A Stock-Flow Consistent Model with Real Estate and Land

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Serge Herbillon-Leprince

Université Paris 13

Introduction

Financing and valuation of Housing played a crucial role in the United-States related bubble and subsequent subprime crisis of 2007-2008. Furthermore, real estate accounts for a large part of households' wealth, together with mortgages counting for a large part of households' liabilities. Yet, only few attempts have been made at modeling housing in a macroeconomic stock-flow consistent framework (Zezza, 2007; Nikolaidi, 2014).

The aim of the model proposed here is to assess the wealth effect on economic growth, taking into account capital gains on financial and non-financial assets accruing to the household sectors. The originality of this model intending to further the former contributions on housing modeling is threefold.

First, the model introduces a stock of land owned by a capitalist-landowner sector. This permits monetization through sales of non-produced assets indispensable to real estate formation. This also induces revenue distribution, affected by land ownership, taking place prior to production. The realized capital gains accruing to capitalists impacts this sector's consumption through a wealth effect, along with financial and real estate prices through portfolio investment.

Second, land valuation is described through real estate market dynamics. Capitalists' and workers' demand for real estate relative to new dwellings drives land prices, which in turn affects real estate prices. As the workers sector finances real estate demand by indebtedness, real estate prices will affect debt relative to disposable income. Prices will also impact net wealth through capital gains resulting in a wealth effect on workers' consumption.

Third, the different pricing of both real estate inputs, namely non-produced land and produced dwellings, allows for a better account of firms' financial needs and allows firms to realize capital gains on unsold real estate. It also permits to integrate construction flows with real estate stocks in a coherent manner.

Given the specifications of the model, our purpose is to investigate through which channels capital gains on land sales affect economic growth.

The model

This model seeks to deal with accounting issues when introducing real estate in a theoretical stock-flow coherent macroeconomic model to better account for capital gains and their impact on economic growth. In Zezza (2007), worker households buy real estate from firms and receive loans from banks. A problem arises since new houses produced by firms are valued and sold at the general price level, but bought at the real estate price level which differs from the former. In Nikolaidi (2014), houses are also produced by firms at the general price level but sold and bought at the real estate price level. In Zezza's model, firms benefit from their production but cannot make capital gains on unsold houses. Instead, in Nikolaidi's model firms make instantaneous capital gains. These assumptions have an impact both on revenue and financing flows and financial stocks. To address these issues, the choice was made to introduce a land stock owned by capitalists. Real estate is composed of built structures accounted for in GDP and of land which is a non-produced, non-financial asset. The land price differs from the general price level which allows for real estate price to differ from the general price level. This permits to link flow variables, such as the production of houses, and stocks of assets, namely real estate.

Model Matrices

The model represents a closed economy made of six institutional sectors, namely the workers sector, capitalists sector, firms, government, banks and a central bank.

Current and financial asset transactions as well as non financial asset transactions are summarized in table 1. Columns represent sectors' transactions and sum up to 0. Lines represent particular transactions with both counterparts and also must sum to 0. The upper part describes revenue distribution among sectors, their expenditures, taxes and interest payments implying positive or negative saving. These financing capacities and needs are then met through financial asset transactions. Worker households have saving but also take on debt to finance their purchases of real estate. Land sales to firms generates revenue for capitalists that increases their financial capacity, which is invested in real estate, government bonds, equities and deposits. Firms build houses and buy land to form real estate. The change in unsold houses stock is implicit as it depends on the difference between construction and land acquisition and current sales. The government, banking sector and central bank are described in a simple way. The three sectors' balance-sheet residual is government bills. The equality between supply of government bills and demand from banks and the central bank is the model's redundant equation.

The table 2 shows the different sectors' balance-sheets. The net financial wealth of all sectors is equal to production capital owned by firms, land and real estate assets, as all sectors' financial liabilities have a financial asset counterpart owned by another sector.

The revaluation matrix is presented in table 3, where movements in asset prices are the missing part to achieve consistency between transactions flows and changes in stocks. Note that capitalists' wealth also increases by the amount of land sales in the OTHER section. With our starting values

and when the model is simulated, if the stock of land in real terms owned by capitalists decreases with land sales, it would take a negative value after a certain time. If the starting value of the stock of land is set up high enough to avoid this problem, the impact on GDP through the wealth effect would be unreasonable and capitalists' stock of assets to disposable income would be unrealistic. As well as that, as land sales generate funds invested in other assets, there would just be a substitution of assets on capitalists balance-sheets.

Instead, the stock of land in real terms owned by capitalists is constant, and land sales increase capitalist wealth. It implies an implicit appreciation rate of the land stock, as new land is available for building through time. Our purpose being a better representation of the real estate market, the stock of land in the model represents building land and not total land that would include agriculture land for instance.

Also note the change in own funds of banks are accounted as capital gains for households. In this model, as in Godley and Lavoie's chapter 11 model in the 2007 "Monetary Economics" book[1], banks do not issue stocks, and are owned by capitalists households, although they have no word in banks behavior in the model.

[1] See Godley and Lavoie, 2007, page 380.

TABLE 1

TRANSACTION MATRIX		HOUSEHOLDS		FIRMS		GOVERNMENT	BANKS	CENTRAL BANK
		WORKERS	CAPITALISTS	CURRENT AC.	CAPITAL AC.			
OUTPUT	CONSUMPTION	-Cm	-Ck	+C				
	INVESTMENT			+I	-I			
	DWELLINGS			+ΔDW	-ΔDW			
	GOV EXP			+G		-G		
WAGES		+Wm	+Wk	-W				
INTERESTS ON	WORKER LOANS	- im(-1) * Lm(-1)					+ im(-1) * Lm(-1)	
	FIRM LOANS			-if(-1)*Lf(-1)			+if(-1)*Lf(-1)	
	DEPOSITS	+ibd(-1)*BDm(-1)	+ibd(-1)*BDk(-1)				-ibd*BD(-1)	
	GOV BILLS					-igs(-1)*gs(-1)	+igs(-1)* gsb(-1)	+igs(-1)*gscb(-1)
	GOV BONDS		+igb*gbk(-1)			-igb*gbs(-1)		
TAXES		-Tm	-Tk	-Tf		+T	-Tb	-Tcb
PROFITS	DISTRIBUTED		+FD	-FDf			-FDb	
	RETAINED			-FUf	+FUf		+FUb	
LAND			+pla*ΔLas		-pla*ΔLad			
REAL ESTATE		-pre*ΔRem	-pre*ΔRek		+pre*ΔRev			
RESERVES							-ΔRES	+ΔRES
CASH		-ΔHm	-ΔHk					+ΔH
DEPOSITS		-ΔBDm	-ΔBDk				+ΔBD	
LOANS		+ΔLm					-ΔLm	
					+ΔLf		-ΔLf	
BILLS						+Δgs	-Δgsb	-Δgsbc
BONDS			-pgb*Δgbk			+pgb*Δgbs		
EQUITIES			-pe*Δed		+pe*Δes			

TABLE 2

BALANCE SHEET		HOUSEHOLDS		FIRMS	GOVERNMENT	BANKS	CENTRAL BANK	Σ
		WORKERS	CAPITALISTS					
LAND			pla*LAk					pla*Lak
NON FINANCIAL ASSETS	CAPITAL			K				K
	REAL ESTATE	pre*Rem	pre*Rek	pre*Rer				pre*RE
RESERVES						+RESd	-RESs	0
CASH		Hm	Hk				-H	0
DEPOSITS		BDm	BDk			-BD		0
LOANS		-Lm				Lm		0
				-Lf		Lf		0
BILLS					-gs	gsb	gscb	0
BONDS			pgb*gbk		-pgb*gbs			0
EQUITIES			pe*Ed	-pe*Es				0
OWN FUNDS			OFb			-OFb		0
NET WEALTH		-Vm	-Vk	-Vf	-Dg	-Vb	-Vbc	-K - pla*La-pre*RE
Σ		0	0	0	0	0	0	0

TABLE 3

REVALUATION MATRIX	HOUSEHOLDS		FIRMS	GOVERNMENT	BANKS	CENTRAL BANK
	WORKERS	CAPITALISTS				
LAND		+Δpla*Lak(-1)				
REAL ESTATE	+Δpre*Rem(-1)	+Δpre*ReK(-1)	+Δpre*Rer(-1)			
BONDS		+Δpgb*gbk (-1)		-Δpgb*gbs (-1)		
EQUITIES		+Δpe*Ed(-1)	-Δpe*Es(-1)			
OWN FUNDS		+ΔOFb			-ΔOFb	
OTHER		+pla*Δlas				

Model equations

Equations in the model are presented by sector. There are accounting identities which give the residual for flows and stocks, link flows to stocks and solve for equilibrium conditions. Behavioral equations describe endogenous variables determined by other variables and parameters.

- ## Working Households

Working households earn wages, interests on past deposits and pay taxes and interests on their loans (equ.1). They consume out of disposable income and past wealth (equ.3). New loans are issued as a fixed share of new real estate demand (equ.5). We have put aside repayment issues and the variation of the stock of loans depends on new loans (equ.6). Net wealth increases by the current saving flow and capital gains on past real estate stock (equ.8). Net wealth and loans are split between cash, deposits and real estate. Transaction demand for cash is determined as a share of current consumption (equ.9). Demand for deposits depends positively on the interest rate and the disposable income level (equ.10). Demand for real estate is the working households balance-sheet residual, and is implicitly negatively impacted by the level of the interest rate on deposits (equ.11).

Disposable income:

$$(1) \quad Yd^m = \omega_1 * W - T^m + i_{-1}^{bd} * BD_{-1}^m - i_{-1}^m * L_{-1}^m$$

Income taxes:

$$(2) \quad T^m = \theta_1 * (\omega_1 * W + i_{-1}^{bd} * BD_{-1}^m)$$

Consumption:

$$(3) \quad C^m = \alpha_1 * Yd^m + \alpha_2 * V_{-1}^m$$

Gross saving:

$$(4) \quad S^m = Yd^m - C^m$$

New loans:

$$(5) \quad \Delta L^m = \alpha_3 * p^{re} * \Delta RE^m$$

Demand for loans:

$$(6) \quad L^m = L_{-1}^m + \Delta L^m$$

Capital gains:

$$(7) \quad CG^m = \Delta p^{re} * RE^m_{-1}$$

Net wealth:

$$(8) \quad V^m = V^m_{-1} + S^m + CG^m$$

Demand for cash:

$$(9) \quad H^m = \alpha_4 * C^m$$

Money deposits:

$$(10) \quad BD^m = (V^m + L^m - H^m) * [\left(\alpha_{10} + \alpha_{11} * i^{bd}\right) + \alpha_{12} * \frac{Yd^m}{V^m + L^m - H^m}]$$

Real stock of real estate:

$$(11.A)\ Re^m = (V^m + L^m - H^m) * \frac{\left[(\alpha_{20} - \alpha_{21} * i^{bd}) - \alpha_{22} * \frac{Yd^m}{V^m + L^m - H^m}\right]}{p^{re}}$$

Real estate as a residual:

$$(11) \quad Re^m = \frac{V^m + L^m - H^m - BD^m}{p^{re}}$$

- Capitalist households

Capitalist households' current transaction equations are similar to working households, except that they receive dividends from both firms and banks (equ.12). The stock of land in real terms is constant (equ.16) and land is supplied on demand (equ.17). As explained previously, sales of land increase capitalists net wealth (equ.18). Capital gains are made on equities, bonds, real estate, land. Own funds of banks are also included (equ.19). Investible wealth is derived from subtracting cash, land and own funds from net wealth (equ.21). The portfolio equations (equ.22-25) rely on tobinesque principles[2]. Once again, deposits act as a residual on capitalists' balance-sheet. Real estate is considered a non-financial investment asset that yields capital gains (equ.26). The equity yield is a dividend one (equ.27), as including capital gains didn't permit the model to solve. Demand

[2] Godley and Lavoie, 2007, p.142.

for equities in real terms is the stock market equilibrium condition, as the portfolio equation for equities (equ.23) determines their price.

Disposable income:

$$(12)\quad Yd^k = \omega_2 * W + FD^f + FD^b + i_{-1}^{bd} * BD_{-1}^k + GB_{-1}^k - T^k$$

Income taxes:

$$(13)\quad T^k = \theta_2 * (\omega_2 * W + FD^f + FD^b + i_{-1}^{bd} * BD_{-1}^k + GB_{-1}^k)$$

Consumption:

$$(14)\quad C^k = \beta_1 * Yd^k + \beta_2 * V_{-1}^k$$

Saving:

$$(15)\quad S^k = Yd^k - C^k$$

Real land stock:

$$(16)\quad La^k = La_{-1}^k$$

Real land sales:

$$(17)\quad \Delta La^s = \Delta La^d$$

Wealth:

$$(18)\quad V^k = V_{-1}^k + S^k + CG^k + p^{la} * \Delta La^s$$

Capital gains:

$$(19)\quad CG^k = \Delta p^{re} * RE_{-1}^k + \Delta p^e * E_{-1}^d + \Delta p^{gb} * GB_{-1}^k + \Delta p^{la} * La_{-1}^k + \Delta OF^b$$

Demand for cash:

$$(20)\quad H^k = \beta_3 * C^k$$

Investible wealth:

$$(21)\quad Vf^k = V^k - H^k - p^{la} * La^k - OF^b$$

Demand for real estate in real terms:

$$(22)\quad Re^k = Vf^k * \frac{\left[\beta_{20} - \beta_{21} * i^{bd} + \beta_{22} * r^{re} - \beta_{23} * r^e - \beta_{24} * r^{gb} - \beta_{25} * \frac{Yd^k}{Vf^k}\right]}{p^{re}}$$

Equity price:

$$(23)\quad p^e = Vf^k * \frac{\left[\beta_{30} - \beta_{31} * i^{bd} - \beta_{32} * r^{re} + \beta_{33} * r^e - \beta_{34} * r^{gb} - \beta_{35} * \frac{Yd^k}{Vf^k}\right]}{E^d}$$

Demand for government bonds in real terms:

$$(24)\quad GB^k = Vf^k * \frac{\left[\beta_{40} - \beta_{41} * i^{bd} - \beta_{42} * r^{re} - \beta_{43} * r^e + \beta_{44} * r^{gb} - \beta_{45} * \frac{Yd^k}{Vf^k}\right]}{p^{gb}}$$

Demand for Deposits:

$$(25)\quad BD^k = Vf^k - p^{re} * RE^k - p^e * E^d - p^{gb} * GB^k$$

Real estate yield:

$$(26)\quad r^{re} = \frac{\Delta p^{re}}{p^{re}_{-1}}$$

Dividend yield:

$$(27)\quad r^e = \frac{\Delta p^e}{p^e_{-1}} + \frac{FD^f}{p^e_{-1} * E^d_{-1}}$$

Stock market equilibrium:

$$(28)\quad E^d = E^s$$

- Firms

Output is the sum of households' consumption, construction of dwellings, firms' investment and government expenditure (equ.29). The wage bill is determined as a share of national income

(equ.30). Firms distribute dividends out of past net profits (equ.34) and retain the residual profit (equ.35). The growth of the capital stock depends on a profit ratio to past capital stock, the growth rate of output, and the level of the interest rate on firms' loans (equ.36). Gross investment is determined both by the growth rate and the depreciation rate of the capital stock (equ.37). The supply of equities is constant (equ.39), so that the residual financial need of firms is met by their demand for loans (equ.40). New dwellings in real terms are determined by the current demand for real estate in real terms and an adjustment towards a target of unsold real estate (equ.41) being a ratio to current sales of real estate[3] (equ.41). Demand for land in real terms is set as a ratio of new dwellings (equ.44). The change in the real stock of unsold real estate (equ.47) is the difference between sales (equ.46) and new real estate (equ.45). The real estate price is a weighted sum of dwellings price and land price (equ.48). Land price is determined by the growth rate of unsold real estate normalized by output growth (equ.49).

Output:

$$(29)\quad Y = C^m + C^k + \Delta DW + I + G$$

Wage bill:

$$(30)\quad W = \gamma_1 * Y$$

Realized profits:

$$(31)\quad F^f = Y - W - i^f_{-1} * L^f_{-1}$$

Taxes on profits:

$$(32)\quad T^f = \theta_3 * F^f$$

Net profits:

$$(33)\quad FN^f = F^f - T^f$$

Dividends of firms:

$$(34)\quad FD^f = \gamma_2 * FN^f_{-1}$$

[3] See Godley and Lavoie, 2007, p.286 for a similar although different assumption as there are no expectations in the present model.

Retained earnings:

$$(35)\quad FU^f = FN^f - FD^f$$

Growth of capital stock:

$$(36)\quad k = \gamma_3 + \gamma_4 * \frac{F^f}{K_{-1}} + \gamma_5 * \frac{\Delta y}{y_{-1}} - \gamma_6 * i^f_{-1}$$

Gross investment:

$$(37)\quad I = (k + \delta) * K_{-1}$$

Capital stock:

$$(38)\quad K = K_{-1} * (1 + k)$$

Nominal amount of new dwellings:

$$(39)\quad \Delta DW = p * \Delta dw$$

Real amount of new dwellings:

$$(40)\quad \Delta dw = \Delta Re^v + \gamma_7 * (Re^{rt} - Re^r_{-1})$$

Real demand for land:

$$(41)\quad \Delta La^d = \rho_1 * \Delta dw$$

Real amount of new real estate:

$$(42)\quad \Delta Re^n = \Delta dw$$

Real sales of real estate:

$$(43)\quad \Delta Re^v = \Delta Re^m + \Delta Re^k$$

Real amount of unsold real estate:

$$(44)\quad Re^r = Re^r_{-1} + \Delta Re^n - \Delta Re^v$$

Unsold real estate target:

$$(45)\quad Re^{rt} = \gamma_8 * \Delta Re^v$$

Real estate price:

$$(46)\quad p^{re} = p + \rho_1 * p^{la}$$

General Price level:

$$(47)\quad p = \overline{p}$$

Price of land:

$$(48)\quad p^{la} = p^{la}_{-1} + p^{la}_{-1} * (\gamma_9 * (1 - \frac{\Delta Re^r}{Re^r_{-1}} / \frac{\Delta Y}{Y_{-1}}))$$

Stock market equilibrium:

$$(49)\quad E^s = \overline{E}^s$$

Demand for loans:

$$(50)\quad L^f = I + p^{re} * \Delta Re^r - FU^f - p^e * \Delta E^s + L^f_{-1}$$

- Private banking sector

The banking sector's profits are determined by the difference between interests received on loans to firms, working households and government bills, and interests paid on deposits (equ.50). The other current transaction equations are similar to those of firms (equ.51-54). The change in own funds is determined by retained profits (equ.55). Banks have reserve requirements on deposits (equ.56). Banks' balance-sheet residual is their demand for government bills (equ.57).

Realized profits:

$$(51)\quad F^b = i^f_{-1} * L^f_{-1} + i^m_{-1} * L^m_{-1} + i^{gs}_{-1} * GS^b_{-1} - i^{bd}_{-1} * BD^m_{-1} - i^{bd}_{-1} * BD^k_{-1}$$

Taxes on profits:

$$(52)\quad T^b = \theta_4 * F^b$$

Net profits:

(53) $FN^b = F^b - T^b$

Dividends of banks:

(54) $FD^b = \delta_1 * F^b_{-1}$

Retained earnings:

(55) $FU^b = FN^b - FD^b$

Own funds of banks:

(56) $OF^b = OF^b_{-1} + FU^b$

Reserve requirements:

(57) $RES^d = \delta_2 * (BD^m + BD^k)$

Demand for government bills (balance-sheet constraint):

(58) $GS^b = BD^m + BD^k + OF^b - RES^d - L^f - L^m$

Wealth:

(59) $V^b = V^b_{-1} - \Delta OF^b$

- Central bank

The central bank transfers all its profits to the government (equ.59) and supplies reserves and cash on demand (equ.60-61). The demand for government bills is the central banks' balance sheet residual (equ.62).

Central bank profits:

(60) $T^{cb} = i^{gs}_{-1} * GS^{cb}_{-1}$

Supply of reserves:

(61) $RES^s = RES^d$

Supply of central bank money:

(62) $H = H^m + H^k$

Demand for government bills (balance-sheet constraint):

(63) $GS^{cb} = RES^s + H$

- Government sector

Government expenditures grow at an exogenous rate epsilon (equ.63). The government deficit is the residual between expenditures and interest payments on bills and bonds, and taxes (equ.64). Bonds are supplied on demand (equ.66) and the bond yield is the bill interest rate plus a fixed mark-up (equ.67). The bond price is the inverse of the yield (equ.68) which also implies that holders of bonds receive 1 for every bond as interest payment. The rate of return on bonds is made of interest and capital gains (equ.69), although to simplify the solving of the model, the price is constant in the current model. The supply of bills is the government's balance-sheet residual (equ.70). Government wealth is equal to its debt, the sum of its liabilities (equ.71).

Government expenditures:

(64) $G = G_{-1} * (1 + \varepsilon_1)$

Government deficit:

(65) $GD = G + i^{gs}_{-1} * GS_{-1} + GB^s_{-1} - T$

Taxes:

(66) $T = T^m + T^k + T^f + T^b + T^{cb}$

Supply of government bonds:

(67) $GB^s = GB^k$

Government bonds yield:

(68) $y^{gb} = i^{gs} + m_{gb}$

Government bonds price:

(69) $p^{gb} = \frac{1}{y^{gb}}$

Rate of return on government bonds:

(70) $r^{gb} = \frac{1+\Delta p^{gb}}{p^{gb}_{-1}}$

Supply of government bills (balance-sheet constraint):

(71) $GS = GS_{-1} + GD - p^{gb} * \Delta GB^{s}$

Wealth:

(72) $DG = -GS - p^{gb} * GB^{s}$

Redundant equation:

(73) $GS = GS^{b} + GS^{cb}$

- Exogenous variables

Interest rate on deposits:

(74) $i^{bd} = i^{res} - m_1$

Mark-up on deposit interest rate:

(75) $m_1 = \bar{m}_1$

Interest rate on loans to households:

(76) $i^{m} = i^{bd} + m_2$

Mark-up on household loans interest rate:

(77) $\boldsymbol{m_2 = \bar{m}_2}$

Interest rate on loans to firms:

(78) $\boldsymbol{i^f = i^{bd} + m_3}$

Mark-up on firm loans interest rate:

(79) $\boldsymbol{m_3 = \bar{m}_3}$

Central bank interest rate:

(80) $\boldsymbol{i^{gs} = i^{res}}$

Interest rate on government bills:

(81) $\boldsymbol{i^{res} = \bar{i}^{res}}$

Mark-up in government bonds yield:

(82) $\boldsymbol{m_{gb} = \bar{m}_{gb}}$

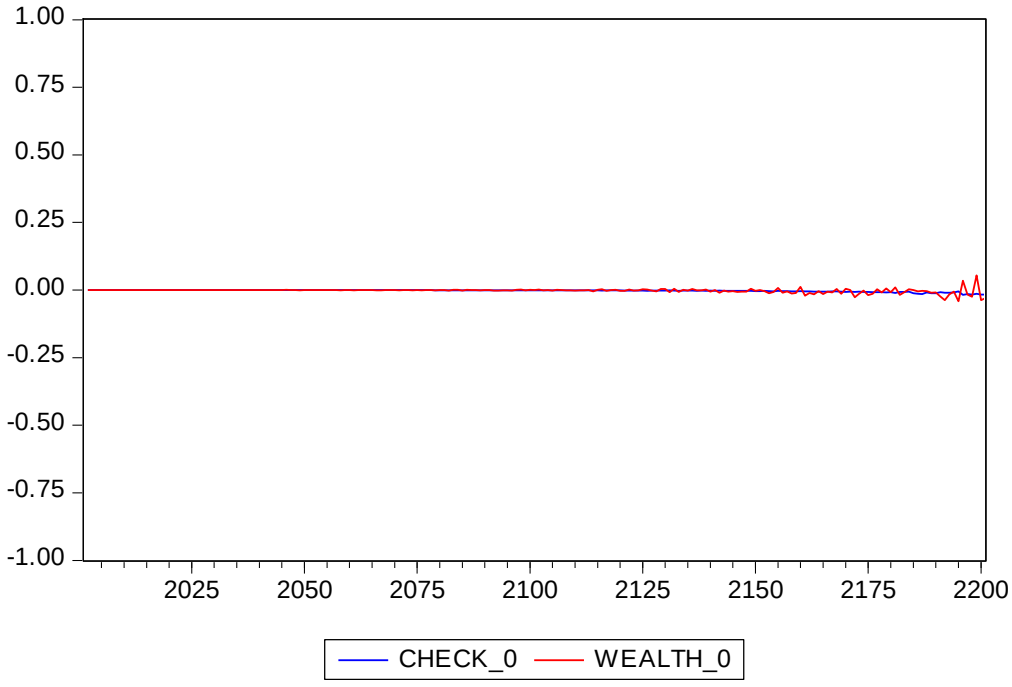
Rate of depreciation of capital:

(83) $\boldsymbol{\delta = \bar{\delta}}$

- **The baseline scenario**

Before simulating macroeconomic scenarios, we present the baseline scenario, which will serve as a reference to compare with different scenarios. It is usefull to

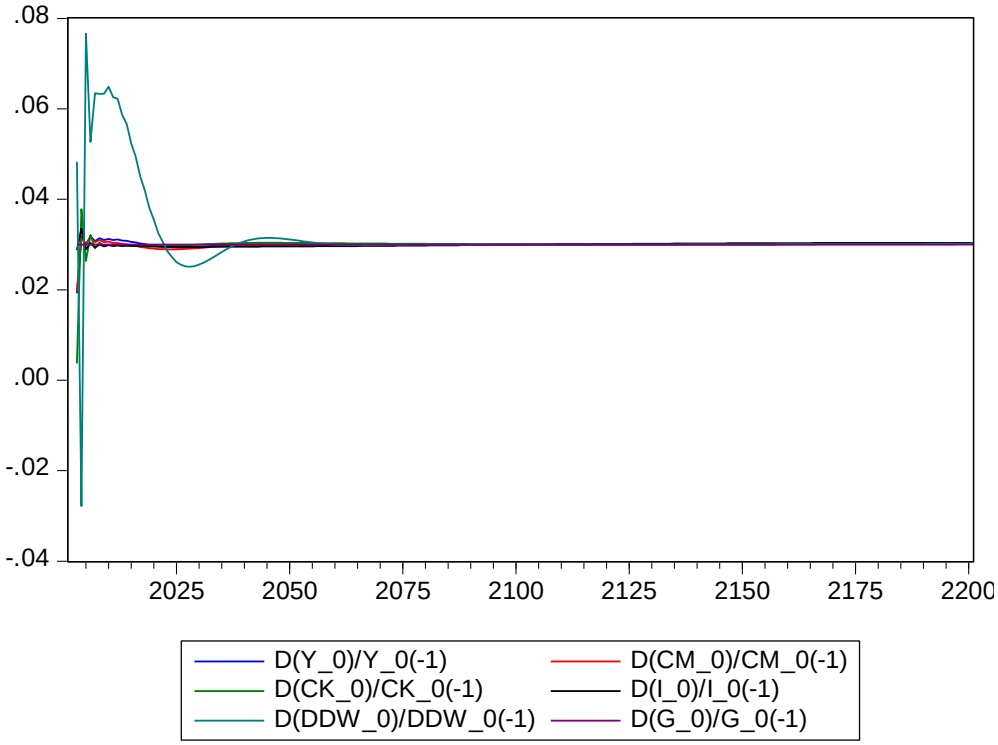
F0.1. Accounting Identities



Two accounting identities are checked, the government bills market equilibrium which is our redundant equation (73), and the aggregate wealth of the economy. The wealth equation checks that the sum of the sectors' net wealth minus the non-financial wealth (productive capital, land and real estate) is zero.

As we can see, after a certain number of periods the identities are not checked, even though they are small. Actually, a perfect zero is never attained but the 'error' should be small enough to permit us to claim accounting consistency.

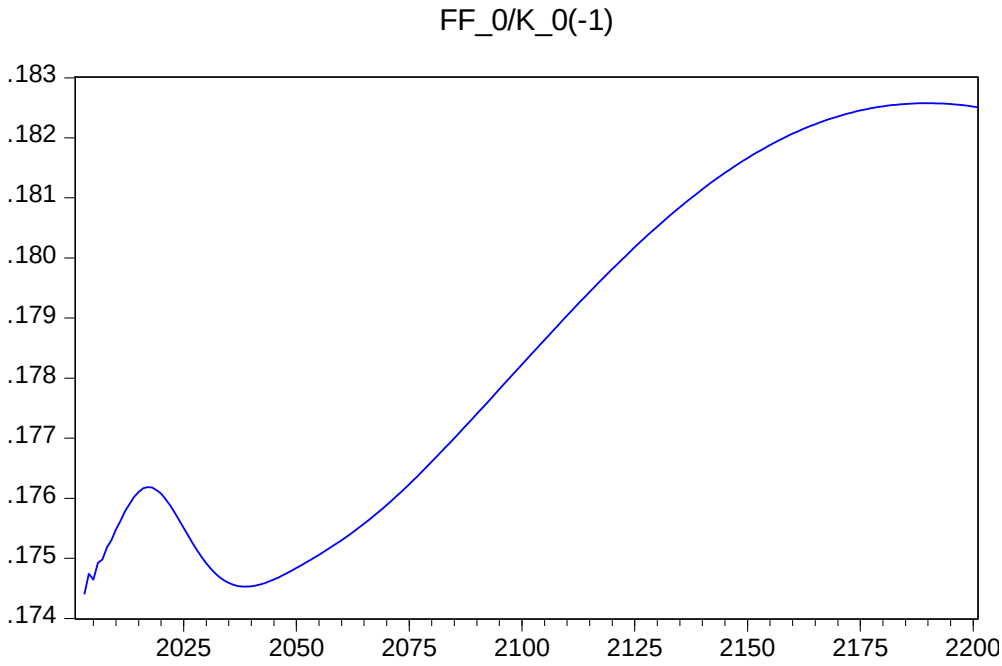
F0.2. GDP Components growth rates



The GDP components, described in the equation 28 are workers consumption (Cm, equation 3), capitalists' consumption (Ck, equation 14), firms' investment (I, equation 36), construction of new dwellings (DDw, equation 38) and government expenditures (G, equation 64). Households' consumptions both represent around 30% of GDP, investment and government expenditures both around 18%, and construction 3-4%.

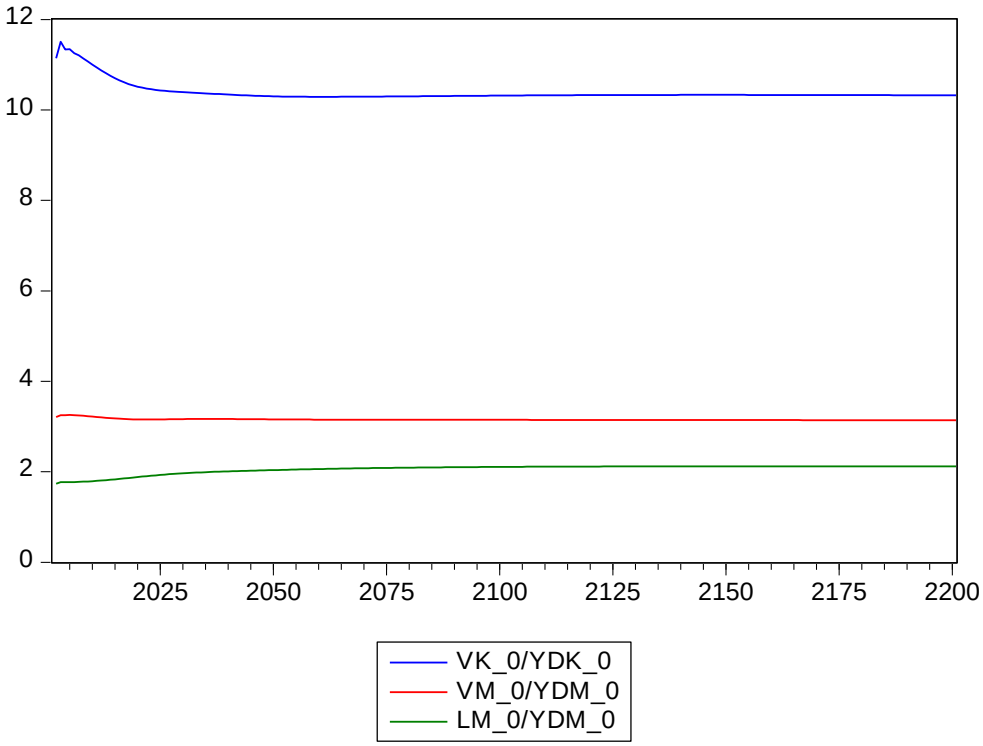
The gross domestic product and its components growth rates converge to approximately 3% after a few periods, driven by the government expenditures growth rate set to an exogenous rate of 3% and the investment growth rate. The construction of new dwellings, which stabilizes at around 4% of GDP, takes over 50 periods to stabilize. This is why shocks on parameters will be performed after 80 periods.

F0.3. Profit Rate



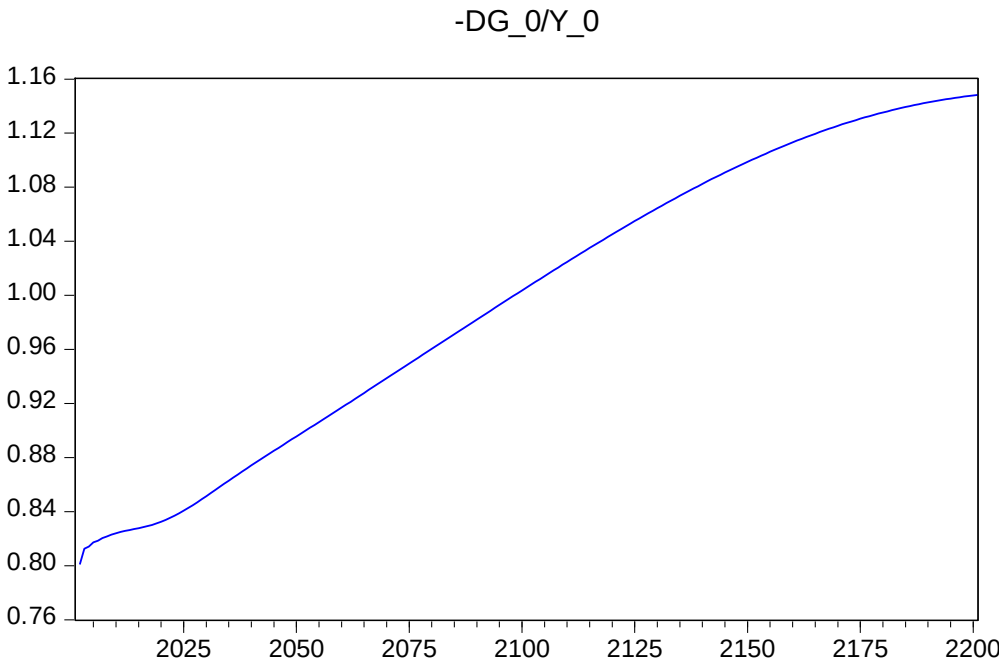
As we can see, the ratio of realized profits of firms (equation 30) over the capital stock (equation 37) takes many periods to converge. If the model was run during a larger number of periods, we would see that this ratio oscillates between 17% and 18%.

F0.4. Households' stock-flow norms



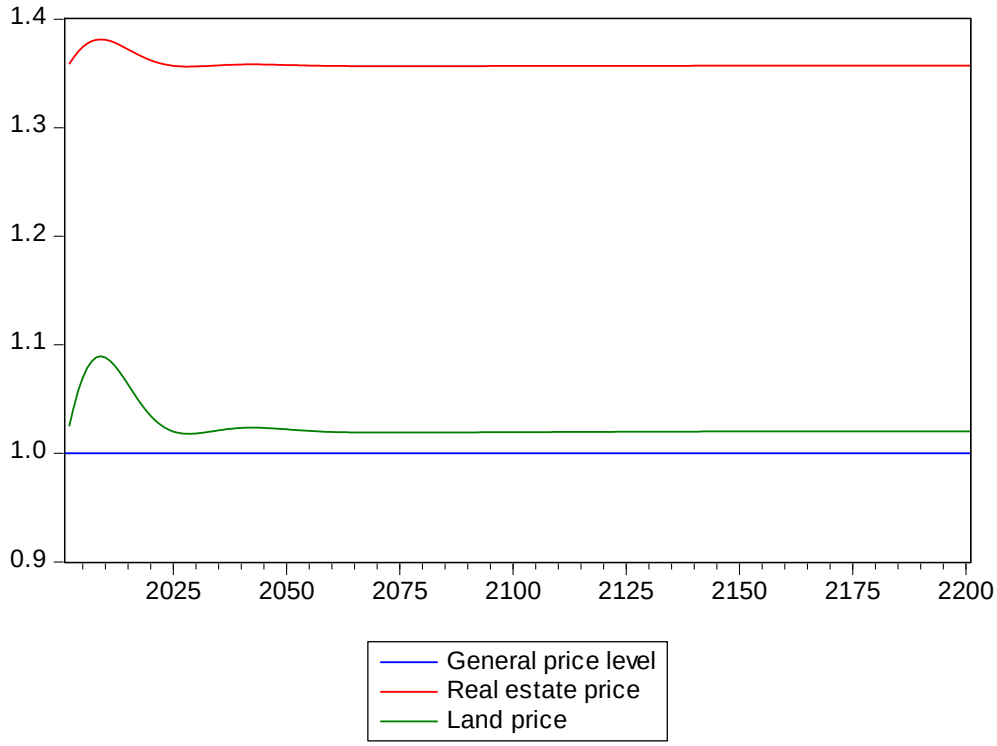
The capitalist households' stock-flow norm of wealth over disposable income converges to 10. Wealth over disposable income and debt over disposable income of working households respectively converge to 3 and 2.

F0.5. Government Debt



Government debt over GDP converges very slowly, above 100% of GDP.

F0.6. Real estate price



The general price level is fixed to 1, with most variables expressed in nominal terms in the model, except for construction, real estate and some financial assets variables. The real estate price being a weighted sum of the land's price and the dwellings price (being the general price), it converges to 1.36.

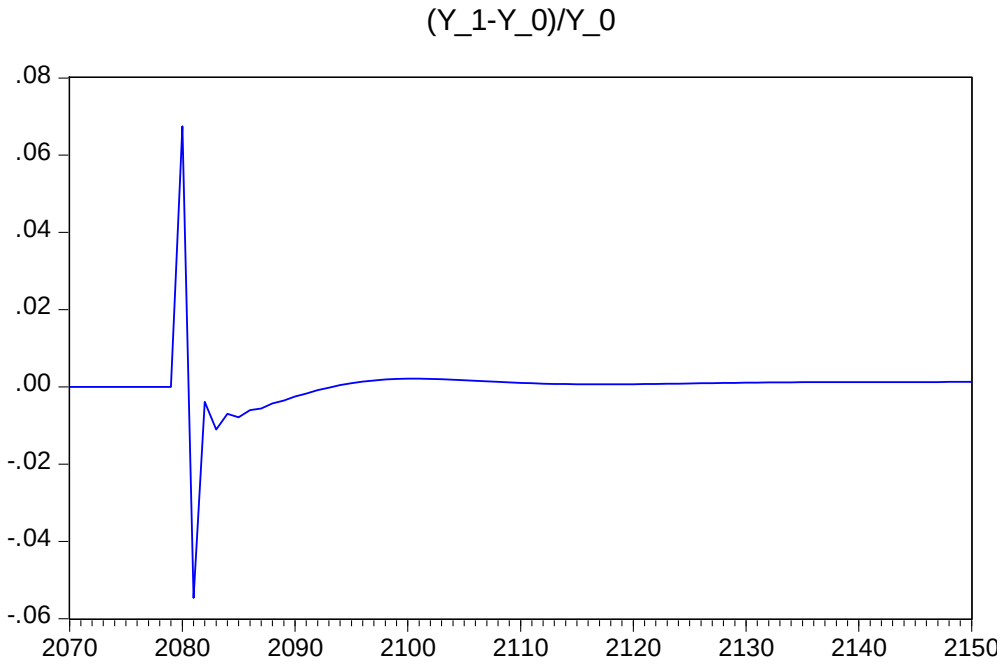
- ## Scenarios

To test the model we perform some simulations by shocking some parameters. We want to see the results our model gives through the channels of transmission of policy shocks, when there is a change in the interest rate reflecting the monetary policy and a change in the government expenditures growth rate for the fiscal policy. Since we have a model with a real estate market, we also shock demand for real estate from households.

Scenario 1: A permanent rise in the central bank interest rate

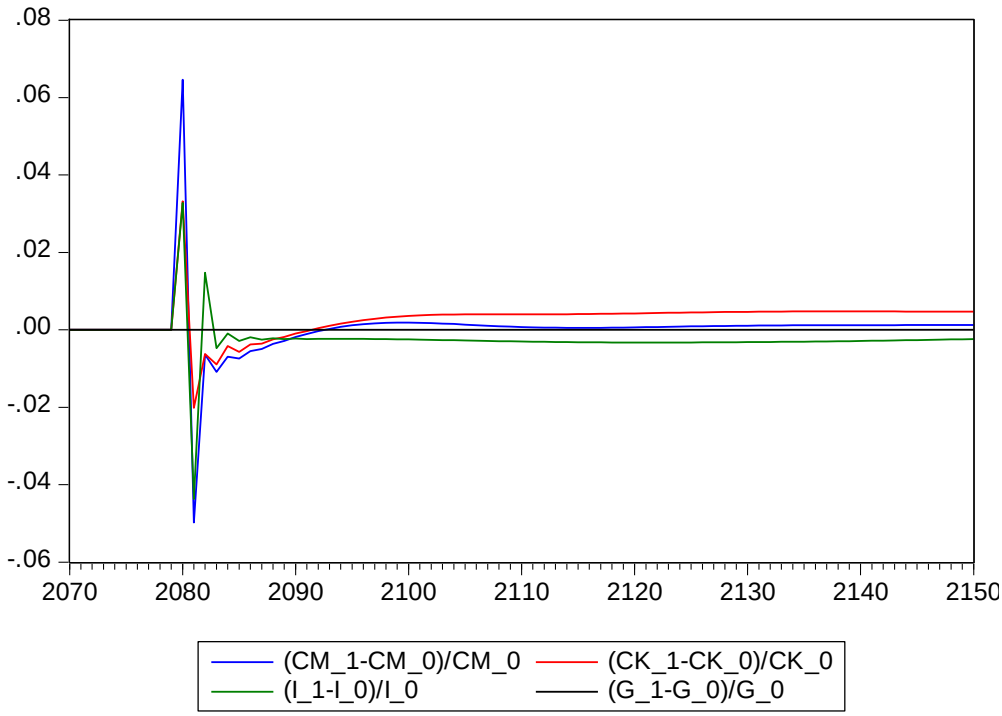
The first scenario is a rise in the central banks' interest rate of over 10 basis points. As all the interest rates have the central bank interest rate as a benchmark, we want to see the effect on debt and portfolios of our sectors.

F 1.1 The GDP Growth Rate



The increase in the central bank's interest rate has a strong effect on GDP in the short term, with a sharp increase followed by a sharp decrease in the scenario's GDP growth rate relative to that of the baseline. It stays below the baseline growth rate for a few periods before it converges again. The initial sharp variations are due to the model adjusting, which shows a high sensitivity of the model variables to the interest rates. It also shows that in this model, there is no long term effect of a small increase in the interest rate on the GDP growth rate.

F 1.2 GDP Components

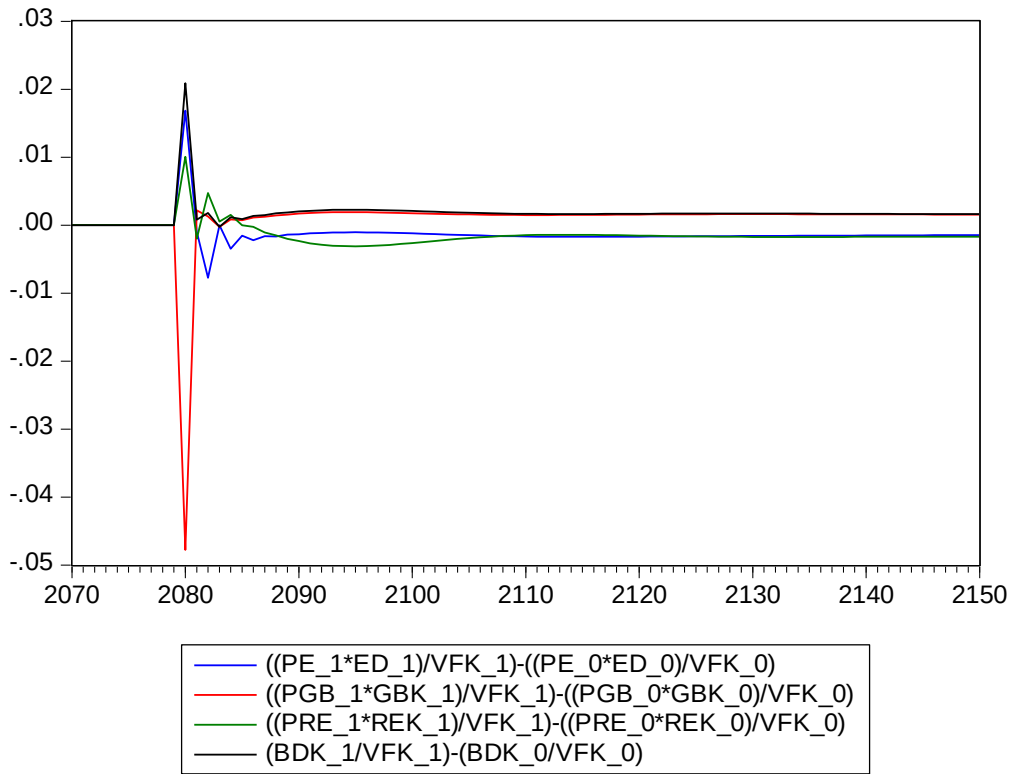


These short term effects are due to the strong reaction of capitalists to an initial decline in the government bonds' price. This generates a stronger demand for other assets including real estate, which boosts construction although demand from workers is lower as it is more interesting to save in the form of deposits with a higher interest rate.

The stronger demand for equity generates immediate capital gains which are fueled in consumption and affect investment, production and revenue, and therefore workers consumption as well.

This effect is corrected in the next period as the yield on government bonds goes up with the interest rates and capitalists rebalance their portfolio. This has an adverse effect on capital gains on equities and therefore a negative impact on consumption and production.

F 1.3 Assets as a share of capitalists' investable wealth



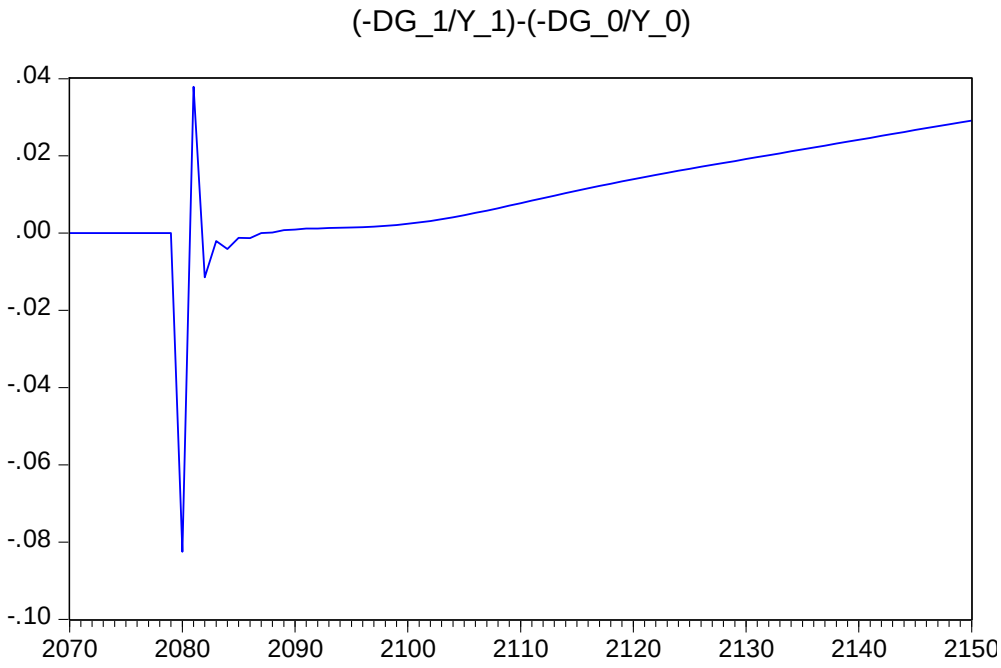
Firms also overreact to the initial increase in real estate demand and then need to adjust the level of unsold real estate by reducing construction.

In the longer run, and due to the capitalists rebalancing of their portfolio towards interest bearing assets (government bonds and deposits), households' consumptions are higher than in the baseline. Therefore, this rentier effect, and due to the income generated by capitalists' consumption has a positive, although scarce effect on workers consumption.

Investment is lower due to a higher cost of financing. Construction converges to a lower level than the baseline due to a persistent, although relatively small, lower demand from capitalists.

Finally, the government debt relative to GDP is higher than the baseline in the long run due to higher interest payments on government bonds, passively supplying them to capitalists that have a larger demand than in the baseline scenario.

F 1.4 Public debt as a percentage of GDP

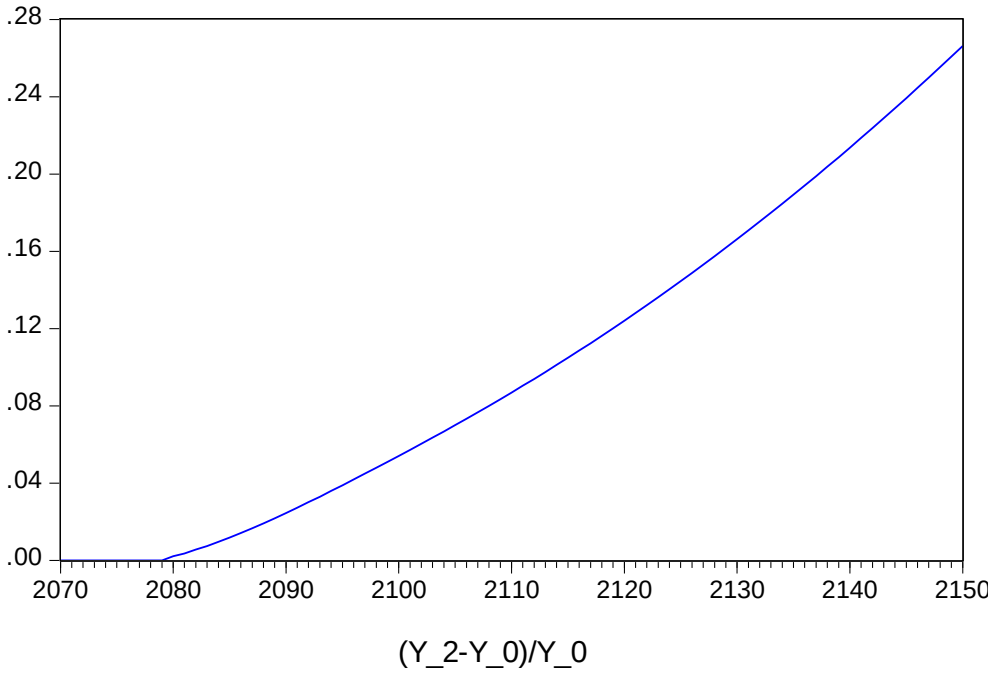


This scenario is interesting as a relatively small change in the interest rate has strong initial effects on GDP and persistent effects on the structure of the economy.

Scenario 2: A permanent rise in government expenditures

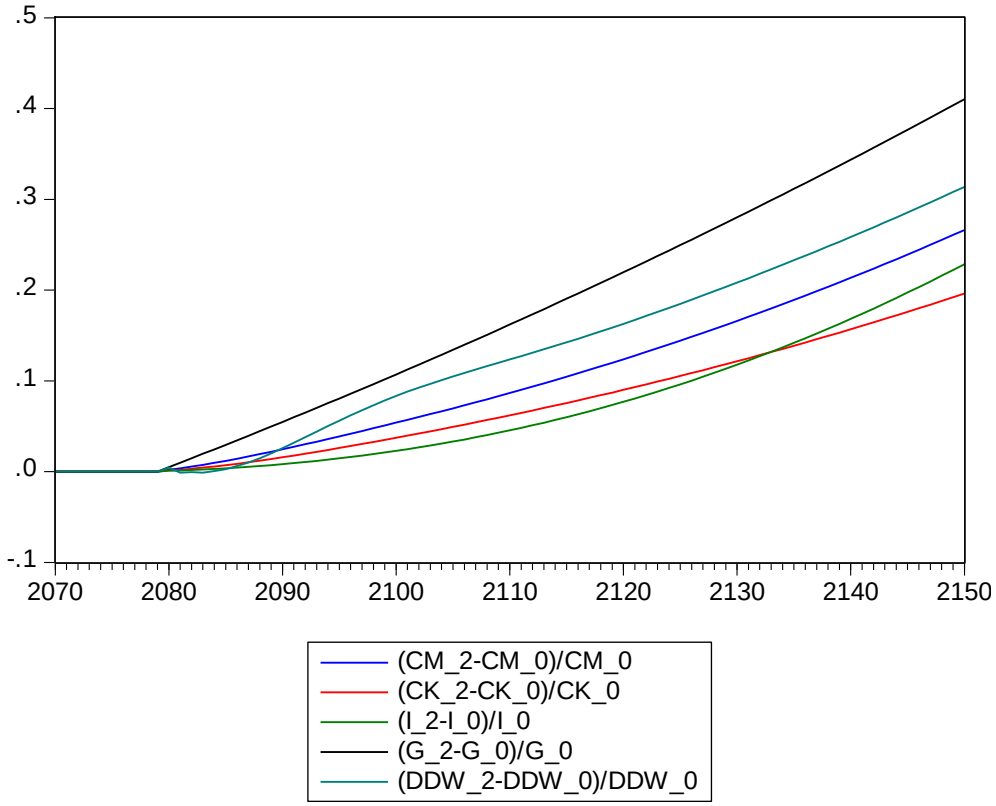
This second scenario bears an increase in the government expenditures growth rate, from 3% to 3.5% per period.

F 2.1 The GDP Growth Rate



In this scenario, as expenditures increase permanently at a higher growth rate, the GDP diverges from that of the baseline.

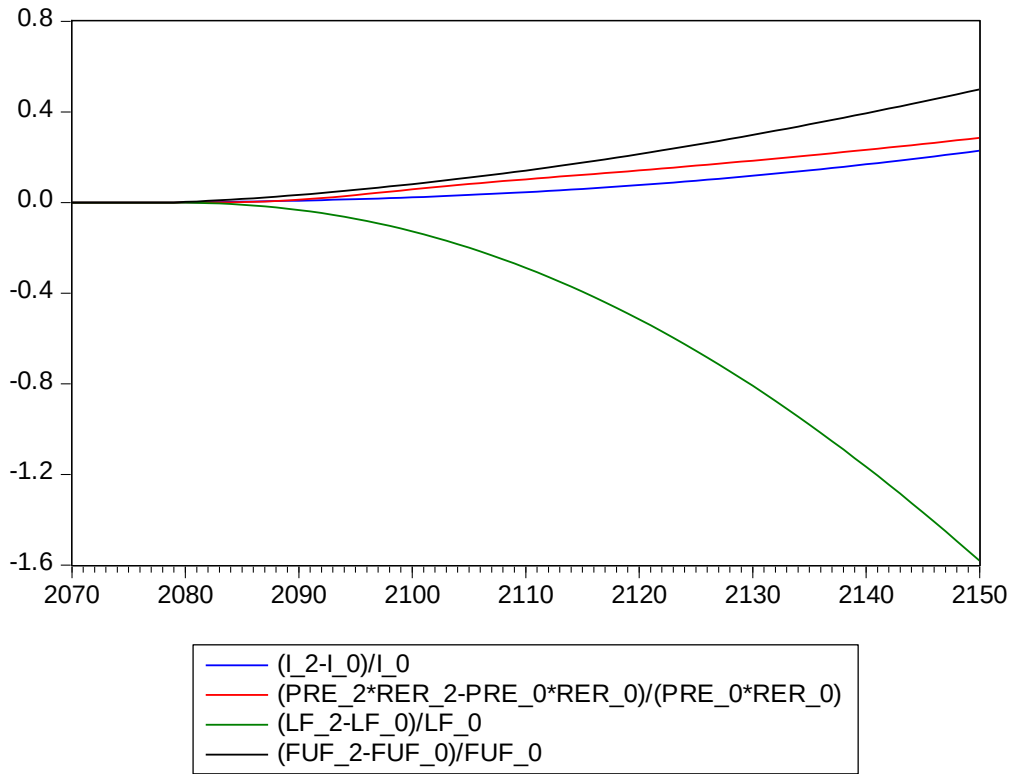
F 2.2 GDP Components



All GDP components diverge positively from the baseline. Capitalists' consumption bears the smallest divergence in the long run.

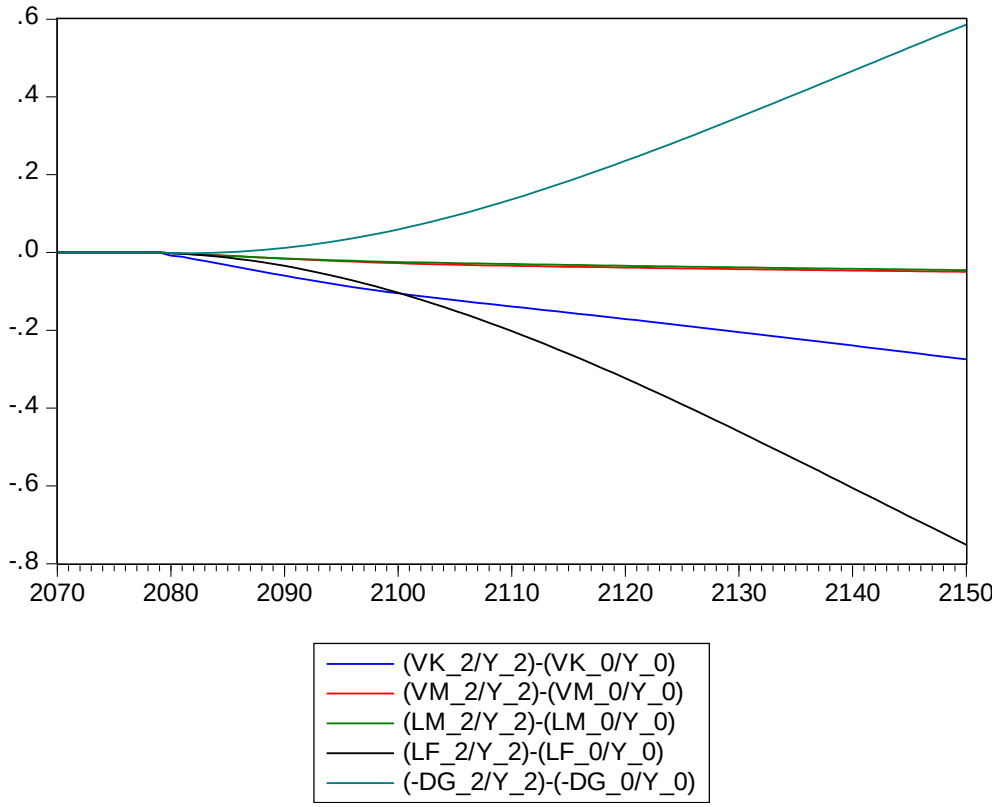
This is because wealth of capitalists grows slower than disposable income, therefore affecting consumption growth. This happens through the impact of relatively smaller distributed profits from banks that diverge negatively from the baseline. Banks' profits are affected by a higher capacity of firms to finance themselves through retained profits. Firms' indebtedness towards banks diverges negatively from the baseline impacting negatively their interest payments to the banks. Also, capitalists demand a relatively larger amount of equities, due to high distributed profits. Their demand for government bonds is relatively smaller. Thus, the government issues relatively more short term bills bought by the banks, bearing a lower interest rates than bonds, and therefore affecting negatively banks profits relatively to the baseline.

F 2.3 Firms' balance-sheet constraint



Retained profits FUF diverge positively whereas demand for loans diverges negatively from the baseline and the most strongly compared to other variables in the firms' balance sheet constraint equation (50). It is also an accelerating divergence.

F 2.4 Capitalist and working households' wealth and debt as a percentage of GDP

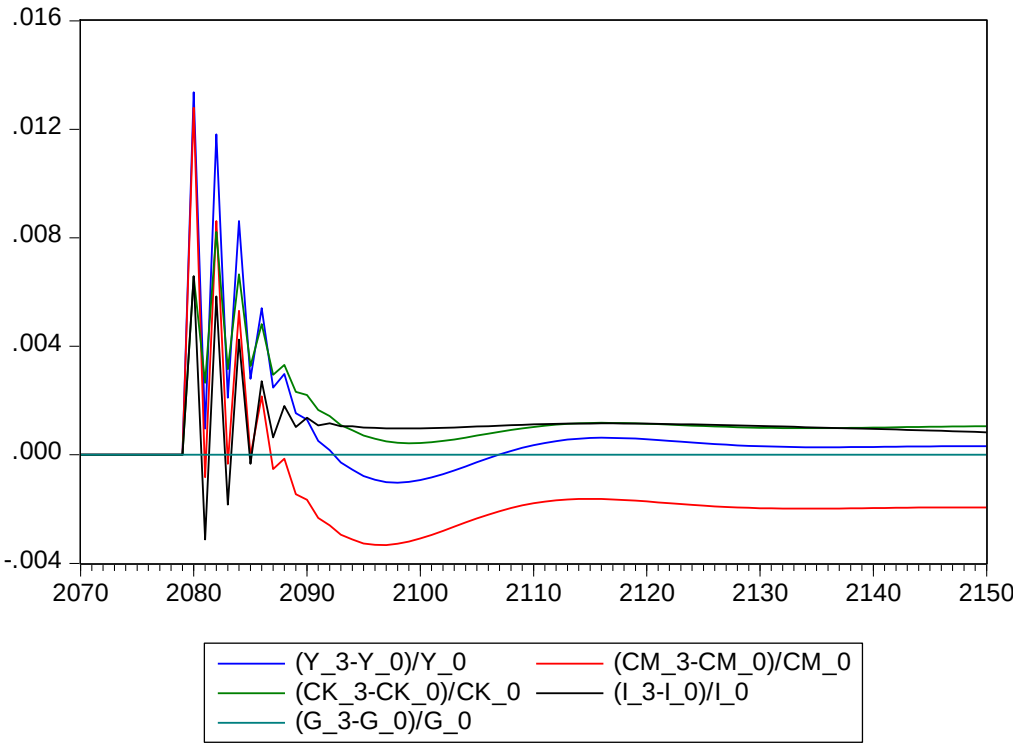


In this scenario, public debt as a percentage of GDP increases and private debt as a percentage of GDP decreases, especially for firms. This translates to a transfer of private to public debt, due to larger public expenditures. It is interesting to notice that working households' net wealth and debt in percentage of GDP decreases, but less than that for capitalists. In this scenario, the effect of larger public expenditures reduces wealth inequalities.

Scenario 3: A larger demand of real estate from working households

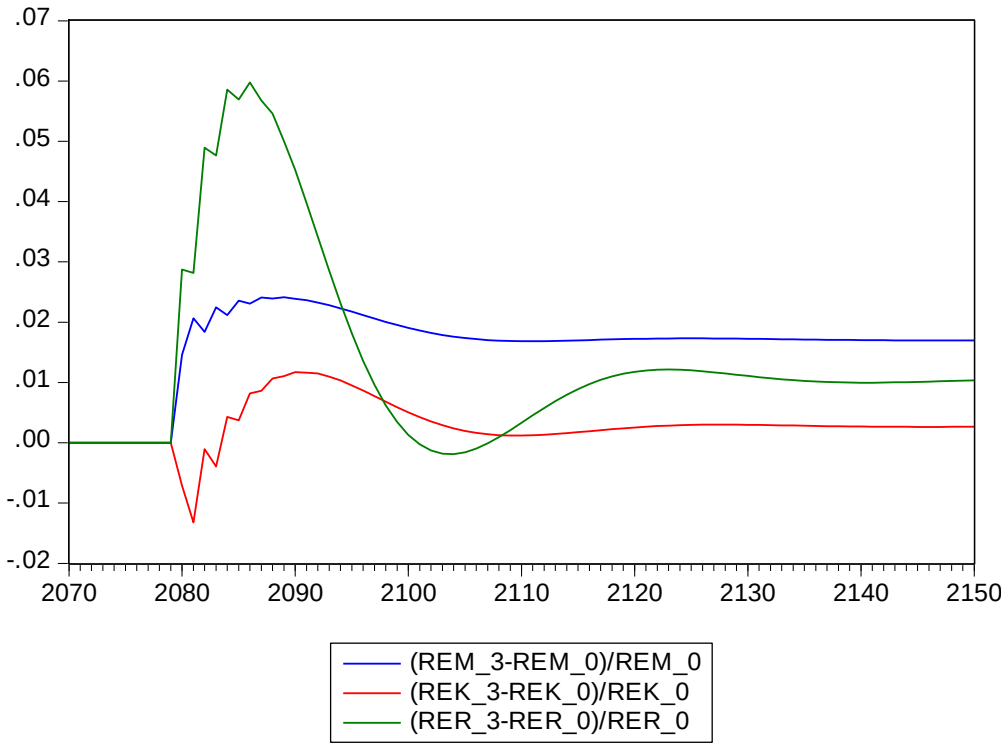
In this scenario we decrease workers household autonomous demand for deposits from 31.5% of gross wealth to 31%, inducing a parallel increase in workers' autonomous demand for real estate.

F 3.1 GDP components



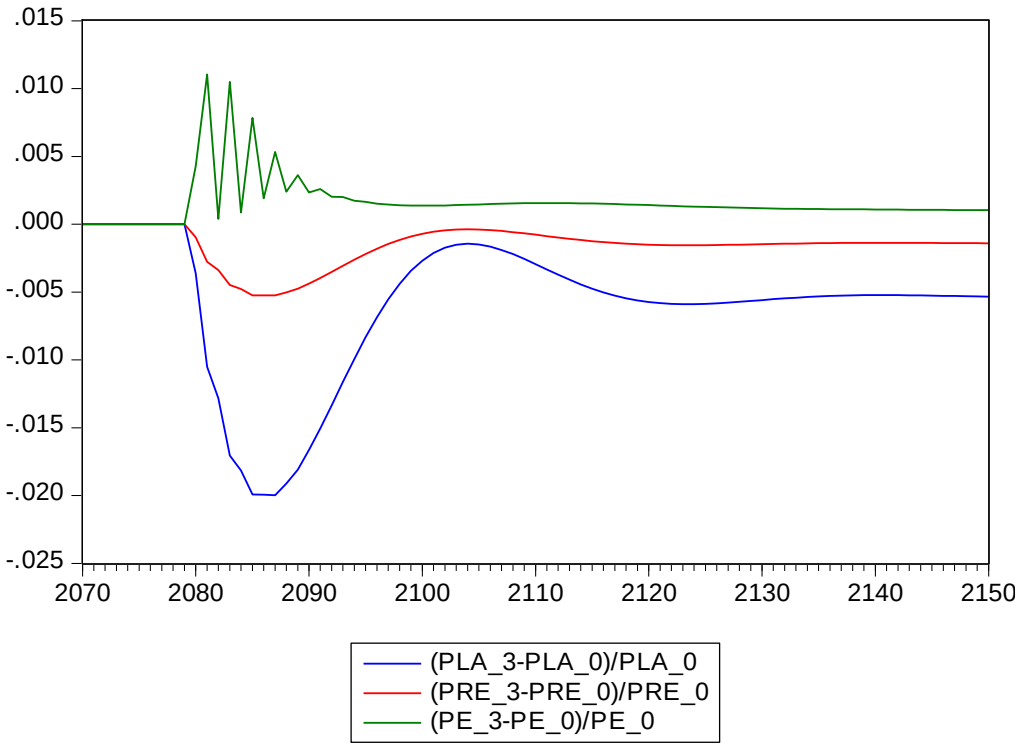
GDP components are very volatile for a few periods. We haven't represented construction of new dwellings relative to the baseline as they follow a similar path with larger variations. Indeed, as unsold real estate is quite low relative to real estate stocks owned by households, the adjustments of construction and their effect on unsold real estate are very large. This is due to their determination in equation 40, linked to the desired amount of unsold real estate from firms adjusting to current sales. This scissor shape is due to constructions affecting firms' flow variables and to adjustments of capitalists portfolio to variations in the price of real estate and equities.

F 3.2 Real estate stocks in real terms

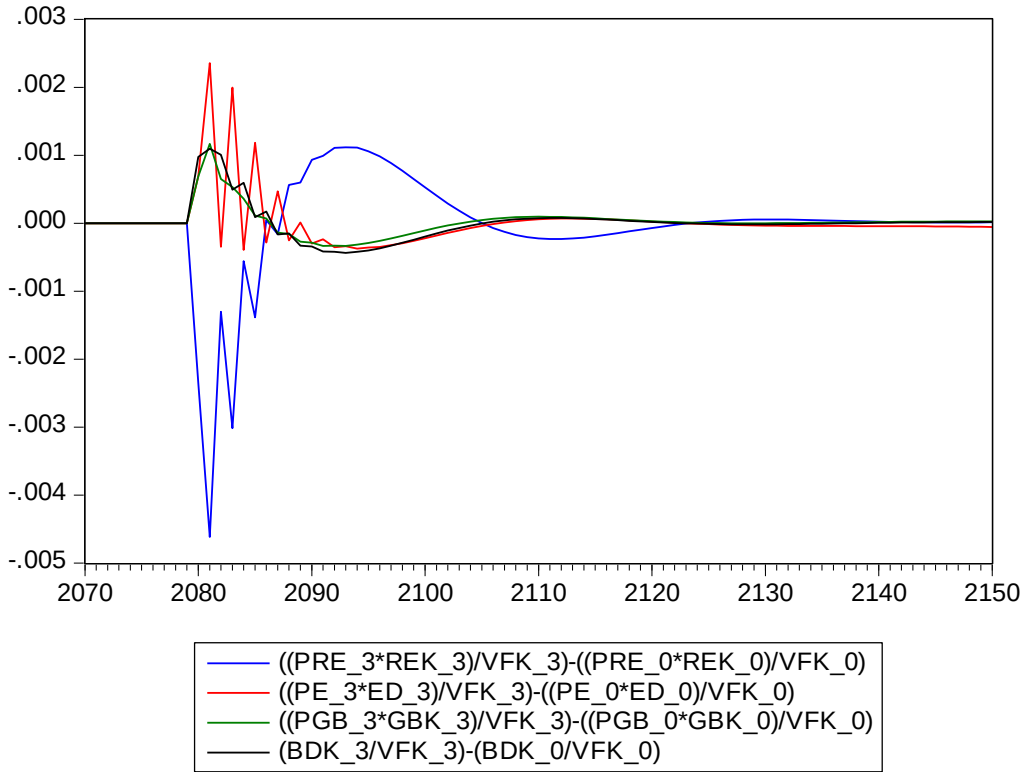


Firms overreact to the increased demand of real estate from working households and unsold real estate soars, affecting negatively land and real estate prices.

F 3.3 Asset prices



F 3.4 Assets as a share of capitalists' investable wealth



The long run effect of this increase in working households' demand for real estate is very low, with a slightly lower consumption from households relative to the baseline due to larger interest payments and less interests received.

It is interesting to see that capitalists benefit from a larger demand of real estate from working households due to increased financial earnings, especially through banks distributed profits.

Further studies

Some changes that could be brought to the model could be to make real estate and land prices less reactive to changes in unsold real estate, and to tame firms' reaction to larger demands of real estate. It doesn't seem so realistic that prices go down when demand increases. It could also be interesting to make the share of new real estate demanded by working households that is financed by bank loans endogenous. It could be done by introducing the effect of the interest rate on loans instead of having an indirect effect through the interest rate on deposits. It could also be done by having real estate price expectations with a duality between fundamentalists and chartists.

Variables, parameters and initial values

Endogenous variables

WORKING HOUSEHOLDS		
(1)	Ydm	Disposable income
(2)	Tm	Income taxes
(3)	Cm	consumption
(4)	Sm	Gross saving
(5)	ΔLm	New loans
(6)	Lm	Demand for loans
(7)	CGm	Capital gains
(8)	Vm	Net Wealth
(9)	Hm	Demand for cash
(10)	BDm	Demand for deposits
(11)	Rem	Real stock of real estate
CAPITALIST HOUSEHOLDS		
(12)	Ydk	Disposable income
(13)	Tk	Income Taxes
(14)	Ck	Consumption
(15)	Sk	Saving
(16)	Lak	Real land stock
(17)	Δlas	Real land sales

(18)	Vk	Wealth
(19)	CGk	Capital gains
(20)	Hk	Demand for cash
(21)	Vfk	Investible wealth
(22)	Rek	Demand for real estate
(23)	Pe	Price of equities
(24)	GBk	Demand for government bonds
(25)	BDk	Deamand for deposits
(26)	rre	Real estate yield
(27)	re	Dividend yield
(28)	Ed	Demand for equities

FIRMS

(29)	Y	Output
(30)	W	Wage Bill
(31)	Ff	Realized profits
(32)	Tf	Taxes on profits
(33)	FNf	Net profits
(34)	FDf	Dividends of firms
(35)	FUf	Retained earnings
(36)	k	Growth of capital stock
(37)	I	Gross investment
(38)	K	Capital stock

(39)	ΔDW	Nominal amount of new dwellings	
(40)	Δdw	Real amount of new dwellings	
(41)	ΔLad	Real demand for land	
(42)	ΔRen	Real amount of new real estate	
(43)	ΔRev	Real sales of real estate	
(44)	Rer	Real amount of unsold real estate	
(45)	Rert	Unsold real estate target	
(46)	Pre	Real estate price	
(47)	P	Price level	1.0
(48)	Pla	Land price	
(49)	Es	Supply of equities	
(50)	Lf	Demand for loans	

PRIVATE BANKING SECTOR

(51)	Fb	Realized profits
(52)	Tb	Taxes on profits
(53)	FNb	Net profits
(54)	FDb	Dividends of banks
(55)	Fub	Retained earnings
(56)	Ofb	Own funds of banks
(57)	RESd	Reserve requirements
(58)	GSb	Demand for government bills

(59)	Vb	Wealth

CENTRAL BANK

(60)	Tcb	Profits
(61)	RESs	Supply of reserves
(62)	H	Supply of central bank money
(63)	GScb	Demand for government bills

GOVERNMENT SECTOR

(64)	G	Government expenditures
(65)	GD	Government deficit
(66)	T	Taxes
(67)	GBs	Supply of government bonds
(68)	ygb	Government bonds yield
(69)	Pgb	Government bonds price
(70)	rgb	Rate of return on government bonds
(71)	GS	Supply of government bills
(72)	DG	Government debt
(73)	GS	Redundant equation

Exogenous variables

(74)	ibd	Interest rate on deposits	0.02
(75)	m1	Mark-up on deposits	0.0078
(76)	im	Interest rate on loans to households	0.06
(77)	m2	Mark-up on loans to households	0.039

(78)	if	Interest rate on loans to firms	0.068
(79)	m3	Mark-up on loans to firms	0.047
(80)	igs	Interest rate on government bills	0.029
(81)	ires	Central bank interest rate	0.029
(82)	mgb	Mark-up in government bonds yield	0.021
(83)	δ	Rate of depreciation of capital	0.096

Parameters

WORKING HOUSEHOLDS PARAMETERS		
ω1	Share of wage bill	0.58
θ1	Income tax rate	0.15
α1	Consumed proportion of disposable income	0.802581447208839
α2	Consumed proportion of past net wealth	0.0346705481042286
α3	Share of new real estate financed by debt	0.7
α4	Transaction demand for cash	0.025
α10	Parameter in demand for deposits	0.31529367824134
α11	Parameter in demand for deposits	0.5
α12	Parameter in demand for deposits	0.5

CAPITALIST HOUSEHOLDS PARAMETERS		
ω2	Share of wage bill	0.42
θ2	Income tax rate	0.151067999071641

β1	Consumed proportion of disposable income	0.6
β2	Consumed proportion of past net wealth	0.0252951323464388
β3	Transaction demand for cash	0.025
β20	Parameter in demand for real estate	0.320082971067129
β21	Parameter in demand for real estate	0.797087356744215
β22	Parameter in demand for real estate	2.39126207023265
β23	Parameter in demand for real estate	0.797087356744215
β24	Parameter in demand for real estate	0.797087356744215
β25	Parameter in demand for real estate	0.1
β30	Parameter in demand for equities	0.352503886751446
β31	Parameter in demand for equities	0.797087356744215
β32	Parameter in demand for equities	0.797087356744215
β33	Parameter in demand for equities	2.39126207023265
β34	Parameter in demand for equities	0.797087356744215
β35	Parameter in demand for equities	0.1
β40	Parameter in demand for bonds	0.11372721944281
β41	Parameter in demand for bonds	0.797087356744215
β42	Parameter in demand for bonds	0.797087356744215
β43	Parameter in demand for bonds	0.797087356744215
β44	Parameter in demand for bonds	2.39126207023265
β45	Parameter in demand for bonds	0.1

FIRMS PARAMETERS		
$\gamma 1$	Wage bill as share of national income	0.7
$\theta 3$	Profit tax rate	0.2
$\gamma 2$	Dividends as share of past profits	0.202345195583348
$\gamma 3$	Exogenous growth in the stock of capital	0.0142504672713663
$\gamma 4$	Relation between the profit rate and the growth in the stock of capital	0.1
$\gamma 5$	Relation between the growth in output and the growth in the stock of capital	0.04
$\gamma 6$	Relation between the interest rate on loans and the growth in the stock of capital	0.05
$\gamma 7$	Speed of adjustment of unsold real estate stock to the target level	0.15
$\gamma 8$	Target unsold real estate stock to sales ratio	0.2
$\rho 1$	Ratio of land to new dwellings	0.35
$\gamma 9$	Relation between normalized unsold real estate stock growth and land price	0.01

PRIVATE BANKING SECTOR PARAMETERS		
$\theta 4$	Profit tax rate	0.2
$\delta 1$	Dividends as share of past profits	0.74955703550274
$\delta 2$	Reserve requirement parameter	0.1

GOVERNMENT SECTOR PARAMETERS		
$\varepsilon 1$	Growth of government expenditures	0.03

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