Inventories, Debt Financing and Investment Decisions: A Bayesian Analysis for the US Economy

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Abstract

The recent debate in Post-Keynesian theories of investment has mainly focused on the endogenous nature of the degree of capacity utilization, overlooking Steindl's and Minsky's insights on the role of inventories and debt financing in shaping investment decisions. In order to fill this gap, this paper develops a Steindl-Minsky SFC model by including inventories, as well as firm's deposits and debt financing into the investment function. The role of investment decisions in shaping economic growth is assessed by considering a model populated by five types of economic actors: workers, firms, rentiers, commercial banks and the central bank. First, business cycle fluctuations are investigated assuming a deterministic steady growth path in the long period, in line with recent developments in heterodox growth theory. Second, we simulate the model, calibrating it for the US economy.

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1 Introduction

The recent debate in Post-Keynesian theories of investment has mainly focused on the endogenous nature of the degree of capacity utilization, overlooking the original insights of Kalecki, Steindl and Minsky on the fundamental role played by inventory investment and debt financing in shaping actual capital formation of the private sector. This paper aims to overcome this *impasse* by developing and empirically testing a Post-Keynesian model of growth and distribution that recovers Kalecki's original *acceleration principle* and its extension proposed by Steindl (1952, 1979), further stressing the role of debt financing and internal finance, in line with Minsky (1978, 1980). In particular, we model gross fixed capital formation of the private sector as dependent on the interaction of multiple economic variables, encompassing inventory investment, expectations on future demand, firms' financing and labor costs.

In this regard, the first research goal is to build a stylized Stock-Flow Consistent (SFC) model able to capture the Kalecki-Steindl-Minsky macrodynamics. Accordingly, we build a one-sector SFC model populated by five types of economic actors: workers, firms, rentiers, commercial banks and the central bank. In doing so, we assume that firms' deposits and expectations on the development of future demand positively affect gross fixed capital formation of the private sector. Conversely, rises in inventories reduce capitalists' profits, thus raising debt exposure and ultimately slowing down investment, following Kalecki's (1971) *principle of increasing risk*. The same negative effect is also produced by an increase in the unit labor cost, under the assumption of incomplete pass-through, i.e. firms will not be able to entirely transfer an increase of labor costs to prices.

Second, we seek to empirically test the model for the US economy in a medium-run framework. In doing so, we expect to confirm the theoretical results, especially as regards investment dynamics.

On the methodological level, our work is based both on a review and reinterpretation of the existing literature and on data analysis. First, we develop the SFC model building upon the seminal contributions of Kalecki (1971), Steindl (1952, 1979) and Minsky (1978, 1980) and their following developments in the Post-Keynesian literature. Second, on the empirical level, we construct our database using quarterly data for the US economy ranging from 1992 to 2018, retrieved from the FRED database.

The present version of the paper does not yet include the estimation part. Future versions of the work will include the empirical analysis, relying upon the Bayesian Maximum Likelihood approach, first applied in the Post-Keynesian literature by Schoder (2012, 2017). The choice is both theoretically and empirically justified. Given the aleatory behavior of firms acting in a fundamentally uncertain world, a more sound empirical strategy to estimate our model ought to rely on multivariate distributions for the data - as in the Bayesian workflow - rather that single-equation estimation, as in the more common frequentist techniques of time series analysis.

The paper is divided as follows. Section 2 presents the one-sector SFC model divided according to the five economic actors considered in the analysis. Section 3 presents the steady-state results of the model and the impulse response analysis. Last, Section 4 concludes, summarizing our findings.

2 Model Equations

This Section presents our model equations for each actor of the economy: workers (Subsection 2.1), rentiers (2.2), firms (2.3), commercial banks (2.4) and the central bank (2.5). Subsection (2.6) presents the equilibria in the goods and labor markets, whereas Subsection (2.7) includes a conflicting claims framework to explain nominal wage inflation, further discussing how workers bargaining power is modeled.

In many respects, our model shows similarities with the work of Schoder (2017). In this sense, a brief comparison of the two contributions is in order. Same as Schoder's paper, we maintain the distinction between worker and rentier households, on one side, and firms, on the other. However, we expand the framework by including a banking system, which receives the deposits from firms and rentier households, and lends to firms according to their demand. Additionally, firms' inventories may vary, according to the difference between expected and actual aggregate demand. Accordingly, firms' inventories generate a path dependence mechanism, in which deviations from the state of past expectations affect current inventories and thus profits, ultimately affecting investment decisions.

2.1 Worker households

In line with the Classical-Kaleckian tradition, we assume that workers do not save ($S_{w,t} = 0$), thus consuming their entire income. Therefore, real consumption ($C_{w,t}$) equals real wage (ω_t) times the employment level (L_t, measured by the number of hours worked).

$$C_{w,t} = \omega_t L_t \tag{1}$$

Furthermore, following Schoder (2017), the ratio between the supply of labor in terms of hours worked ($N_{w,t}$) and its steady-state level (N_w) follows a first-order auto-regressive shock process.

$$\frac{N_{w,t}}{N_w} = V_{n,t} \tag{2}$$

2.2 Rentier households

Rentier households may decide to consume ($C_{r,t}$) or to save in the form of deposits ($M_{r,t}$). Therefore, their level of deposits represent their wealth. They receive the bank profits (B_t), part of the firms' profits ($Z_{r,t}$), and interests on their deposits in the last period.

$$\frac{C_{r,t}}{M_r} = \left(\frac{Z_{r,t}}{M_r}\right)^{\varphi_{c,z}} \left(\frac{B_t}{M_r}\right)^{\varphi_{c,b}} \left[\frac{(1 + r_{m,t-1})}{\Pi_{p,t}} \frac{M_{r,t-1}}{M_r \Gamma}\right]^{\varphi_{c,m}} V_{c,t} \tag{3}$$

where M_r, $r_{m,t}$, $\Pi_{p,t}$, Γ, and $V_{c,t}$ are the steady-state level of deposits, the interest rate on deposits, the gross price inflation rate, the deterministic growth rate of the economy, and a first-order auto-regressive shock process. Their budget constraint is given by:

$$C_{r,t} + M_{r,t} \leq Z_{r,t} + B_t + \frac{(1 + r_{m,t-1})}{\Pi_{p,t}} \frac{M_{r,t-1}}{\Gamma} \tag{4}$$

2.3 Firms

Under the simplifying assumption that only one good is produced in the economy (used both for consumption and saving), we assume that firms produce it by combining labor (L_t, measured in terms of hours worked) and capital (K_t) in a Cobb-Douglas technology of production. Moreover, the output-to-capital ratio (ψ) is assumed to be constant, which implies that we can derive the level of employment from the production function, as demonstrated below:

$$Y_t = V_{\alpha,t} K_t^{\alpha} L_t^{1-\alpha} \quad \Rightarrow \quad L_t = \frac{Y_t}{V_{\alpha,t}^{\frac{1}{1-\alpha}}} \psi^{\frac{\alpha}{1-\alpha}} \tag{5}$$

where $V_{\alpha,t}$ and ψ are a first-order auto-regressive shock process and a constant output-capital ratio.

We assume that firms produce according to their expectations and to the difference between the level of inventories and the desired level:

$$Y_t = Y_t^e \left(\frac{A_{t-1}}{A}\right)^{-\varphi_{ya}} \tag{6}$$

The unit labor cost is given by:

$$\phi_t = \frac{\omega_t}{V_{\alpha,t}} \frac{1}{(1-\alpha)} \left(\frac{\psi}{V_{\alpha,t}}\right)^{\frac{\alpha}{1-\alpha}} \tag{7}$$

which is the same as in Schoder (2017). We also assume, following Kalecki (1971) and Schoder (2017), that the firm's pricing decision is a function of the gross mark-up over unit labor cost (ε):

$$1 = (1+\varepsilon)\Big(\frac{\Pi^e_{w,t}}{\Pi_w}\Big)^{-\varphi_{\phi\pi}}\phi_t \tag{8}$$

where $\Pi^e_{w,t}$ and Π_w are the expected wage inflation and the actual wage inflation.

One of the main contributions of this paper is that the investment function depends not only on expected aggregate demand, but also on the level of indebtedness and on the cost of production, i.e. the unit labor cost:

$$\frac{I_t}{K_t} = \Big[1-(1-\delta)\frac{1}{\Gamma}\Big]\Big(\frac{Y^e_t}{Y}\Big)^{\varphi_{i,y}}\Big(\frac{M_{f,t-1}}{M_f}\Big)^{\varphi_{i,m_f}}\Big(\frac{D_{t-1}}{D}\Big)^{-\varphi_{i,d}}\Big(\frac{r_{D,t}}{r_D}\Big)^{-\varphi_{i,r_d}}\Big(\frac{\phi_t}{\phi}\Big)^{-\varphi_{i,\phi}}V_{i,t} \tag{9}$$

where M_f, D, and r_D are the steady-state firms' deposits, the steady-state firms' debt, and the steady-state interest on firms' debt, in this order.

The stock of capital evolves according to:

$$K_t = I_t + (1-\delta)\frac{1}{\Gamma}K_{t-1} \tag{10}$$

where δ is the depreciation rate.

Firms' profits (Z_t) are given by the difference between their revenues and their expenses. They receive the output of this economy (Y_t) and interests ($r_{M,t-1}$) on their deposits from the previous period ($M_{f,t-1}$). On the other hand, they pay wages, a fraction $(1-\xi_t)$ of the investment, and the interests ($r_{D,t-1}$) on their debt from the previous period (D_{t-1}). Their profits are also negatively affected by the variation in inventories (where A_t is their inventory in t).

$$Z_t = Y_t - \omega L_t - (1-\xi_t)I_t - \frac{r_{D,t-1}}{\Pi_{p,t}\Gamma}D_{t-1} + \frac{r_{M,t-1}}{\Pi_{p,t}\Gamma}M_{f,t-1} - \Big(A_t - \frac{A_{t-1}}{\Pi_{p,t}\Gamma}V_{A,t}\Big) \tag{11}$$

A fraction ξ_t of the investment is financed by new loans, according to the following decision rule:

$$1+\xi_t = \Big[\frac{M_{f,t-1}/(\Pi_{p,t}\Gamma)}{M_f}\Big]^{-\varphi_{\xi,m_f}}\Big[\frac{D_{t-1}/(\Pi_{p,t}\Gamma)}{D}\Big]^{-\varphi_{\xi,d}}\Big(\frac{r_{D,t}}{r_D}\Big)^{-\varphi_{\xi,r_d}} \tag{12}$$

For the sake of simplicity, we do not consider the possibility of debt amortization. Accordingly, the debt balance can only be reduced by inflation, as follows:

$$D_t - \frac{D_{t-1}}{\Pi_{p,t}\Gamma} = \xi_t I_t \tag{13}$$

Furthermore, firms distribute a fraction β of their profits to rentier households, saving the other fraction as deposits:

$$Z_{r,t} = \beta Z_t \quad , \quad M_{f,t} - \frac{M_{f,t-1}}{\Pi_{p,t}\Gamma} = Z_{f,t} = (1-\beta)Z_t \tag{14}$$

2.4 Commercial Banks

Commercial banks distribute all their profits (B_t) to rentier households in the form of profits, which are equal to the difference between the interest received on loans and the interest paid on deposits.

$$B_t = \frac{r_{D,t-1}}{\Pi_{p,t}}\frac{D_{t-1}}{\Gamma} - \frac{r_{M,t-1}}{\Pi_{p,t}}\frac{(M_{f,t-1} + M_{r,t-1})}{\Gamma} \tag{15}$$

In line with Post-Keynesian endogenous money theory, commercial banks are assumed to set the interest on loans on the basis of a given mark-up factor:

$$r_{D,t} = (1+\theta)r_{M,t} \tag{16}$$

2.5 Central Bank

In a loanable funds model, the interest rate is given by the equality between supply and demand for money. In a model of endogenous money, however, this adjustment mechanism is not possible.[3] Therefore, we assume that the central bank sets the interest rate on deposits according to a Taylor rule:

$$\frac{r_{M,t}}{r_M} = \left(\frac{\Pi_{p,t}}{\Pi_p}\right)^{\varphi_{r,\pi}} \left(\frac{Y_t}{Y}\right)^{\varphi_{r,y}} V_{r,t} \tag{17}$$

2.6 Equilibrium

The goods market clears as follows[4]:

$$Y_t = C_{w,t} + C_{r,t} + I_t + \left(A_t - \frac{A_{t-1}}{\Pi_{p,t}\Gamma}V_{A,t}\right) \tag{18}$$

Unemployment, real wage growth, and adaptive expectations follow equations (18)-(21) in Schoder (2017):

$$u_t = 1 - \frac{L_t}{N_{w,t}} \tag{19}$$

$$\frac{\omega_t}{\omega_{t-1}} - 1 = \Pi_{w,t} - \Pi_{p,t} \tag{20}$$

[3]However, as we show in Appendix B, the equality below holds in the steady state: $D^* = M_r^* + M_f^*$

[4]To solve the model, we assume that Equation (6) determines Firms' production. Hence, the goods market equilibrium in (18) determines the variation in inventories.

$$\frac{\Pi^e_{w,t}}{\Pi_{w,t}} = \left(\frac{\Pi_{w,t-1}}{\Pi_{w,t}}\right)^{\varphi_{\pi e}} \tag{21}$$

$$\frac{Y^e_t}{Y_t} = \left(\frac{Y_{t-1}}{Y_t}\right)^{\varphi_{ye}} \tag{22}$$

2.7 Bargaining claims

Regarding nominal wage inflation, our analysis differs from Schoder (2017) to the extend that it substitutes its Nash-type bargaining game with a conflicting claims process more in line with Post-Keynesian views on inflation. Therefore, following Lavoie (2014, Section 8.3), we assume that nominal wage inflation varies according to the difference between workers' target real wage (ω^d_w) and its actual level in the previous period (ω_{t-1}). The adjustment is weighted by the parameter (ν), measuring workers' bargaining power, hence indicating "to what extent labour unions react to a discrepancy between the actual and the desired real-wage rate" (*ibid.*, p. 550).

$$\Pi_{\omega,t} - 1 = \nu(\omega^d_w - \omega_{t-1}) \tag{23}$$

Following Schoder (2017), the workers' bargaining power is given by:

$$\frac{\nu_t}{\nu} = \left(\frac{L_t}{L}\right)^{\varphi_{\nu l}} V_{\nu,t} \tag{24}$$

3 Steady-state Results and Impulse Response Analysis

In this section, we analyze the response of the model to impulses in inventories, workers' bargaining power, investment, labor supply, interest rates, rentiers' consumption, and technology of production. This impulse-response exercise is performed by analyzing the effects of a one-standard-deviation non-cumulative shocks in $V_{A,t}$, $V_{\eta,t}$, $V_{i,t}$, $V_{n,t}$, $V_{r,t}$, $V_{c,t}$, and $V_{\alpha,t}$, respectively, and can be verified in Equations (18), (24), (9), (2), (17), (3), (5), in this order.

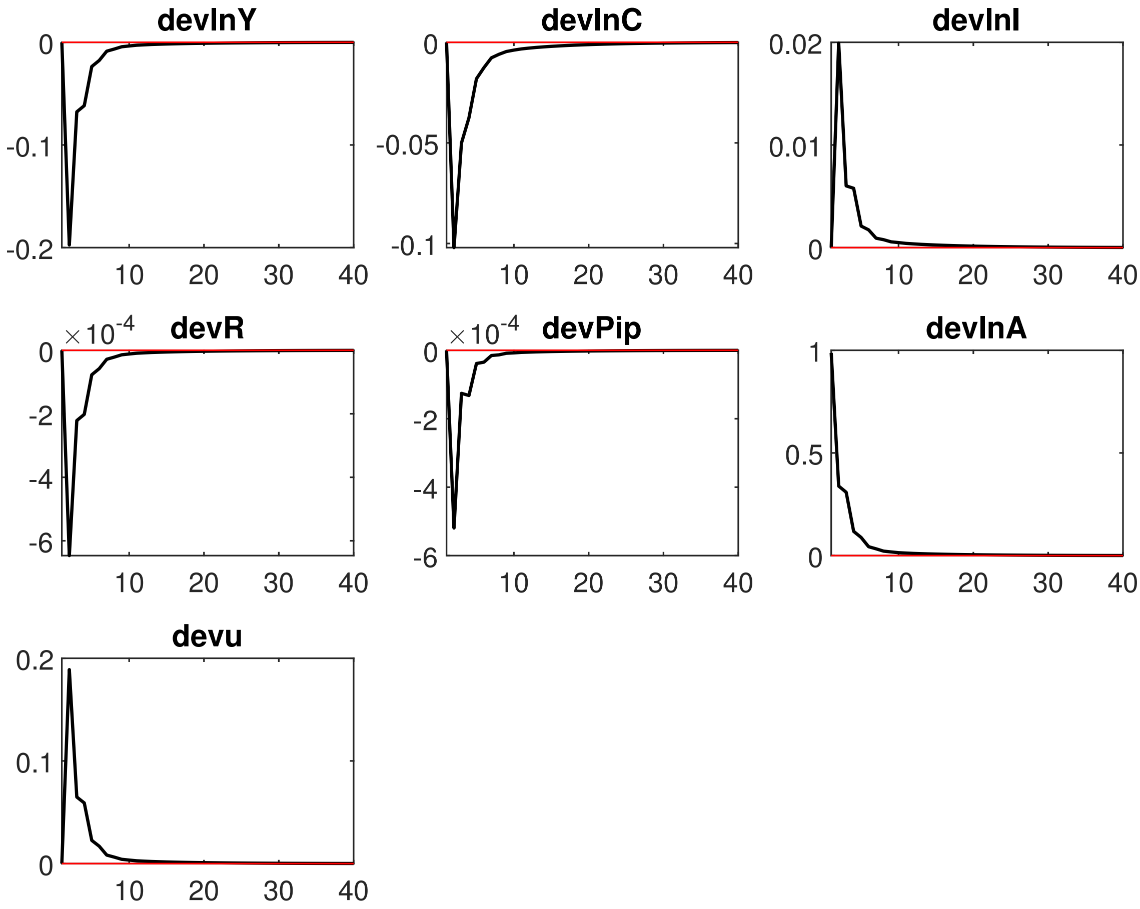

Figure 1: Macroeconomic responses to a positive shock in inventories

Figure 1 shows the response of the model to a positive shock in inventories ($devlnA$). Given that production depends on expected demand and the difference between inventories and their steady-state level (which may also be interpreted as firms' desired level of inventories), the first impact of the shock is a reduction in production ($devlnY$). As a consequence, unemployment increases ($devu$) and, in its turn, household consumption (sum of rentier and worker households) is reduced ($devlnC$). The lower economic activity and employment levels slightly reduce inflation ($devPip$), also leading to a small reduction in the discount rate ($devR$). Then, investment increases ($devlnI$) in response to the lower labor cost and interest rate, leading aggregate demand again to the level before the shock.

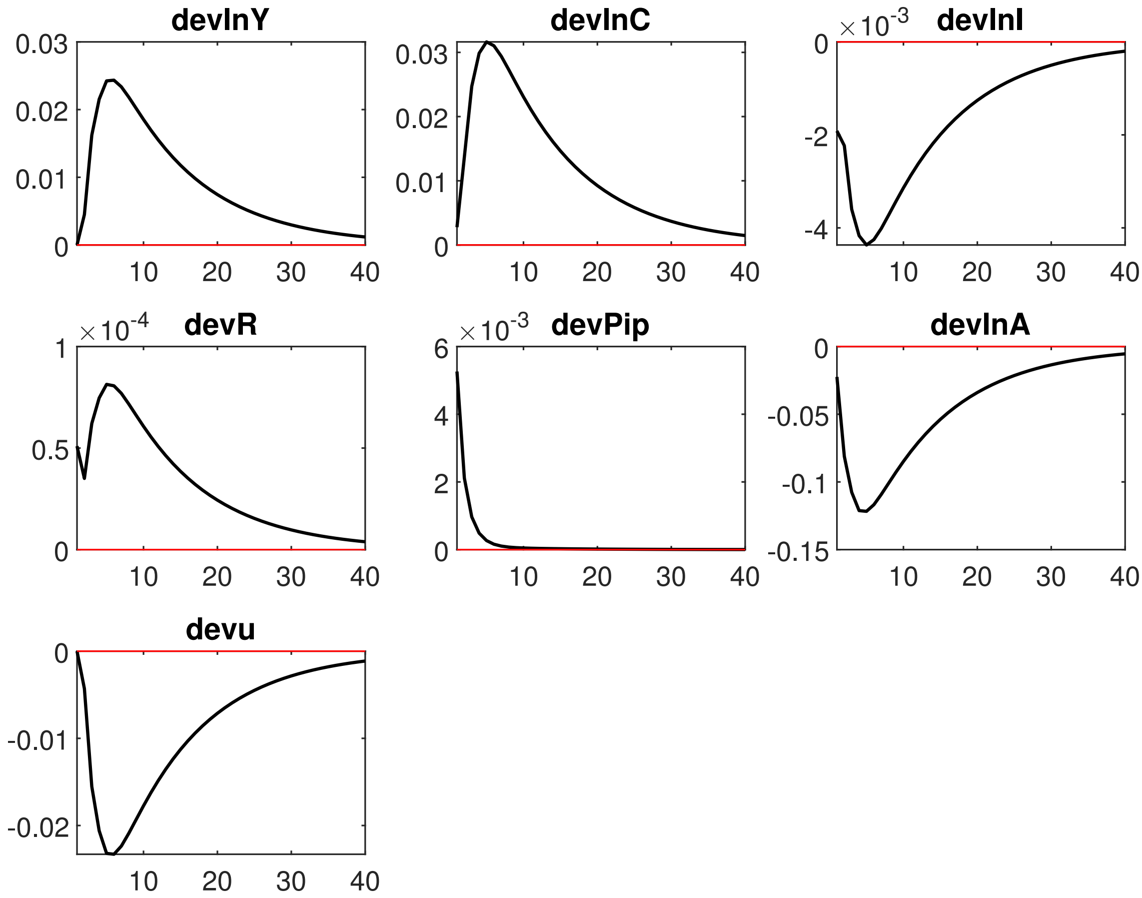

Figure 2: Macroeconomic responses to a positive shock in workers' bargaining power

The impact of an increase in workers' bargaining power is represented in Figure 2. The consequence of this shock is higher real wages leading to an increase in consumption ($devlnC$) and thus in the level of aggregate demand, in turn reducing the level of inventories ($devlnA$). In this process, firms increase production ($devlnY$) to recompose stocks, reducing unemployment ($devu$). However, the higher labor costs discourage investment ($devlnI$), leading aggregate demand back to its previous level. Accordingly, this model is similar to others that present wage-led demand, but profit-led growth, thus corresponding to the case of stagnationist conflict in the terms of Bhaduri and Marglin (1990).

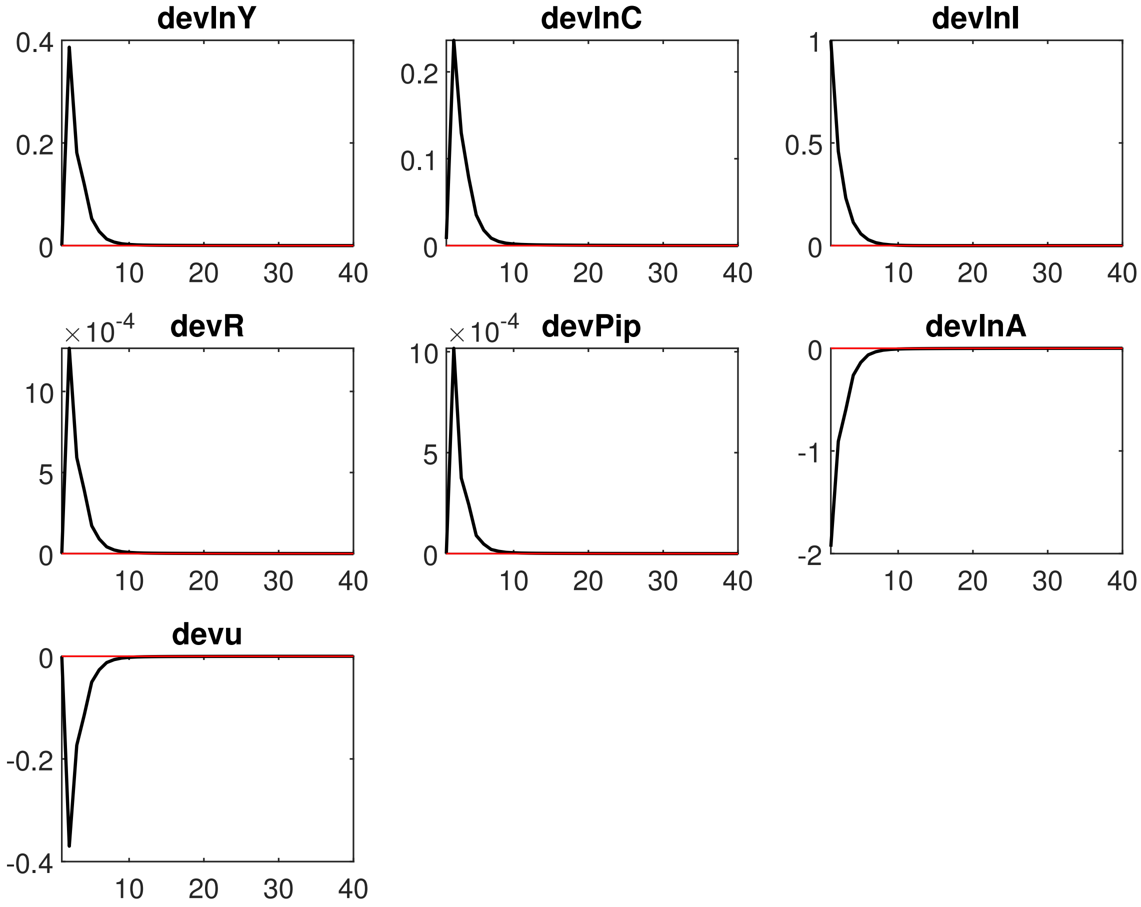

Figure 3: Macroeconomic responses to a positive shock in investment

A shock in investment, as represented in Figure 3, increases aggregate demand, reducing the level of inventories ($devlnA$). As a response, firms increase production ($devlnY$), which leads to a fall in unemployment ($devu$) and an increase in consumption ($devlnC$). Acting counter-cyclically, the central bank will intervene, increasing the interest rate and thus dissipating the shock.

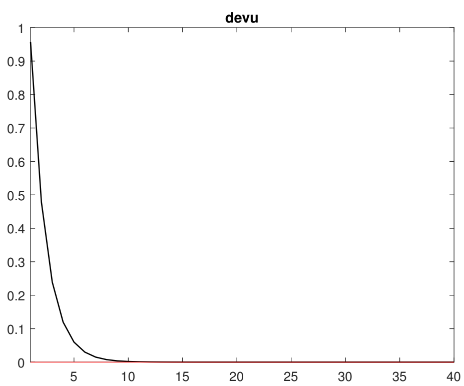

Figure 4: Macroeconomic responses to a positive shock in labor supply

Our model builds upon the Classical-Keynesian assumption of inelastic labor supply, with the labor market being determined as a residual rather than as the *causa causans*. Accordingly, labor supply does not affect the equilibrium level of employment in the model. For this reason, a positive shock in the supply of hours worked (Figure 4) only alters the rate of unemployment, in line with Post-Keynesian growth theory.

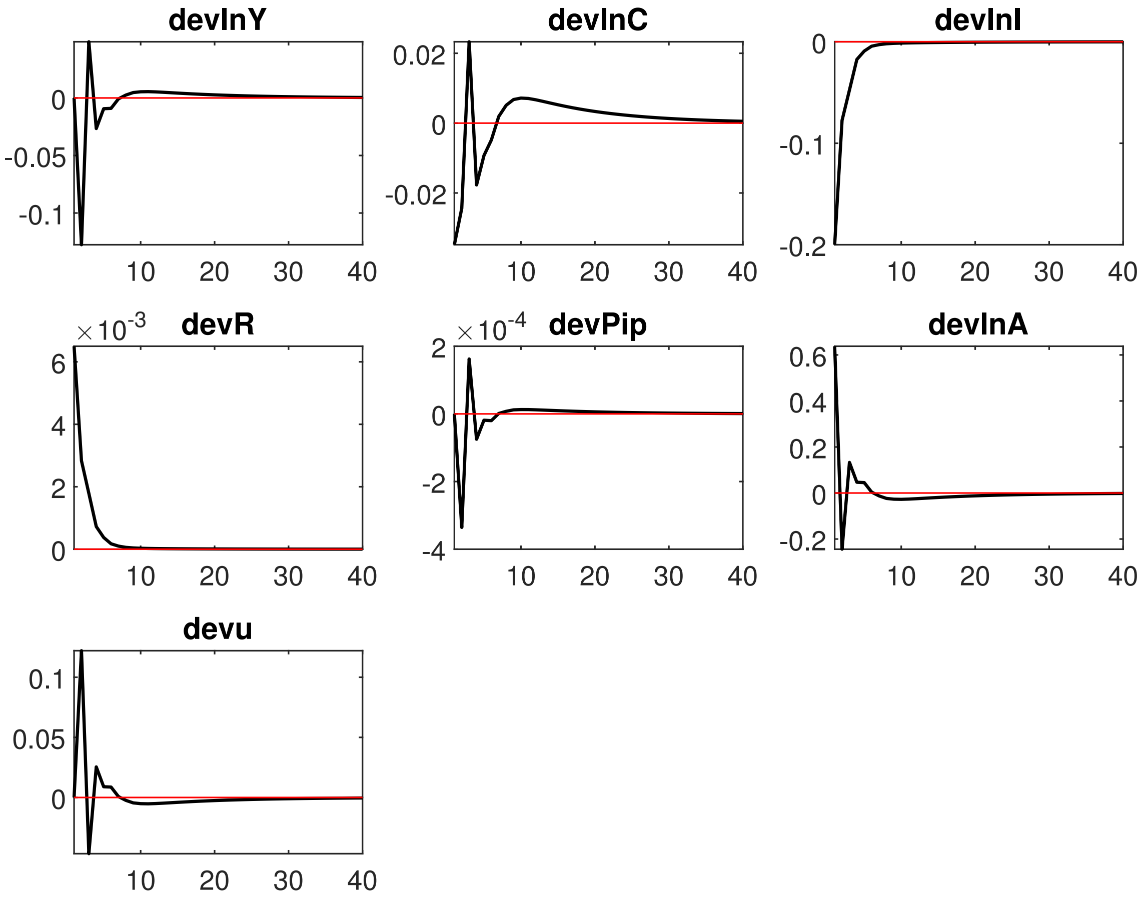

Figure 5: Macroeconomic responses to a positive shock in the interest rate

Contractionary monetary policies, as the one represented in Figure 5, negatively impact aggregate demand through investment ($devlnI$), leading to an increase in inventories ($devlnA$). Besides, the increase in the interest rate also leads firms to fund a higher fraction of their investment with their own resources (Equation 12), reducing firms' profit distribution (Equation 11), which explains the decrease in consumption in the first period ($devlnC$).

In the following period, production responds to the shock in the previous period by reducing production ($devlnY$), given the higher level of inventories, which affects the unemployment rate ($devu$). However, we still observe a positive behavior of rentier households' consumption, as a result of the higher returns on deposits from the previous period and an increase in banks profits. Combined with the dissipation of the shock in the interest rate leading to a recovery of investments, this increase in consumption conducts the economic growth to its trend.

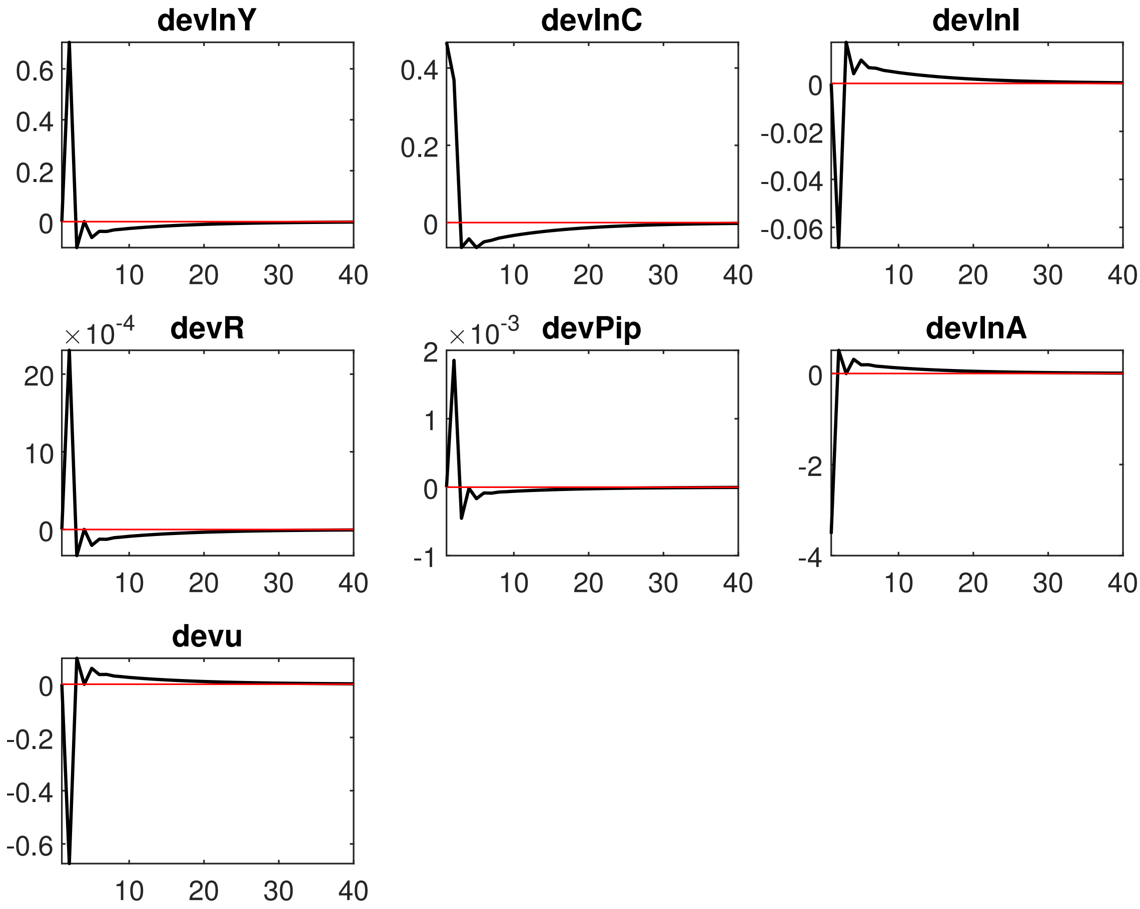

Figure 6: Macroeconomic responses to a positive shock in consumption

Figure 6 illustrates the impact of a shock in rentier households' consumption. The immediate effect, given the increase in aggregate demand, is a reduction in inventories ($devlnA$), which stimulates firms to increase production in the following period ($devlnY$), reducing the unemployment rate ($devu$). The central bank response to the higher level of activity ($devR$) and higher inflation ($devPip$) leads to a reduction in investments ($devlnI$), offsetting the initial increase in aggregate demand.

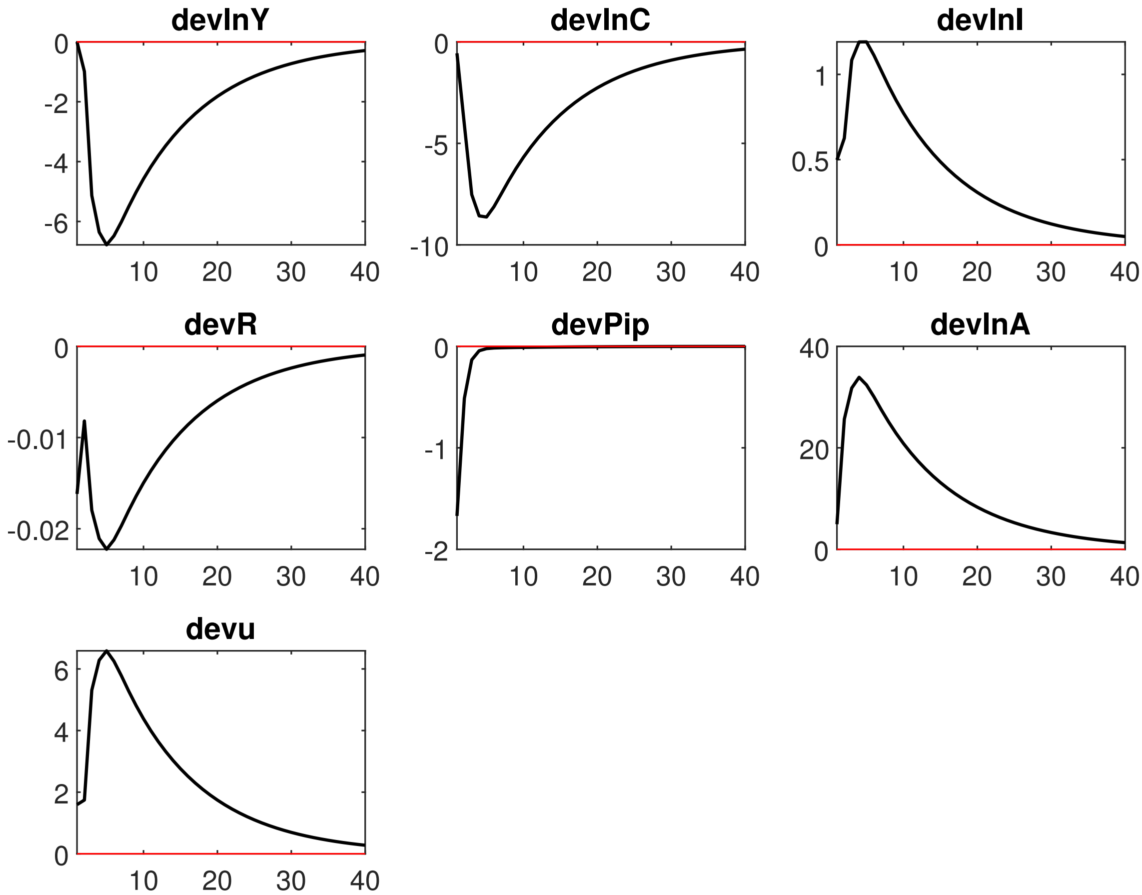

Figure 7: Macroeconomic responses to a positive technological shock

Next, we present the impact of a technological shock in the model. To analyze this effect, however, we must bear in mind that this is a model aimed to comprehend cycles, not the trend of economic growth. Therefore, we are only able to analyze the former, not the latter effects of technological progress. Figure 7 shows the results of a shock in $V_{\alpha,t}$. Given that production is demand-driven in the model, the technological shock leads to an immediate reduction in employment ($devu$), consumption ($devlnC$), and prices as consequence ($devPip$). The result of this reduction in aggregate demand is an increase in inventories in the first period ($devlnA$) and a reduction of interest rates by the central bank ($devR$). The lower costs of production stimulate investment ($devlnI$), leading to a recovery of aggregate demand and, for its part, of production.

4 Conclusion

The paper developed an SFC model encompassing the insights on investment determination and the role of finance in a Kalecki-Steindl-Minsky framework. The model helped showing the interdependencies among investment dynamics, growth and the functional distribution of income. More specifically, it showed as increases in inventories reduce profits, thus increasing debt exposure and ultimately slowing down investment, following Kalecki's (1971) *principle of increasing risk*. A similar effect is appreciated in the case of a rising unit labor cost, that slows down investment while raising consumption.

The overall impact effects have been assessed computing the theoretical impulse response functions. In this regard, we verified the role of inventories in accommodating aggregate demand shocks, and its consequences to production and investment in the following periods. The next steps include estimating the model by means of a Bayesian Maximum Likelihood approach, in order to assess the empirical performance of the model.

Table 1: Parameters and Steady-State Variables

Parameter	**Value**	**Description**	**Source**
α	0.4	Capital elasticity of output	Chirinko et al. (2004).
β	0.85	Fraction of firms' profits distributed to rentier households	Nonfinancial corporate business: Profits after tax (U.S. BEA) NFCB: net dividends paid (FED Economic Data), Own calculation.
Γ	1.006	Deterministic growth rate of the economy (all assuming that a period is one quarter)	Real Gross Domestic Product (U.S. BEA). Own calculation.
δ	0.014	Capital depreciation rate	Penn World Table (Feenstra et al., 2015).
ε	0.3	Price mark-up	Schoder (2017).
θ	1.15	Loans mark-up on deposits interest rate	Bank loan prime rate (US Board of Governors of the Federal Reserve System).
ν	0.5	Workers bargaining power	Own calibration.
Π_w	1.007	Long-run gross wage inflation rate	FOMC Summary of Economic Projections for the Personal Consumption Expenditures Inflation Rate, Central Tendency, Midpoint.
ψ	0.1	Fixed output-capital ratio	Schoder (2017).
A	0.106	Long-run steady-state inventories	US Total Business inventories (US Census Bureau - Trend 1992-2018).
r_m	0.0065	Long-run gross interest rate	10-Year Treasury Constant Maturity Rate (FED Economic Data).
u	0.043	Long-run unemployment rate	Civilian Unemployment Rate (US BLS-Current Population Survey).
Y	1	Long-run output	Normalized to 1.

Table 2: Parameters (Cont.)

Parameter	**Value**	**Description**
$\varphi_{\phi\pi}$	0.5	wage inflation elasticity of the markup
$\varphi_{c,z}$	0.3	income elasticity of rentier consumption to firms' profits-deposit ratio
$\varphi_{c,b}$	0.3	income elasticity of rentier consumption to banks' profits-deposit ratio
$\varphi_{c,m}$	0.3	income elasticity of rentier consumption to deposits dynamics
φ_{i,m_f}	0.2	elasticity of firms' deposits to investment
$\varphi_{i,d}$	0.2	elasticity of firms' debt to investment
φ_{i,r_d}	0.2	elasticity of interest on firms' debt to investment
$\varphi_{i,\phi}$	0.2	elasticity of unit labor cost to investment
φ_{iy}	0.2	expected sales elasticity of investment
$\varphi_{r,\pi}$	1.5	inflation elasticity of the interest rate
$\varphi_{r,y}$	0.5	output elasticity of the interest rate
$\varphi_{\nu l}$	0.5	employment elasticity of the workers' bargaining power
φ_{ya}	0.2	elasticity of inventories to production
ρ_a	0.5	autoregressive coefficient for shock process (technology of production)
ρ_r	0.5	autoregressive coefficient for shock process (monetary policy)
ρ_c	0.5	autoregressive coefficient for shock process (consumption)
ρ_n	0.5	autoregressive coefficient for shock process (labor supply)
ρ_i	0.5	autoregressive coefficient for shock process (investment)
ρ_ν	0.5	autoregressive coefficient for shock process (workers' bargaining power)
ρ_{inv}	0.5	autoregressive coefficient for shock process (inventories)
$\varphi_{\pi e}$	0.5	stickiness of nominal wage expectations
φ_{ye}	0.5	stickiness of firms output expectations
φ_{ξ,m_f}	10	elasticity of firms' deposits to the fraction of investment financed by new loans
φ_{ξ,r_d}	1	elasticity of interest rate to the fraction of investment financed by new loans
$\varphi_{\xi,d}$	10	elasticity of firms' debt level to the fraction of investment financed by new loans

Table 3: Transactions Flow Matrix

	WH	RH	Firms Current	Firms Capital	Banks Current	Banks Capital	Σ
Consumption	$-C_{w,t}$	$-C_{r,t}$	$+C_t$				0
Investment			$+I_t$	$-I_t$			0
Δ Inventories			$+\Delta A_t$	$-\Delta A_t$			0
Wages	$+\omega_t L_t$		$-\omega_t L_t$				0
Firms' Profits		$+Z_{r,t}$	$-Z_t$	$+Z_{f,t}$			0
Banks' Profits		$+B_t$			$-B_t$		0
Depos. Interests		$+r_{m,t-1}M_{r,t-1}$	$+r_{m,t-1}M_{f,t-1}$		$-r_{m,t-1}M_{t-1}$		0
Loan Interests			$-r_{D,t-1}D_{t-1}$		$+r_{D,t-1}D_{t-1}$		0
Δ Deposits		$-\Delta M_{r,t}$		$-\Delta M_{f,t}$		$+\Delta M_t$	0
Δ Loans				$+\Delta D_t$		$-\Delta D_t$	0
Σ	0	0	0	0	0	0	0

Notes: Based on Godley and Lavoie (2007) and Kapeller and Schütz (2014).

Table 4: Balance Sheet Matrix

	WH	RH	Firms	Banks	Σ
Loans			$-D_t$	$+D_t$	0
Deposits		$+M_{r,t}$	$+M_{f,t}$	$-M_t$	0
Fixed Capital			$+K_t$		$+K_t$
Inventories			$+A_t$		$+A_t$
Net Worth		$-NW_{r,t}$	$-NW_{f,t}$	$-NW_{B,t}$	$-(K_t + A_t)$
Σ	0	0	0	0	0

Notes: Based on Godley and Lavoie (2007) and Kapeller and Schütz (2014).

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Appendix A

In this section, we compute the steady-state of the model. From the firms' technology of production in (5), given the steady-state output level, the levels of employment and unemployment are given by:

$$L = Y\psi^{\frac{\alpha}{1-\alpha}} \tag{25}$$

$$u = 1 - \frac{L}{N_w} \tag{26}$$

By using equations (7) and (8), The firms' pricing decision determine wages and the unit cost of labor:

$$\omega = \frac{(1-\alpha)}{(1+\varepsilon)\psi^{\frac{\alpha}{1-\alpha}}} \tag{27}$$

$$\phi = \frac{1}{(1+\varepsilon)} \tag{28}$$

Given that ψ represents the output-to-capital ratio, equation (10) implies:

$$I = K\Big[1 - (1-\delta)\frac{1}{\Gamma}\Big] = \frac{Y}{\psi}\Big[1 - (1-\delta)\frac{1}{\Gamma}\Big] \tag{29}$$

Equations (20) and (23) define the desired wage and price inflation:

$$\omega_w^d = \frac{\Pi_\omega - 1}{\nu} + \omega \tag{30}$$

$$\Pi_w = \Pi_p \tag{31}$$

According to equations (12) and (13), the fraction of investment financed by debt and the stock of debt in the steady-state are given by:

$$\xi = \Big[\frac{1}{\Pi_p \Gamma}\Big]^{-\varphi_{\xi,d} - \varphi_{\xi,m_f}} - 1 \tag{32}$$

$$D = \frac{\xi I}{1 - \frac{1}{\Pi_p \Gamma}} \tag{33}$$

Worker households' consumption is, given (1):

$$C_w = \omega L \tag{34}$$

The goods market clearing defines Rentier households' consumption:

$$C_r = Y - C_w - I - A\Big(1 - \frac{1}{\Pi_p \Gamma}\Big) \tag{35}$$

From Equations (11) and (14):

$$Z = \frac{Y - \omega L - (1-\xi)I - \frac{r_D}{\Pi_p \Gamma} D - A\Big(1 - \frac{1}{\Pi_p \Gamma}\Big)}{\Big[1 - \frac{r_M (1-\beta)}{\Pi_p \Gamma (1 - \frac{1}{\Pi_p \Gamma})}\Big]} \tag{36}$$

$$Z_r = \beta Z \quad , \quad Z_f = (1-\beta) Z \quad , \quad M_f = \frac{Z_f}{1 - \frac{1}{\Pi_p \Gamma}} \tag{37}$$

The banking system, represented in Equations (15) and (16), and the rentier households' budget constraint in (4) determine:

$$r_D = (1+\theta) r_M \tag{38}$$

$$M_r = \frac{Z_r - C_r + \frac{(r_D D - r_M M_f)}{\Pi_p \Gamma}}{\Big(1 - \frac{1}{\Pi_p \Gamma}\Big)} \tag{39}$$

$$B = \frac{r_D}{\Pi_p} \frac{D}{\Gamma} - \frac{r_M}{\Pi_p} \frac{(M_f + M_r)}{\Gamma} \tag{40}$$

Appendix B

In the steady state, from (4) and (15), we have:

$$C_r + M_r\Big[1 - \frac{(1+r_m)}{\Pi_P\Gamma}\Big] = Z_r + \Big[\frac{r_D}{\Pi_P}\frac{D}{\Gamma} - \frac{r_M}{\Pi_P}\frac{(M_f+M_r)}{\Gamma}\Big] \tag{41}$$

$$C_r + M_r\Big[1 - \frac{1}{\Pi_P\Gamma}\Big] = Z_r + \Big[\frac{r_D}{\Pi_P}\frac{D}{\Gamma} - \frac{r_M}{\Pi_P}\frac{M_f}{\Gamma}\Big] \tag{42}$$

From (1) and (18):

$$C_r = Y - \omega L - I - A\Big(1 - \frac{1}{\Pi_p\Gamma}\Big) \tag{43}$$

From (11) and (14):

$$Z = Y - \omega L - (1-\xi)I - \frac{r_D}{\Pi_p\Gamma}D - A\Big(1 - \frac{1}{\Pi_p\Gamma}\Big) + \frac{r_M}{\Pi_p\Gamma}\frac{(1-\beta)Z}{(1-\frac{1}{\Pi_p\Gamma})} \tag{44}$$

$$Z = \frac{Y - \omega L - (1-\xi)I - \frac{r_D}{\Pi_p\Gamma}D - A\Big(1 - \frac{1}{\Pi_p\Gamma}\Big)}{1 - \frac{r_M}{\Pi_p\Gamma}\frac{(1-\beta)}{(1-\frac{1}{\Pi_p\Gamma})}} \tag{45}$$

Combining (42) and (43), and using (14):

$$Y - \omega L - I - A\Big(1 - \frac{1}{\Pi_p\Gamma}\Big) + M_r\Big[1 - \frac{1}{\Pi_P\Gamma}\Big] = \beta Z + \Big[\frac{r_D}{\Pi_P}\frac{D}{\Gamma} - \frac{r_M}{\Pi_P}\frac{M_f}{\Gamma}\Big] \tag{46}$$

$$Y - \omega L - I - A\Big(1 - \frac{1}{\Pi_p\Gamma}\Big) + M_r\Big[1 - \frac{1}{\Pi_P\Gamma}\Big] = -(1-\beta)Z + \frac{r_D}{\Pi_P}\frac{D}{\Gamma} + Z\Big[1 - \frac{r_M}{\Pi_P\Gamma}\frac{(1-\beta)}{(1-\frac{1}{\Pi_p\Gamma})}\Big] \tag{47}$$

Using (45), (14) and (13):

$$M_r\Big(1 - \frac{1}{\Pi_P\Gamma}\Big) = -M_f\Big(1 - \frac{1}{\Pi_P\Gamma}\Big) + D\Big(1 - \frac{1}{\Pi_p\Gamma}\Big) \tag{48}$$

$$M_r + M_f = D \tag{49}$$