios as indicators of rising financial fragility in firms' sector (Pedrosa, 2019).

4 Growth, demand and households' debt dynamics

In this section we compare household debt dynamics in canonical versions of NK and SM models. With that purpose in mind, we adopt a second specification of the benchmark model. To focus on how household debt affects demand and the other way around, we assume that firms' take no external funding for investment that is not covered by retained earnings ($L_f = 0$). They otherwise issue equities for that purpose ($p_e E > 0$). We also assume there are no capital gains. This allows to concentrate on household debt and demand interactions without making additional arbitrary assumptions regarding households and firms savings (since banks do not profit). Introducing household debt into the analysis ($L_h > 0$) implies for the SM that induced consumption out of financial income is longer redundant since the autonomous consumption component can be read as consumption out of new loans taken by households, poorer households in this case. Therefore the consumption function adopted here will be the one represented by equation 5. As for the NK model, introducing household debt means households emulate richer households consumption ($\eta > 0$) which is given by consumption out of financial income

as in equation 7.

After clarifying the adopted specifications, we can move on to the comparison of how household debt might affect demand and growth in both models.

4.1 Households' leverage ratio impact on growth and demand

Substituting equations 15 and 5 and equations 18 and 7 into equation 14, respectively for the SM and for the NK model, and normalizing it by the capital stock, we get the short-term equilibrium capacity utilization rates (equations 32 and 34). Where l_h denotes households' debt ratio in both equations. If if we further assume a constant z ratio for the SM model and a constant emulation consumption to capital ratio in the NK model, we obtain equations 33 and 35 that allow us to address both the impacts of new loans and debt services on demand. Otherwise, using equations 32 and 34, from the derivative of u with respect to l_h we get just the net impact of interest payment on loans (see table 6). For analyzing both derivatives we assume the Keynesian stability condition holds.

In the SM model, taking the derivative of u (equation 33) with respect to l_h, we notice that household debt ratio will have a positive impact on capacity utilization in the short and medium run if the growth of autonomous expenditures exceeds the net negative impact of debt service on households' consumption (assuming the propensity to consume out of wages is larger than out of financial income), which is represented by the difference between the propensity to consume out of net wages income and financial income. Otherwise, if the net negative impact of debt services is larger than the rate of growth of autonomous expenditures, demand will be debt-burdened.

As for the NK model, the derivative of u (equation 34) with respect to l_h shows us that for demand to be debt-led the emulation parameter has to be grater than the difference between the propensity to consume out of wages and out of financial income. Also taking the derivative of equation 35 with respect to l_h sheds some light into the mechanisms through which household debt affects demand in the NK model. What the condition for a debt-led demand regime, where ϕ sums up a term that is the inverse of the multiplier of equation 34, says in this case is that since consumption out of credit is induced by income and only business investment is autonomous, the effect of investment over income has to be greater than the net negative impact of interest payments on households' consumption. The likelihood of an increase in households' debt ratio to have a positive effect on demand is higher the higher is autonomous investment and the higher is the weight of induced investment on the multiplier for a given net debt service.

As for household debt impact on growth in the NK model, since the conditions are virtually the same we do not repeat them. In the SM model, since autonomous expenditures growth is exogenous as matter of *simplification* the terminology of debt-led (burdened) growth regime does not apply.

In the next section we investigate how demand and growth might impact household debt in both models.

4.2 Growth and demand impacts on households' leverage ratio

At this point we turn our attention to the conditions under which a higher aggregate demand and/or a faster pace of accumulation lead to the emergence of the paradox of debt in household sector. We start by finding the differential equation that shows how household debt ratio evolves through time. In the SM model, we normalize equation 4 by the capital stock and then substitute equation 17 into the resulting equation. This leads to the differential equation in 37.

$$\dot{l}_h = z - \frac{hu}{v} l_h \tag{37}$$

$$l_h^* = \frac{z}{g_z} \tag{38}$$

From the derivatives of $\dot{l}_h$ with respect to u and l_h^* to g_z (table 7), in what concerns the debt regime in the SM, one can notice that both in the short run and in the long run for the paradox of debt to emerge it is a necessary and sufficient condition that household debt to capital ratio is positive (and also the propensity to invest and the capital to output ratio if we are not assuming an stable z ratio), that is, a positive autonomous consumption to capital ratio.

For the NK model, we do the same procedure: we normalize equation 6 by the capital stock and then substitute equation 19 in the resulting equation, which leads to equation 39. The conditions required for the debt regimes to emerge get slightly more complicated, but we can still grasp the intuition behind them. We notice that a paradox of debt (the absence of a paradox) in the household sector is more likely to happen the lower (the higher) the emulation of household consumption out of dividends in relation to the induced part of investment and the higher (the lower) household debt ratio. This condition is similar to the one obtained for firms' Steindl regime, in which the debt ratio played a role.

Table 6: Households' debt effect on demand and growth

		Capacity utilization rate	Debt demand regimes
Specification 2: $L_h > 0$; $\eta > 0$; $L_f = 0$; $\beta_2 = 0$; $p_e E > 0$;	SM	$u_{sm} = \frac{v(z + (\alpha_2 - \alpha_1) i l_h)}{1 - \alpha_1(1-\pi) - \alpha_2(1-s_f)\pi - h}$ (32)	Debt-led: $g_z - (\alpha_1 - \alpha_2) i > 0$ Debt-burd: $g_z - (\alpha_1 - \alpha_2) i < 0$
		$u_{sm} = \frac{v(l_h g_z + (\alpha_2 - \alpha_1) i l_h)}{1 - \alpha_1(1-\pi) - \alpha_2(1-s_f)\pi - h}$ (33)	
	NK	$u_{nk} = \frac{v(\beta_0 + [(\eta+1)\alpha_2 - \alpha_1] i l_h)}{1 - \alpha_1(1-\pi) - (\eta+1)\alpha_2(1-s_f)\pi - \beta_1 v}$ (34)	Debt-led: $\eta + 1 - \frac{\alpha_1}{\alpha_2} > 0$ Debt-burd: $\eta + 1 - \frac{\alpha_1}{\alpha_2} < 0$
		$u_{nk} = \frac{v(\beta_0 + (\beta_0 + (\alpha_2 - \alpha_1) i) i l_h)}{1 - \alpha_1(1-\pi) - (\eta+1)\alpha_2(1-s_f)\pi - \beta_1 v(1 + l_h)}$ (35)	Debt-led: $\beta_0 - \frac{(\alpha_1 - \alpha_2) i}{1 + \frac{\beta_1 v}{\phi}} > 0$ Debt-burd: $\beta_0 - \frac{(\alpha_1 - \alpha_2) i}{1 + \frac{\beta_1 v}{\phi}} < 0$
		Growth rate	Debt growth regimes
	SM	g_Z	–
	NK	$g^* = \beta_0 + \beta_1 \left(\frac{v(\beta_0 + [(\eta+1)\alpha_2 + \alpha_1] i l_h)}{1 - \alpha_1(1-\pi) - (\eta+1)\alpha_2(1-s_f)\pi - \beta_1 v} \right)$ (36)	Growth and debt regimes have the same conditions

Differently from the analysis of firms' debt ratio, in the case of household debt, we can find a steady growth solution for households' debt to capital ratio more easily and isolate the effect of the autonomous part of investment on households' debt ratio. Assuming household debt ratio has stabilized ($\dot{l}_h = 0$), substituting the equilibrium values of capacity utilization and the growth rate (34 and 36) into equation 39 and solving for l_h, we get two solutions that would lead to a steady household debt ratio. Since one of these solutions is zero and, thus, is not economically meaningful for our purposes, we focus on the other solution that delivers an equilibrium with a positive value for household debt ratio (considering reasonable values for the parameters) (equation 40). Taking the derivative of l_h^* with respect to β_0 we observe that it will be negative when the propensity to consume out of wages is larger than the propensity to consume out of financial income (even if households completely emulate richer households consumption). That said, an increase in firms' animal spirits will reduce households' debt to capital ratio. If we look at the part of household debt under they control, taking the derivative of l_h^* with respect to η, we realize that households attempt to de-leverage will succeed unless autonomous investment grows at a fairly high rate.

$$\dot{l}_h = \eta\alpha_2(1-s_f)\pi\frac{u}{v} + \eta\alpha_2 i l_h - \beta_0 l_h - \beta_1 u l_h \tag{39}$$

$$l_h^* = \frac{[(\eta+1)\alpha_2 - \alpha_1]\eta\alpha_2(1-s_f)\pi + \beta_0(\phi + \beta_1 v)}{[(\eta+1)\alpha_2 - \alpha_1]i\beta_1 v} \tag{40}$$

We notice that while in the SM model, there is always the paradox of debt in the household sector; in the NK model, whether or not household debt ratio will increase following a rise in workers' emulation parameter depends on the effect this stimulus to consumption will have on capacity utilization and, consequently, on the growth rate. If the effect on the level of activity and on growth is high enough, as represented by the last condition of table 7, household debt ratio may actually decrease allowing for the paradox of debt to happen also in the NK model.

Despite the fact that an increase in the rate of autonomous consumption always leads to a reduction in household debt ratio in the SM model, since it will trigger firms' reaction to the observed increase in capacity utilization that follows the higher consumption pattern and, thus, will lead to an acceleration in the pace of capital accumulation that makes income grow at a faster pace than debt; it is not true that the model does not allow for an increase in the liabilities-to-income ratio in the household sector at all circumstances. If we substitute equation 24 into equation 4 and take its derivative with respect to the interest rate as shown in 41, we notice that an increase in the interest rates,

Table 7: Household debt regimes in NK and SM models

	Paradox of debt regime (demand)	No paradox regime (demand)
SM	$\frac{\partial \dot{l}_h}{\partial u} < 0$, if $\frac{hl_h}{v} > 0$ or $z > 0$	$\frac{\partial \dot{l}_h}{\partial u} > 0$, if $\frac{hl_h}{v} < 0$ or $z < 0$
NK	$\frac{\partial \dot{l}_h}{\partial u} < 0$, if $\frac{\eta\alpha_2(1-s_f)\pi}{\beta_1 v} - l_h < 0$	$\frac{\partial \dot{l}_h}{\partial u} > 0$, if $\frac{\eta\alpha_2(1-s_f)\pi}{\beta_1 v} - l_h > 0$
	Paradox of debt regime (growth)	No paradox regime (growth)
SM	$\frac{\partial l_h^*}{\partial g_z} < 0$, if $z > 0$	$\frac{\partial l_h^*}{\partial g_z} > 0$, if $z < 0$
NK	$\frac{\partial l_h^*}{\partial \beta_0} < 0$, if $\frac{\beta_1 v + \phi}{\beta_1 v(\alpha_2(1+\eta) - \alpha_1)i} < 0$	$\frac{\partial l_h^*}{\partial \beta_0} > 0$, if $\frac{\beta_1 v + \phi}{\beta_1 v(\alpha_2(1+\eta) - \alpha_1)i} > 0$
	$\frac{\partial l_h^*}{\partial \eta} < 0$, if $\beta_0 - \frac{(\alpha_1 - \alpha_2(1+\eta))^2\pi(1-s_f)}{\beta_1 v + \phi} > 0$	$\frac{\partial l_h^*}{\partial \eta} > 0$, if $\beta_0 - \frac{(\alpha_1 - \alpha_2(1+\eta))^2\pi(1-s_f)}{\beta_1 v + \phi} < 0$

as long as Keynesian stability holds and as long as households have a larger propensity to consume out of wages in relation to the propensity to consume out of financial income, will actually increase household debt ratio. So even if the higher interest rates do not affect the pace of debt accumulation they affect income and temporarily the capital accumulation process.

$$\frac{\partial \dot{l}_h}{\partial i} = \frac{-l_h^2(\alpha_2 - \alpha_1)}{1 - \alpha_1(1-\pi) - \alpha_2(1-s_f)\pi - h} > 0 \tag{41}$$

That is also to say that even if the model does not allow in its canonical version an increase in household debt ratio as the economy grows at a faster pace, it allows for a rough representation of a financial crises process as triggered, for instance, by a credit constraint imposed by banks or a reduction in households' willingness to take on more loans. In the model this could be represented by a lower rate of growth of autonomous expenditures. The process that follows shows that since this reduction in the pace of autonomous expenditures has a negative effect on income and capital accumulation, households' debt to income ratio increases as a result of a change in households and/or banks behavior.

4.3 Dynamic stability conditions

Analyzing household debt ratio dynamics in the SM model (table 8), we notice that for household debt to capital ratio to stabilize it is enough that autonomous expenditures grow at a positive rate, a very unrestrictive condition. However, this condition is not enough to guarantee the systems' stability.

Substituting equation 4, 10 and households savings into equation 9, normalizing by the capital stock, we get households' deposits ratio dynamic equation. Stability of households' deposits to capital ratio requires the derivative of equation 42 to be negative.

$$\frac{\partial \dot{m}}{\partial m} = -g_z + (\alpha_1 - \alpha_2)i < 0 \tag{42}$$

Since this stability condition is more restrictive than the one of household debt ratio, we realize that for the system to be stable it is necessary that the autonomous expenditure grows at a positive rate but also at a faster pace than the negative effect of debt service on household consumption. At this point, a careful reader would have noticed that the stability condition for households deposits ratio is the same condition required for demand to be debt-led. That said, a debt-burdened demand regime would fall into an unstable zone of the model. If we think about the economic reasoning, it makes sense that in an economy in which household consumption financed by credit leads growth if debt services (or debt amortization, which we are not considering by simplification) put a very strong drag on demand its trajectory will be unstable.

As for the NK model, household debt ratio stability requires the condition given in column two of table 8 to be verified. If we attribute values to these parameters, we can see that for t household debt ratio to be stable autonomous investment must grow at a faster pace than the one given by these parameters. Since this value is not very high, the stability condition can be easily respected.

Table 8: Households' debt ratio dynamic stability conditions

SM model	NK model
$\frac{\partial \dot{l}_h}{\partial l_h} < 0$, if $g_z > 0$	$\frac{\partial \dot{l}_h}{\partial l_h} < 0$, if $\beta_0 - \frac{[\eta\alpha_2(1-s_f)\pi - 2\beta_1 v l_h][(\eta+1)\alpha_2 - \alpha_1]i}{\phi + \beta_1 v} > 0$

5 Final remarks

In the previous sessions we carried out a comparative analysis of firms' and households' debt accumulation process in canonical versions of both the SM and the NK model. In this comparison we addressed both the effects of debt on short run capacity utilization and on the growth rate (for the NK model) and the effects of short run capacity utilization and growth on debt accumulation. We also analyzed the partial stability conditions of debt ratios of household and firms sector. From this comparative exercise we have reached some conclusions in what regards the process of debt accumulation in these models.

Starting by firms' debt, we have seen that both in the SM and in the NK model, firms can face a Steidlian or a Minskyian debt regime. So in the SM model as in the NK one, an increase in financial fragility as represented by a higher debt ratio in the firms sector is feasible. Besides that, in the SM model, a Steindl debt regime in the long run seems more likely to fall into a zone of unstable debt accumulation process.

In addition to this, the intuition for the emergence of a debt regime is very similar in both models. For instance, a Minsky debt regime is more likely to emerge, cet. par., the lower the leverage ratio and the lower the retained share of profits in relation to the propensity to invest (or the induced part of investment in the NK model).

In the SM, firms' debt ratio will have no effect on the short run capacity utilization rate or on the growth rate of the economy while in the NK model it does affect these variables.

In what concerns household debt accumulation, in the canonical version of the SM model a positive autonomous consumption ratio is enough to establish the paradox of debt in the household sector and a positive growth rate of autonomous expenditures guarantees household debt accumulation is stable. Yet the system will be dynamically unstable if the positive effect of this autonomous expenditure component on consumption is not enough to compensate for the negative effect that debt service payments may have on consumption.

As for the NK model, whether there is a paradox of debt in the household sector it depends on the magnitude of emulation consumption effect on capacity utilization and growth. The higher the effect on demand and growth the more likely there will also be a paradox of debt in the NK model.

In the SM model, there will be episodes of rising household leverage ratio following increases in the interest rates, in the profit share and a decrease in the growth rate of autonomous expenditures. Even if interest rates and income distribution have no

permanent effect on the growth rate in the canonical version of the model, a positive shock to these variables will lead to a permanently higher household debt ratio. That said, even if there is no increase in the leverage ratio following an increase in the autonomous expenditure growth rate, an episode of financial crisis as triggered by policy decisions can still be represented in the SM model.

As a more general assessment of these models, none of them in their canonical versions seem appropriate to deal with an endogenous process of rising financial fragility. As Lavoie points out: "(...) another line of defense of the financial instability hypothesis has been that steady-state models cannot claim to be faithful to Minsky's views, since a crucial feature of these is that 'stability is destabilizing' (...)"(Lavoie, 2014, p.446). But then this is not a matter of choosing the appropriate model closure but rather choosing the appropriate method of analysis to the issue of interest.

Moreover, for firms' sector a higher or increasing aggregate leverage ratio may not say as much as we would like about financial fragility as an indicator of firms' ability to come up with the funds needed to cover their cash commitments (Pedrosa, 2019). As for the household sector, we also know that the distribution of liabilities across different income groups and income inequality also matter for financial fragility (Cardaci, 2018). That might indicate purely macroeconomic models are not the right place to deal in detail with these issues.

Given these caveats, one can still represent the outcomes of a very stylized financial crisis in the sense employed by Toporowski (2005), according to whom a financial crisis and/or the turning point of a boom depends on a explicit policy decision, in a simplified macroeconomic model provided the appropriate financial crisis channels one is interested into are in place. We therefore claim that the SM model can be modified to tackle changes in household demand for credit and in banks lending rules and to address how these could affect the growth rate of autonomous expenditures by the introduction of the appropriate behavioral equations as has been done in NK models.

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