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Conventional and unconventional economic policies in an econometric SFC model of the French economy

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Abstract

Based on the national accounts an econometric SFC model of the French economy is presented. It is an aggregate model with a single product distinguishing five domestic agents and the rest of the world with a complete representation of economic and financial accounts in flows and stocks. The structure of the model is close to that of existing SFC models with demand-led dynamics, an accumulation behavior of a Kaleckian type and an indebtedness norm. A new version is proposed with an impact of demand pressure on firms' investment described via an output gap. The dynamic simulations on the past over the period 1996-2019 provide acceptable results. A comparison of the two models, with or without output gap effect on investment, is made with the help of usual multipliers. The results of both models seem close.

The model is used to study the effects of different forms of unconventional monetary policies. First, a distribution of helicopter money in favor of the government to finance additional public investments or social transfers has a stimulating impact without increasing public debt. However, as a counterpart the wealth and own funds of the central bank deteriorate by an amount equivalent to the initial shock. Second, the combination of public indebtedness and repurchase by the central bank is described. The results appear close to the case where there is no repurchase by the central bank. Third, partial cancellation of the public debt held by the central bank is examined. It has, as a counterpart, a degradation of the wealth and own founds of the central bank which are too important to remain without consequences. Taxation of wealthy households to finance social transfers in favor of the bottom income brackets is also simulated and provides positive results. Imported inflationary shocks are studied with various policy responses which are compared; increasing social transfers to support households, increasing wages in the hope of preserving purchasing power, restrictive monetary policy with an increase of interest rates. Last, a simple endogenization of the rate of interest, based on the balance of the public bonds market, has been tested. Results seem close to the results of the model with exogenous interest rates, except for the public finance which worsens further.

Introduction

The financial crisis of 2008 and the Covid crisis have led to increasing public debts and to the launching of unconventional economic policies. Thanks to a complete description of the balance sheets of the domestic and foreign agents, stock flow consistent (SFC) modelling was well-equipped to evaluate the economic consequences of these crises. The founding works of

Godley and Lavoie (Godley, 1999; Lavoie and Godley, 2001; Godley and Lavoie, 2007) on SFC modelling were well-adapted to study financialized economies but were simply calibrated. Since 2005, better calibrated or econometrically-based SFC models became more frequent. The Levy model of the US (Godley et al., 2005) was a forerunner. The econometric SFC model of the Italian economy (Zezza and Zezza, 2020) seems one of the most complete. A first version of an econometric SFC model of the French economy based on the accumulation accounts from INSEE and on the financial accounts of the Bank of France has been presented (Mazier and Reyes, 2022a). It provides the overall structure, the main equations and the basic properties of the model.

This paper is based on the same model with some improvements. The determinants of the structure of the interest rates are more developed. The treatment of the central bank includes the description of the interests received and paid. A key equation of the model, the rate of capital accumulation of the firms, has been modified in order to introduce a demand effect. Also a provisional version of the model with endogenous public bonds interest rate is shown at the end of the paper. These improvements do not change fundamentally the properties of the model but some inflexions can be noticed.

The paper is organized as follows. A second part presents the overall structure of the model. A third part is devoted to the main equations with a focus on the new ones. The simulations on the past are also displayed. A fourth section is devoted to basic shocks with an evaluation of the value of the multipliers of this version of the model compared with a previous one. A fifth section analyzes some forms of unconventional monetary and fiscal policy, helicopter money to finance public investment or social transfers, partial cancellation of public debt held by the central bank and taxation of the wealthiest households. A sixth section evaluates the impact of an imported inflationary shock. A last section gives some proposals towards endogenization of public bonds interest rate. A final part concludes.[1]

Model structure

The economy is divided into five domestic agents: firms, households, banks, the central bank, the government, all of which interact with the rest of the world. The model is aggregate with a single product. Its structure is analogous to that of already existing national-level SFC models. Production in volume is determined by domestic and foreign demand (exports net of imports). The general price level depends on a mark-up pricing rule, and is a function of unit labor costs with an effect from demand pressures. Value added is split among the different agents depending on simple structural parameters. Its distribution between wages, profits and taxes is based on a wage-price-unemployment equation and on institutional relations in order to arrive at the balance of the agents' accounts, that also takes into account their expenditures. Exports and imports are analyzed at the level of all goods and services determined by demand and relative prices. Financing methods via bank credit, bond and equity issuing, as well as financial investment behavior, are described for each agent. Changes in assets and liabilities, as well as investment and changes in inventories, combined with the revaluation accounts for capital gains or losses, allow for the transition of the accumulation

[1] The complete working paper of the first version and the technical documentation are available on the website of the *Chaire Energie et Prospérité*.

accounts from one year to the next in an SFC manner. The balance sheet structure of the domestic and foreign agents (Table 1) and the uses-resources table combined with the flow of funds (Table 2) provide the definition of the main variables of the model. Although not fully consistent with a post-Keynesian approach, a supply constraint is introduced, mainly for empirical reasons. It results in a simple production function that determines potential output and allows for computation of an output gap. Its impact on accumulation rate of firms and on inflation appears significant and representative of demand pressure.

The main closures are the following:

- Firms balance their accounts by issuing the necessary shares.
- Households balance their account by getting into debt with banks.
- Bank reserves balance the banks' accounts.
- The equilibrium between assets and liabilities of the central bank corresponds to the missing equation of the model deducted from the writing of the other balances.
- Public debt, in the form of bank debt and bonds, balances the government's account.
- Deposit liabilities, as representative of foreign deposits held by domestic agents, adjust the rest of the world's account.
- Banks absorb all public bonds available and extend credit without restriction.
- Banks balance the market of private domestic bonds and the domestic equities market, whose price depends on the price of foreign equity, which has a dominant effect.
- Foreign bonds and equity issued by the rest of the world equal their domestic demand.

Some more specific points can be underlined:

- With respect to non-financial assets, a distinction is made between produced capital (productive capital and housing), outstanding stocks and non-produced capital (land), whose sharp rise is one of the characteristics of financialized capitalism.
- The item TARGET2 deserves particular attention, and corresponds to the balance of the real and financial exchanges between France and the rest of the Eurozone, and is considered exogenous because its determinants lie largely outside of the model. It is, respectively, on the asset side of Bank of France and on the liability side for the European Central Bank (ECB) thus appearing in the column rest of the world since the monetary and financial operations from the ECB are included there in the statistical convention that has been adopted.
- The treatment of Other Changes in Volume (OCV) and of revaluations is important and rather technical. Without delving into the details, it suffices to say that for each item of the balance sheet an OCV or asset price must be accounted for/computed in order to ensure stock-flow consistency.
- An adjustment item appears between the capital account and the financial account. It corresponds to a statistical discrepancy between the real sector accounts from INSEE and the financial accounts by Bank of France.

Table 1 Balance sheet structure of economic agents

		Non-Fin. Corporations		Financial institutions: Banks		Financial institutions: Banque de France		Government		Households + NPISH		Rest of the world	
		Asset	**Liab.**	**Asset**	**Liab.**	**Asset**	**Liab.**	**Asset**	**Liab.**	**Asset**	**Liab.**	**Asset**	**Liab.**
ANF_1	*Produced non-financial assets*	$p^F_{K_1}K^F_1$		$p^B_{K_1}K^B_1$				$p^G_{K_1}K^G_1$		$p^H_{K_1}K^H_1$			
ANF_{12}	*Inventories (12) + valuables (13)*	$p^F_{K_{12}}K^F_{12}$						$p^F_{K_{12}}K^F_{12}$		$p^F_{K_{12}}K^F_{12}$ $p^F_{K_{13}}K^F_{13}$			
ANF_2	*Non-produced non-financial assets*	$p^F_{K_2}K^F_2$		$p^B_{K_2}K^B_2$				$p^G_{K_2}K^G_2$		$p^H_{K_2}K^H_2$			
F_1	*Monetary gold and SDRs*					$p^{CB}_G G^{CB}$							$p^{CB}_G G^{CB}$
F_2	*Bills and coins*	H^F		H^B			H			H^H		H^R	
	Digital currency	EH^F		EH^B			EH^{CB}_L	EH^G		EH^H			
	Refinancing between financial institutions				RF	RF^{CB}							RF^R
	Bank reserves			RES			RES						
	Govt. account at CB						$D^{CB_G}_L$	$D^{CB_G}_A$					
	Target 2					$TRGT2$							$TRGT2$
	Deposits	D^F_A		D^B_A	D^B_L	D^{CB}_A	D^{CB}_L	D^G_A	D^G_L	D^H_A		D^R_A	D^R_L
F_3	*Public securities*	$p^{F_G}_{B_A}B^{F_G}_A$		$p^{B_G}_{B_A}B^{B_G}_A$		$p^{CB_G}_{B_A}B^{CB_G}_A$			$p^G_{B_L}B^G_L$			$p^{R_G}_{B_A}B^{R_G}_A$	
	Foreign securities	$p^{F_R}_{B_A}B^{F_R}_A$		$p^{B_R}_{B_A}B^{B_R}_A$		$p^{CB_R}_{B_A}B^{CB_R}_A$		$p^{G_R}_{B_A}B^{G_R}_A$		$p^{H_R}_{B_A}B^{H_R}_A$			$p^R_{B_L}B^R_L$
	Other securities		$p^F_{B_L}B^F_L$	$p^B_{B_A}B^B_A$	$p^B_{B_L}B^B_L$	$p^{CB}_{B_A}B^{CB}_A$		$p^G_{B_A}B^G_A$		$p^H_{B_A}B^H_A$		$p^R_{B_A}B^R_A$	
F_4	*Loans*	L^F_A	L^F_L	L^B_A		L^{CB}_A			L^G_L		L^H_L	L^R_A	L^R_L
F_5	*[Domestic] Equity and inv. fund shares*	$p^{F_{FR}}_{E_A}E^{F_{FR}}_A$	$p^F_{E_L}E^F_L$	$p^{B_{FR}}_{E_A}E^{B_F}_A$	$p^B_{E_L}E^B_L$	$p^{CB_{FR}}_{E_A}E^{CB}_A$	$p^{CB}_{E_L}E^{CB}_L$	$p^{G_{FR}}_{E_A}E^{G_{FR}}_A$		$p^{H_{FR}}_{E_A}E^{H_{FR}}_A$		$p^R_{E_A}E^R_A$	
	[Foreign] Equity and inv. fund shares issued by RoW	$p^{F_R}_{E_A}E^{F_R}_A$		$p^{B_R}_{E_A}E^{B_R}_A$		$p^{CB_R}_{E_A}E^{CB_R}_A$		$p^{G_R}_{E_A}E^{G_R}_A$		$p^{H_R}_{E_A}E^{H_R}_A$			$p^R_{E_L}E^R_L$
F_6	*Insurance. pension funds and s.g.s.*	A^F_A			A^B_L			A^G_A		A^H_A		A^R_A	
F_7	*Fin. derivatives and employee stock options*	X^F_A			X^B_L			X^G_A		X^H_A			X^R_L
F_8	*Other accounts receivable/payable*	Z^F		Z^B		Z^{CB}		Z^G		Z^H		Z^R	
F	***Financial wealth***		FW^F		FW^B		FW^{CB}		FW^G		FW^H		FW^R
B90	***Net worth***		$WLTH^F$		$WLTH^B$		$WLTH^{CB}$		$WLTH^G$		$WLTH^H$		$WLTH^R$

Closes the column (sector) in flow Closes the row (instrument) in flow

Table 2 Uses-resources table and flow of funds

		Firms		Financial inst excl BdF		Banque de France		Government		Households		Rest of the world		Total (uses -res.)
Code	**Item**	**paid**	**received**	**paid**	**received**	**paid**	**received**	**paid**	**received**	**paid**	**received**	**paid**	**received**	
P6	Exports											$p_X X$		$p_X X$
P7	Imports												$p_{IM} IM$	$p_{IM} IM$
B11	*Trade balance*												$-TB$	TB
P1	Production		$p_Q Q^F$		$p_Q Q^B$				$p_Q Q^G$		$p_Q Q^H$			$p_Q Q$
P2	Intermediate consumption	$p_{IC} IC^F$		$p_{IC} IC^B$				$p_{IC} IC^G$		$p_{IC} IC^H$				$p_{IC} IC^H$
B1	*Value added*		VA^F		VA^B				VA^G		VA^H			VA
D11	Wages and salaries	W^F_p		W^B_p				W^G_p		W^H_p	W^H_r	W^R_p	W^R_r	0
D12	Labor contributions	LC^F_p		LC^B_p				LC^G_p		LC^H_p	LC^H_r	LC^R_p	LC^R_r	0
D29	Taxes on payroll and miscellaneous taxes on production	T^F_L		T^B_L				T^G_L	T_L	T^H_L			T^R_L	0
D319	Subsidies on production								$-Sub$				$-Sub^R$	$-Sub'$

D39	Other subsidies on production		$-Sub_r^F$		$-Sub_r^B$				$-Sub_r^G$		$-Sub_r^H$		$-Sub_r^R$	$-Sub^*$
D39b	Operating subsidies								$-Sub_r^{G'}$					$-Sub_r^G$
B2	*Gross operating surplus*		Π^F		Π^B		$[\Pi^{CB}]$		$[\Pi^G]$		$[\Pi^H]$			Π
D21	Net taxes on production								T_P				T_P^R	T_P^T
D41	Interest	Int_p^F	Int_r^F	Int_p^B	Int_r^B	Int_p^{CB}	Int_r^{CB}	Int_p^G	Int_r^G	Int_p^H	Int_r^H	Int_p^R	Int_r^R	0
D42	Distributed income of corporations	Div_p^F	Div_r^F	Div_p^B	Div_r^B	Div_p^{CB}	Div_r^{CB}		Div_r^G		Div_r^H	Div_p^R	Div_r^R	0
D43	Reinvested earnings on direct foreign investment	$RFDI_p^F$	$RFDI_r^F$	$RFDI_p^B$	$RFDI_r^B$							$RFDI_p^R$	$RFDI_r^R$	0
D44	Property income attributed to insurance policy holders		INS_r^F	INS_p^B					INS_r^G		INS_r^H		INS_r^R	0
D45	Rents	$RENT_p^F$							$RENT_r^G$	$RENT_p^H$	$RENT_r^H$			0
D5	Taxes on income and wealth	T^F		T^B		T^{CB}			T	T^H		T^R		0
D61	Social contributions		SC_r^F		SC_r^B				SC_r^G	SC_p^H		SC_p^R	SC_r^R	0
D62	Social benefits	SB_p^F		SB_p^B				SB_p^G			SB_r^H	SB_p^R	SB_r^R	0
D7	Transfers	Tr_p^F		Tr_p^B	Tr_r^B			Tr_p^G			Tr_r^H		Tr_r^R	0
B6	*Gross disposable income*		Y_d^F		Y_d^B				Y_d^G		Y_d^H			Y_d
P3	Consumption							$p_C^H C^H$		$p_C^G C^G$				$p_C C$
B8	*Gross saving*		S^F		S^B				S^G		S^H			S
D9	Capital transfers		$Tr_{K_r}^F$		$Tr_{K_r}^B$			$Tr_{K_p}^G$		$Tr_{K_p}^H$		$Tr_{K_p}^R$	$Tr_{K_r}^R$	0
P51	Gross Fixed Capital Formation	$p_{I_1}^F I_1^F$		$p_{I_1}^B I_1^B$				$p_{I_1}^G I_1^G$		$p_{I_1}^H I_1^H$				$p_{I_1} I_1$
P52	Changes in inventories	$p_{I_{12}}^F I_{12}^F$						$p_{I_{12}}^G I_{12}^G$		$p_{I_{12}}^H I_{12}^H$				$p_{I12} I_{12}$
P53	Acquisition less disposals of valuables									$p_{I_{13}}^H I_{13}^H$				$p_{I_{13}}^H I_{13}^H$
NP	Acquisitions less disposals of non-fin non-produced assets	NP_p^F		NP_p^B				NP_p^G		NP_p^H				0
B9NF	*Financing capacity*	FCN^F		FCN^B		*0*		FCN^G		FCN^H		FCN^R		*0*
Adj	***Adjustment B9F - B9NF***	$\boldsymbol{Adj^F}$		$\boldsymbol{Adj^B}$		$\boldsymbol{Adj^{CB}}$		$\boldsymbol{Adj^G}$		$\boldsymbol{Adj^H}$		$\boldsymbol{Adj^R}$		***0***
		Firms		***Financial inst excl BdF***		***Banque de France***		***Government***		***Households***		***Rest of the world***		
Flow	*Instrument*	*Asset*	*Liability*	*Asset*	*Liability*	*Asset*	*Liability*	*Asset*	*Liability*	*Asset*	*Liability*	*Asset*	*Liability*	
F1	Monetary gold and SDRs					$p_G^{CB}\Delta^* G^{CB}$							$p_G^{CB}\Delta^* G^{CB}$	0
F21	Bills and coins	$\Delta^* H^F$		$\Delta^* H^B$			$\Delta^* H^{CB}$			$\Delta^* H^H$		$\Delta^* H^R$		0
F295	Refinancing between FI				$\Delta^* RF$	$\Delta^* RF^{CB}$							$\Delta^* RF^R$	0
res	Bank reserves			$\Delta^* RES$			$\Delta^* RES$							0
gcb	Govt acc at the CB						$\Delta^* D_A^{CB_G}$	$\Delta^* D_A^{CB_G}$						0
tgt2	Target2					$\Delta^* TRGT2$							$\Delta^* TRGT2$	0
F2	Deposits	$\Delta^* D_A^F$		$\Delta^* D_A^B$	$\Delta^* D_L^B$	$\Delta^* D_A^{CB}$	$\Delta^* D_L^{CB}$	$\Delta^* D_A^G$	$\Delta^* D_L^G$	$\Delta^* D_A^H$		$\Delta^* D_A^R$	$\Delta^* D_L^R$	0
F3e	Public securities	$p_{B_A}^{F_G}\Delta^* B_A^{F_G}$		$p_{B_A}^{B_G}\Delta^* B_A^{B_G}$		$p_{B_A}^{CB_G}\Delta^* B_A^{CB_G}$			$p_{B_L}^G\Delta^* B_L^G$			$p_{B_A}^{R_G}\Delta^* B_A^{R_G}$		0
F3d	Foreign securities	$p_{B_A}^{F_R}\Delta^* B_A^{F_R}$		$p_{B_A}^{B_R}\Delta^* B_A^{B_R}$		$p_{B_A}^{CB_R}\Delta^* B_A^{CB_R}$		$p_{B_A}^{G_R}\Delta^* B_A^{G_R}$		$p_{B_A}^{H_R}\Delta^* B_A^{H_R}$			$p_{B_L}^R\Delta^* B_L^R$	0
F3g	Other securities		$p_{B_L}^F\Delta^* B_L^F$	$p_{B_A}^B\Delta^* B_A^B$	$p_{B_L}^B\Delta^* B_L^B$	$p_{B_A}^{CB}\Delta^* B_A^{CB}$		$p_{B_A}^G\Delta^* B_A^G$		$p_{B_A}^H\Delta^* B_A^H$		$p_{B_A}^R\Delta^* B_A^R$		0
F4	Loans	$\Delta^* L_A^F$	$\Delta^* L_L^F$	$\Delta^* L_A^B$		$\Delta^* L_A^{CB}$			$\Delta^* L_L^G$		$\Delta^* L_L^H$	$\Delta^* L_A^R$	$\Delta^* L_L^R$	0
F5e	Domestic equity and investment fund shares	$p_{E_A}^F\Delta^* E_A^F$	$p_{E_L}^F\Delta^* E_L^F$	$p_{E_A}^B\Delta^* E_A^B$	$p_{E_L}^B\Delta^* E_L^B$	$p_{E_A}^{CB}\Delta^* E_A^{CB}$	$p_{E_L}^{CB}\Delta^* E_L^{CB}$	$p_{E_A}^G\Delta^* E_A^G$		$p_{E_A}^H\Delta^* E_A^H$		$p_{E_A}^R\Delta^* E_A^R$		0
F5d	Foreign equity and investment fund shares	$p_{E_A}^{F_R}\Delta^* E_A^{F_R}$		$p_{E_A}^{B_R}\Delta^* E_A^{B_R}$		$p_{E_A}^{CB_R}\Delta^* E_A^{CB_R}$		$p_{E_A}^{G_R}\Delta^* E_A^{G_R}$		$p_{E_A}^{H_R}\Delta^* E_A^{H_R}$			$p_{E_L}^R\Delta^* E_L^R$	0
F6	Insurance, pension funds and s.g.s.	$\Delta^* A_A^F$			$\Delta^* A_L^B$			$\Delta^* A_A^G$		$\Delta^* A_A^H$		$\Delta^* A_A^R$		0
F7	Fin. derivatives and employee stock options	$\Delta^* X_A^F$			$\Delta^* X_L^B$	$\Delta^* X_A^{CB}$		$\Delta^* X_A^G$		$\Delta^* X_A^H$			$\Delta^* X_L^R$	0
F8	Other accounts receivable/payable	$\Delta^* Z_A^F$		$\Delta^* Z_A^B$		$\Delta^* Z_A^{CB}$		$\Delta^* Z_A^G$		$\Delta^* Z_A^H$		$\Delta^* Z_A^R$		0
	Net acquisition of financial assets		$\boldsymbol{NAFA^F}$		$\boldsymbol{NAFA^B}$		$\boldsymbol{NAFA^{CB}}$		$\boldsymbol{NAFA^G}$		$\boldsymbol{NAFA^H}$		$\boldsymbol{NAFA^R}$	***0***

Cells in blue represent the closing items of the corresponding line

Note: The Central Bank's financing capacity is nil; it is paid in full to the government in form of a tax

Main equations

Our focus in this paper is on the equations that have changed from the previous version (see footnote 1), mainly the firms' rate of non-financial accumulation and the modelling of the interest rate.

Firms

Non-financial firms have an accumulation rate of productive capital $\left(\frac{\Delta^* K_1^F}{K_{1-1}^F}\right)$ that depends on four variables, following a post-Keynesian logic: the share of profit in value added $\left(\frac{\Pi^F}{VA^F}\right)$ representative of firms' profitability; the output gap of the market sector representative of a demand effect; the real interest rate[2] $(r_L^F - \pi_Y)$ with a negative sign; the debt structure here represented as the debt-to-own funds ratio $\left(\frac{L_L^F}{p_{E_L}^F E_L^F + WLTH^F}\right)$, also with a negative effect. A version without the output gap (gap), a positive effect of the lagged rate of profit and a negative effect of the financial profitability, was used in the previous version of the model, more in line with a Kaleckian logic. The results are not fundamentally different. The multiplier effect was slightly smaller in the previous version of the model due to the absence of a direct demand effect in firms' investment. This will be discussed more in detail below.

Without output gap (previous model)

$$\left(\frac{\Delta^* K_1^F}{K_{1-1}^F}\right) = 0.02 + 0.1\left(\frac{\Pi^F{}_{-1}}{p_{K_{1-1}}^F K_{1-2}^F + p_{K_{2-1}}^F K_{2-2}^F}\right) - 0.2(r_L^F - \pi_Y) - 0.01(r_{E_A}^F - \pi_Y) - 0.03\left(\frac{L_L^F}{p_{E_L}^F E_L^F + WLTH^F}\right)$$

1983-2019 (5.9) (2) (-2.2) (-2.3) (-4) R^2 = 0.5

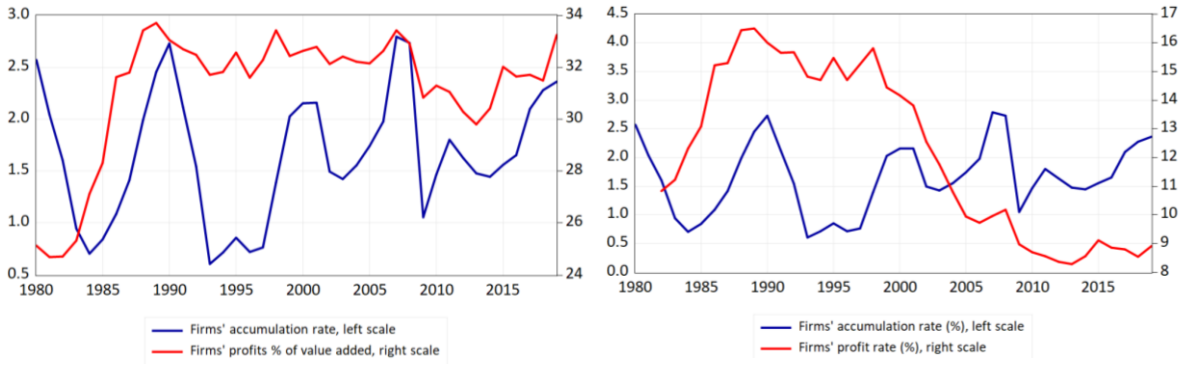
With output gap (this model)

$$\left(\frac{\Delta^* K_1^F}{K_{1-1}^F}\right) = 0.08\left(\frac{\Pi^F}{VA^F}\right) + 0.3gap - 0.12(r_L^F - \pi_Y) - 0.01\left(\frac{L_L^F}{p_{E_L}^F E_L^F + WLTH^F}\right)$$

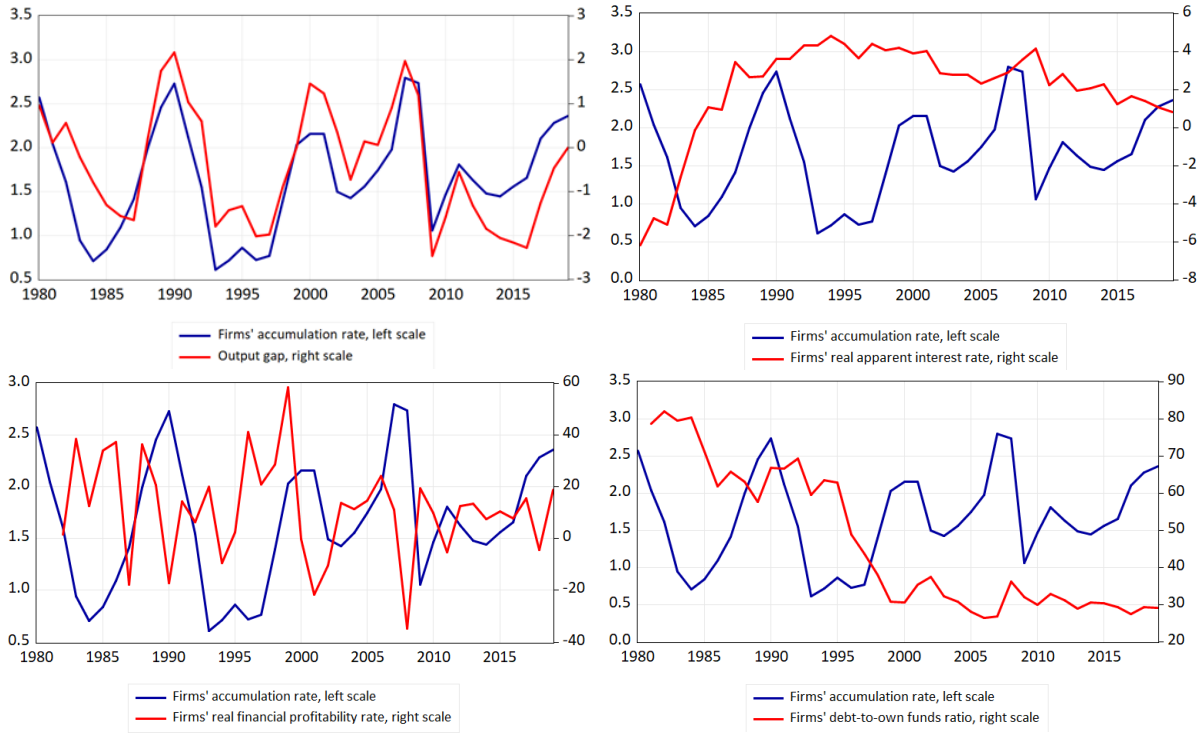
1983-2019 (17.2) (8.2) (-5.1) (-5.6) R^2 = 0.81

$gap = \left(\frac{va^M - va^{pM}}{va^{pM}}\right)$, where va^M is the market sector's value added and va^{pM} the potential value added.

Figure 1 Firms' accumulation rate and its determinants (1980-2019)



[2] r_L^F is the apparent (or implicit) interest rate, calculated as the ratio of interests paid by firms and the stock of indebtedness from the previous period.



In financialized capitalism, firms tend to favor financial accumulation at the expense of productive accumulation. This translates into a financial accumulation rate that is an increasing function of the profit rate and of financial profitability of equities held, where (unlike the case of productive capital) indebtedness plays a supporting role. The change in firms' deposits and the flow of inter-firm credit, i.e. credits granted by the firms to other firms and/or themselves, are the subject of a simplified model in which the real 10-year interest rate (with a negative sign) and the firms' indebtedness (as a liability) intervene respectively. Firms have an indebtedness behavior. In the medium-term their debt structure, as a ratio of total non-financial capital, depends positively on the profit rate and negatively on the real interest rate. More than a debt behavior, it is an indebtedness norm, which reflects a given institutional relation between firms and banks. A split between bank debt and bonds is also made. Equities issued close the firms’ account.

Households

Household consumption depends on disposable income and a wealth effect. Apart from disposable income, household investment is a function of the real interest rate with a negative effect and of the growth rate of the land price, which contributes to enhance the housing boom. Land price is itself a function of household investment.

Household bank deposits depend on the 10-year real interest rate with a negative sign. Equity purchases are a function of the financial rate of return and the 10-year real interest rate with a negative sign. There is a split between foreign and domestic equities held by households. Insurance purchases are related to the weight of the eldest in total population, supplemented in the short-term by a positive effect of the real 10-year interest rates and financial profitability. Loans close households’ account.

Banks

Banks are accommodating in the current version of the model. They grant all credits requested ($\Delta^* L_A^B$), buy all public bonds available ($p_{B_A}^{B_G}\Delta^* B_A^{B_G}$) and balance the market for domestic private bonds ($p_{B_L}^B\Delta^* B_L^B$), as well as domestic equities ($p_E^{FR}\Delta^* E_L^B$). The accumulation rate of foreign securities ($\frac{\Delta^* B_A^{B_R}}{B_{A-1}^{B_R}}$) depends on the foreign-domestic long-term interest rate differential ($i^{LTcr} - i^{LT*}$). The demand for private domestic securities ($p_{B_A}^B\Delta^* B_A^B$) depends of the domestic rate of growth and of the domestic – foreign interest rate differential after exchange rate adjustment ($r_A^B - i_{10yr}^* + \frac{\Delta NEER}{NEER_{-1}}$). Banks' financial accumulation rate $\left(\frac{\Delta^* E_A^B}{E_{A-1}^B}\right)$ depends on financial profitability lagged one period $\left(r_{E_{A-1}}^B - \pi_{Y-1}\right)$. There is a split between foreign and domestic equities $\left(\frac{p_{E_A}^{B_R}E_A^{B_R}}{p_{E_A}^B E_A^B}\right)$ a function of exchange rate variation. Banks collect net deposits (D_L^B), insurance policies (A_L^B) and financial derivatives (X_L^B). Last but not least, banks' reserves (RES) close the banks' account.

$$p_{B_L}^B\Delta^* B_L^B = p_{B_A}^B\Delta^* B_A^B + p_{B_A}^{CB}\Delta^* B_A^{CB} + p_{B_A}^G\Delta^* B_A^G + p_{B_A}^H\Delta^* B_A^H + p_{B_A}^R\Delta^* B_A^R - p_{B_L}^F\Delta^* B_L^F$$

$$\left(\frac{\Delta^* B_A^{B_R}}{B_{A-1}^{B_R}}\right) = 0.65\left(\frac{\Delta^* B_{A-1}^{B_R}}{B_{A-2}^{B_R}}\right) - 3.1(i^{LTcr} - i^{LT*})$$

$$\left(\frac{p_{B_A}^B\Delta^* B_A^B}{p_Y Y}\right) = 0.6\left(\frac{\Delta Y}{Y_{-1}}\right) + 0.6\, r_A^B - 0.6\left(i^{LT*} - \frac{\Delta NEER}{NEER_{-1}}\right)$$

$$\left(\frac{\Delta^* E_A^B}{E_{A-1}^B}\right) = 0.03 + 0.4\left(\frac{\Delta^* E_{A-1}^B}{E_{A-2}^B}\right) + 0.04\left(r_{E_{A-1}}^B - \pi_{Y-1}\right)$$

$$\left(\frac{p_{E_A}^{B_R}E_A^{B_R}}{p_{E_A}^B E_A^B}\right) = 0.03 + 0.86\left(\frac{p_{E_{A-1}}^{B_R}E_{A-1}^{B_R}}{p_{E_{A-1}}^B E_{A-1}^B}\right) - 0.4\left(\frac{\Delta NEER}{NEER_{-1}}\right)$$

Banque de France

Interests and dividends paid and received by the Banque de France are computed according to the corresponding assets. Profits are transferred to the government as tax. Bills and coins (H) are supplied by the central bank. Central bank deposits held by the government ($D_L^{CB_G}$) are isolated as they are used to study helicopter money. Foreign bonds held by the central bank ($p_{B_A}^{CB_R}B_A^{CB_R}$), public bonds ($p_{B_A}^{CB_G}\Delta^* B_A^{CB_G}$), other domestic bonds ($p_{B_A}^{CB}\Delta^* B_A^{CB}$) and refinancing ($RF^{CB}$) correspond to different forms of quantitative easing. Equities issued by the central bank ($p_{E_L}^{CB}E_L^{CB}$) are exogenous. Central bank equilibrium is the unwritten equation of the model.

$$\Delta^* H = \Delta^* H^F + \Delta^* H^B + \Delta^* H^H + \Delta^* H^R$$

$$D_L^{CB_G} = D_A^{G_{CB}}$$

$$p_{B_A}^{CB_R}B_A^{CB_R} = \varphi_{BA}^{CB}p_Y Y$$

$$p_{B_A}^{CB_G}\Delta^* B_A^{CB_G} = \gamma_{B_A}^{CB_G}p_Y Y$$

$$p_{B_A}^{CB}\Delta^* B_A^{CB} = \gamma_{B_A}^B p_Y Y$$

$$\Delta^* RF^{CB} = \varphi_{RF}^{CB}p_Y Y$$

$$p_G^{CB}\Delta^* G^{CB} + \Delta TRGT2 + \Delta^* RF^{CB} + \Delta^* D_A^{CB} + p_{B_A}^{CB_G}\Delta^* B_A^{CB_G} + p_{B_A}^{CB_R}\Delta^* B_A^{CB_R} + p_{B_A}^{CB}\Delta^* B_A^{CB} + \Delta^* L_A^{CB} + p_E^{CB}\Delta^* E_A^{CB}$$
$$= \Delta^* H + \Delta^* RES + \Delta^* D_L^{CB} + \Delta^* D_L^{CB_G} + p_{E_L}^{CB}\Delta^* E_L^{CB} + Adj^{CB}$$

Interest rates and assets' prices

The ECB key interest rate ($r_€$) and the 10-year interest rate on public bonds (i_{10yrs}) are exogenous in this version of the model. Proposals will be made at the end of the paper to endogenize the 10-year interest rate. Apparent (or implicit) interest rates are calculated for the various securities and are determined with simple margins with respect to the 10-year bonds interest rate or the ECB interest rate. The short-term interest rate on deposits (r_D) and the long-term interest rate on credit ($i^{LT_{cr}}$) are determined in the same manner. The price of public bonds ($p^G_{B_L}$) varies inversely with respect to the one paid by the government (r^G_L). It plays a leading role in the determination of other prices of bonds such as bonds issued by firms ($p^F_{B_L}$), public bonds held by firms ($p^{F_G}_{B_A}$), private bonds held by households ($p^H_{B_A}$) or private bonds held by banks ($p^B_{B_A}$). Lastly, for each security (domestic private bonds, foreign bonds, public bonds), one price ($p^B_{B_L}$, $p^{B_R}_{B_A}$, $p^{R_G}_{B_A}$) must be obtained implicitly to guarantee flow-stock consistency by writing that the sum of the revaluation effects equals to zero.

$$r^F_A = 3.6 + 0.63r_€$$

$$r^H_A = 1.6 + 0.5r_€$$

$$r^F_L = 1.9 + 0.6i_{10yrs} + 0.2r_€$$

$$r^B_A = 0.4 + 0.5r^B_{A-1} + 0.4i_{10yrs}$$

$$r^B_L = 1.9 + 0.4i_{10yrs} + 0.7r_€$$

$$r^G_A = 2.5 + 1.6r_€$$

$$r^G_L = 1.1 + 0.75i_{10yrs} + 0.1r_€$$

$$r^H_L = 0.9 + 0.5i_{10yrs} + 0.4r_€$$

$$r^R_A = i_{10years} + \kappa^R_{r_A}$$

$$i^{LT_{cr}} = 0.93i_{10yrs}$$

$$r_D = 1.4 + 0.5r_€$$

$$\ln\left(p^G_{B_L}\right) = -0.39 + 0.1\ln\left(\frac{1}{r^G_L}\right)$$

$$\ln\left(p^F_{B_L}\right) = 0.8\ln\left(p^F_{B_{L-1}}\right) + 0.9\ln\left(p^G_{B_L}\right) - 0.7\ln\left(p^G_{B_{L-1}}\right)$$

$$p^{F_G}_{B_A} = \psi^{F_G}_{p_{BA}} p^G_{B_L}$$

$$p^H_{B_A} = \psi^H_{p_{BA}} p^B_{B_L}$$

$$\Delta\ln\left(p^B_{B_A}\right) = 0.2\Delta\ln\left(p^B_{B_{A-1}}\right) + 0.7\Delta\ln\left(p^G_{B_L}\right)$$

$$\Delta p^B_{B_L} = -\left(\frac{B^F_{L-1}}{B^B_{L-1}}\right)\Delta p^F_{B_L} + \sum_i \left(\frac{B^i_{A-1}}{B^B_{L-1}}\right)\Delta p^i_{B_A} \quad \text{for } i = B, CB, G, H, R$$

$$\Delta p^{B_R}_{B_A} = \left(\frac{B^R_{B_{L-1}}}{B^{B_R}_{B_{A-1}}}\right)\Delta p^R_{B_L} - \sum_i \left(\frac{B^{i_R}_{B_{A-1}}}{B^{B_R}_{B_{A-1}}}\right)\Delta p^{i_R}_{B_A} \quad \text{for } i = F, CB, G, H$$

$$\Delta p^{R_G}_{B_A} = \left(\frac{B^G_{L-1}}{B^{R_G}_{A-1}}\right)\Delta p^G_{B_L} - \sum_i \left(\frac{B^{i_G}_{A-1}}{B^{R_G}_{A-1}}\right)\Delta p^{i_G}_{B_A} \quad \text{for } i = F, B, CB$$

Government

The government is described in a traditional manner with taxes linked to economic activity and incomes, government's value added linked to public wages and public employment and expenditure exogenous. Total public indebtedness closes the account of the government with a split between loans and public bonds.

Rest of the world

Exports and imports depend on foreign and domestic demand (Y^f and Y, respectively) as measured by GDP in volume, and in the case of exports also negatively by a relative price indicator ($\frac{p_X}{p_{X*}}$). Since the analyses are conducted for all goods services (rather than treating traded volumes and prices only), it is more difficult to obtain satisfactory econometric results for price competitiveness. For imports the relative price effects could not be identified and only import prices could be isolated. Export and import prices are determined in standard fashion with a price maker/price taker arbitrage.

$$\Delta \ln(X) = 0.3\Delta \ln(X_{-1}) + 0.4\Delta \ln(Y^f) - 0.2\Delta \ln\left(\frac{p_X}{p_{X*}}\right) - 0.14vc_{-1}$$

$$vc = \ln(X) - 1.7 - 0.6 \ln(Y^f) + 0.5 \ln\left(\frac{p_X}{p_{X*}}\right)$$

$$\ln(p_X) = 0.03 + 0.5 \ln(p_{X*}) + 0.3 \ln(p_Y)$$

$$\Delta \ln(IM) = 2.2\Delta \ln(Y) + 0.5vc_{-1}$$

$$vc = \ln(IM) - 1.8 \ln(Y) + 0.2 \ln(p_{IM}) + 8.5 - 0.01t$$

$$\Delta \ln(p_{IM}) = 0.12\Delta \ln(p_{IM-1}) + 0.7\Delta \ln(p_{MSH}) - 0.45vc_{-1}$$

$$vc = \ln(p_{IM}) - 0.6 \ln(p_{MSH})$$

Capital inflows, in the form of bank deposits and of loans granted by the rest of the world, depend on economic activity and on the short-term interest rate differential after correction of the exchange rate variation. Similarly, public bonds and other debt securities held by the rest of the world are linked to economic activity and to the long-term interest rate differential. Share purchases, including inward foreign direct investment, depend on economic activity and financial profitability for shares. Since the mid-2000s, purchases of government securities by the rest of the world have been part of quantitative easing policy. Capital outflows, in the form of credit to the rest of the world, depend on foreign economic activity. It was not possible to find a significant effect of the interest rate differential. Foreign securities issued by the rest of the world, medium term capital outflows, are determined by the demand of foreign securities by domestic agents. Likewise, foreign equities issued by the rest of the world, including outward foreign direct investments, equal the sum of the demand of foreign equities by domestic agents. Lastly, the flow of deposit liabilities of the rest of the world held in France balance (closes) the rest of the world's account.

Prices, wages and employment

The general price level (p_Y) is determined by mark-up pricing from unit labor costs (ULC) with a short-term effect on demand pressure, measured (in the absence of a better indicator) by an output gap (gap). A short-term effect of import price (p_{IM}) has also been added. Potential output of the market sector (va^{M^p}) results from a simple production function used as a first

approximation. Wage per worker in the market sector (w^M) results from a wage-price-unemployment relation with an indexation slightly less than unity and a medium-term labor productivity $\left(\frac{va^M}{N^M}\right)$ effect. This wage per worker in the market sector serves as a reference for the evolution of that of the other sectors. Employment in the market sector (N^M) adjusts with respect to medium-term employment resulting from the previous production function. Public employment is exogenous. Active population (AP i.e. labor force) results from flexion of activity rates (AP/TAP) as a function of job creation (N).

$$\Delta \ln(p_Y) = 0.01 + 0.4\Delta \ln(ULC) + 0.3GAP + 0.03\Delta \ln(p_{IM-1}) - 0.4vc_{-1}$$

$$vc = \ln(p_Y) - 0.4 - 0.9 \ln(ULC)$$

$$GAP = \left(\frac{va^M - va^{pM}}{va^{pM}}\right)$$

$$\ln\left(\frac{va^{Mp}}{N^M}\right) = 0.8 + 0.5 \ln\left(\frac{K_1^M}{N^M}\right) + 0.014t - 0.01t_{1992-2019}$$

$$\Delta \ln(w^M) = 0.005 + 0.5\Delta \ln(w_{-1}^M) + 0.4\Delta \ln(p_C^H) + 0.43\Delta \ln\left(\frac{va^M}{N^M}\right) - 0.38\Delta \ln\left(\frac{va_{-1}^M}{N_{-1}^M}\right) - 0.2vc_{-1}$$

$$vc = \ln(w^M) - 0.9 \ln(p_C^H) + 0.1 \ln(u) - 0.7 \ln\left(\frac{va^M}{N^M}\right)$$

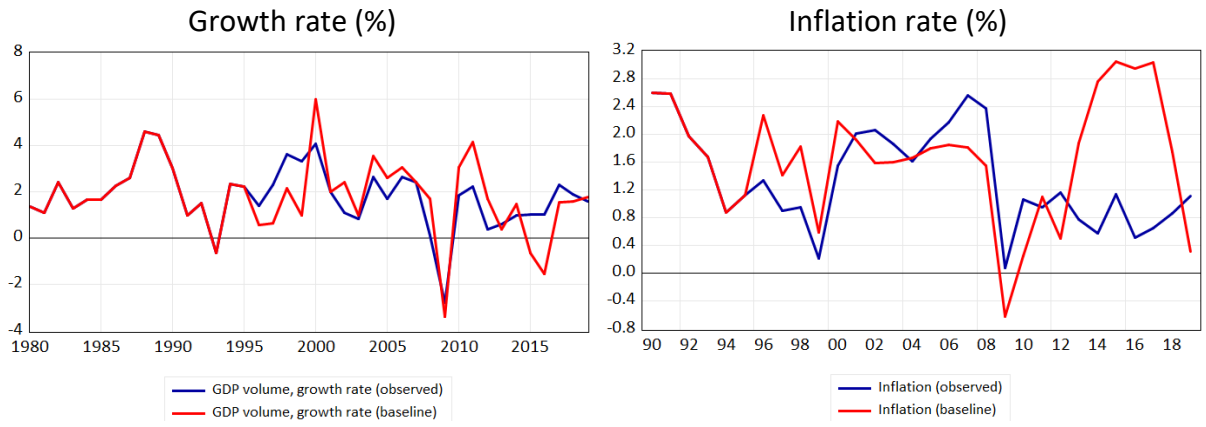
$$\ln(N^M) = 2 \ln(va^M) - 1.6 - \ln(K_1^M) - 0.028t + 0.02t_{1992}$$

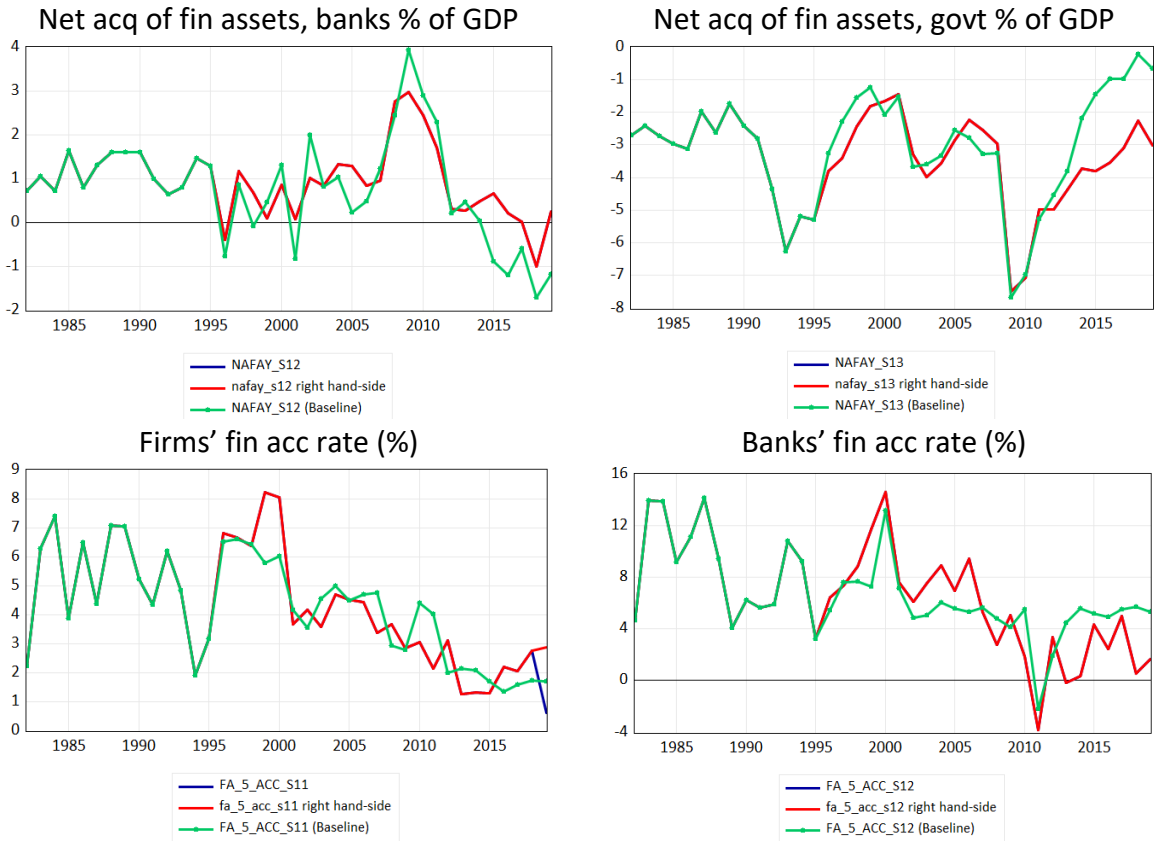
$$\ln(AP) = 0.37 \ln(N) + 0.56 \ln(TAP) + 0.002t$$

Simulations on the past

Figure 2 allows for a comparison between the observed and simulated evolution of a sample of series in the model, which includes the output gap in the specification for firms' non-financial accumulation rate. The model performs rather well. The gap between the observed series and the baseline lies within reasonable limits, with a few exceptions (for instance the inflation rate between 2013 and 2018).

Figure 2 Model performance; selected series, observed vs simulated. Simulations start in 1996

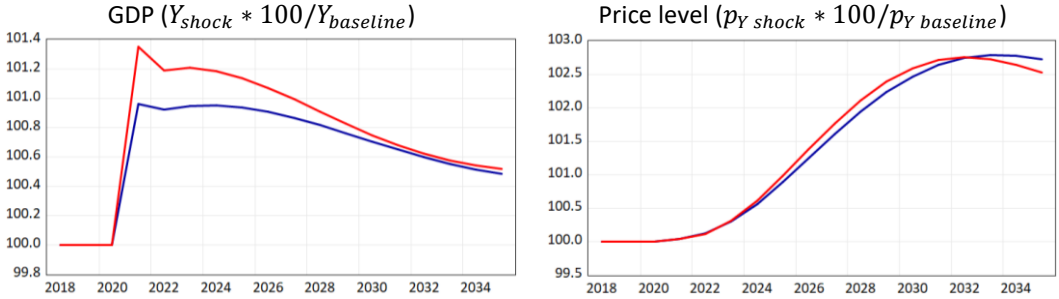


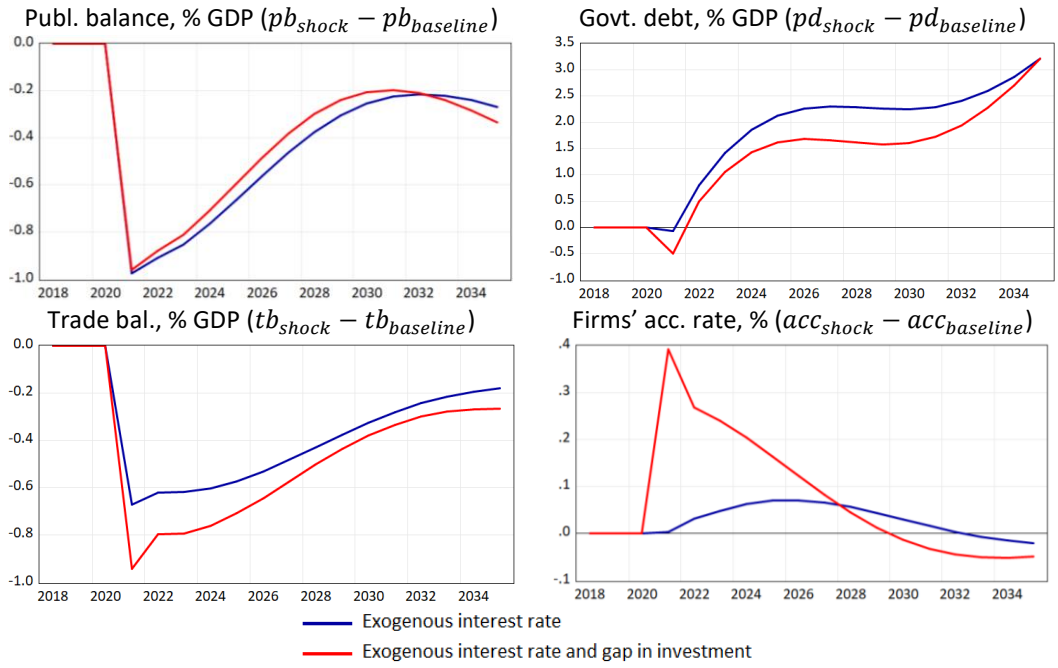


Basic shocks and model comparison

Changing specifications in the model yields different, although not contradictory, results. In this part we compare the multiplier effects of two model specifications, one with no output gap in firms' accumulation rate, the other that includes it. Three shocks are examined, first a permanent increase of public investment of 1% of GDP, second a 1% increase in the 10-year interest rate on bonds that is coupled with an increase in the rate by the ECB, third an increase of 1% in the growth rate of wage per worker.

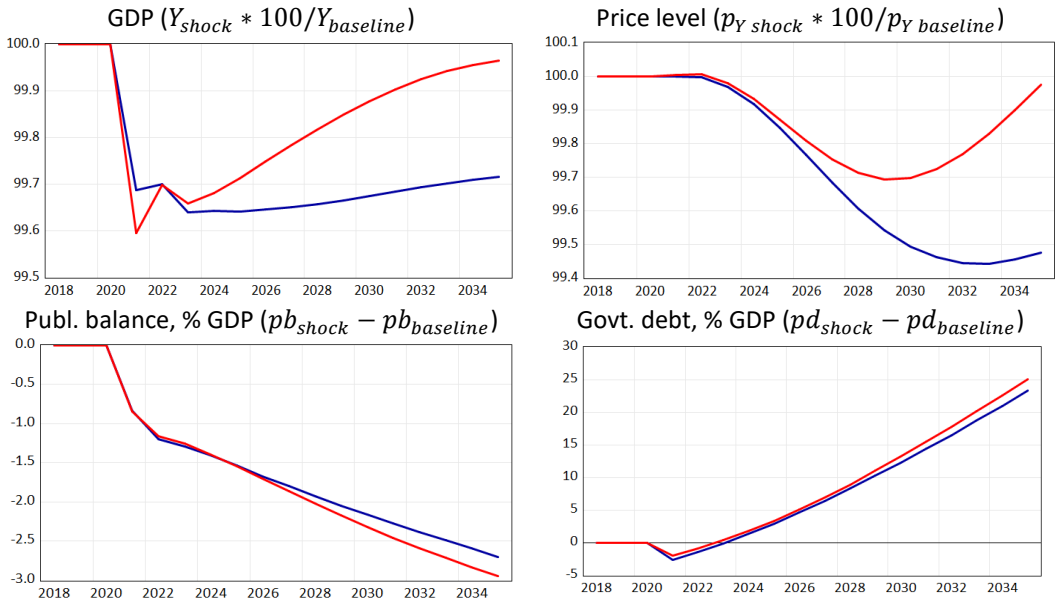
Figure 3 Public investment increases permanently by 1% of GDP between 2021 and 2035

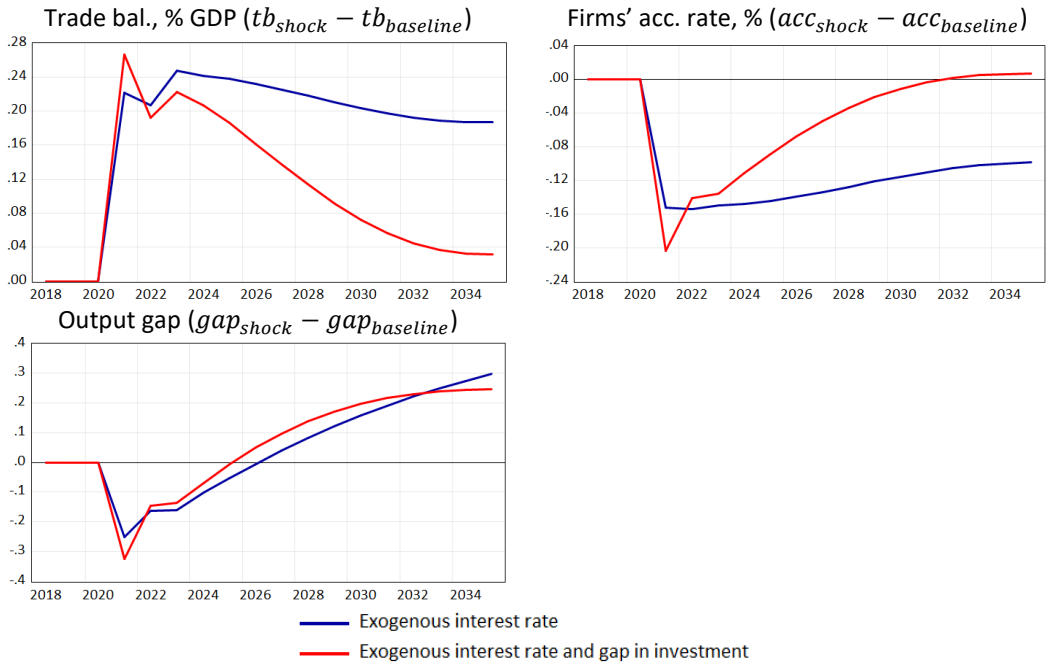




The increase in public investment has a larger effect on economic growth in the short-term in the model including a demand effect in the accumulation rate of the firms (1.35% in 2021 compared to 0.9%). Unsurprisingly, this is due to the larger increase of the rate of non-financial accumulation of firms (0.3% in the short-term) but this accumulation boom does not last long, as the output gap decreases with the increase in the capital stock. In the long-term the multiplier effect of the two models are similar. The evolution of the price level is also similar in both; it increases by about 2.5% after 10 years. The trade balance worsens more in 2021 in the model with the output gap effect due to the more sustained growth (-1% of GDP instead of -0.7%). Similarly, public finances worsen less and public debt increases less (Figure 3).

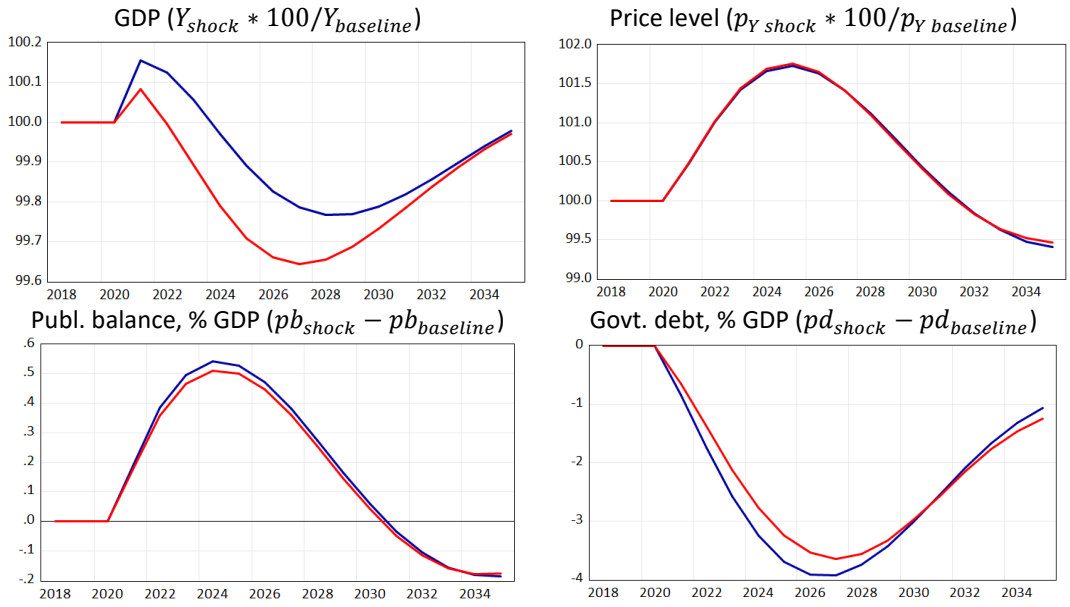
Figure 4 Interest rate increases permanently by 1% between 2021 and 2035

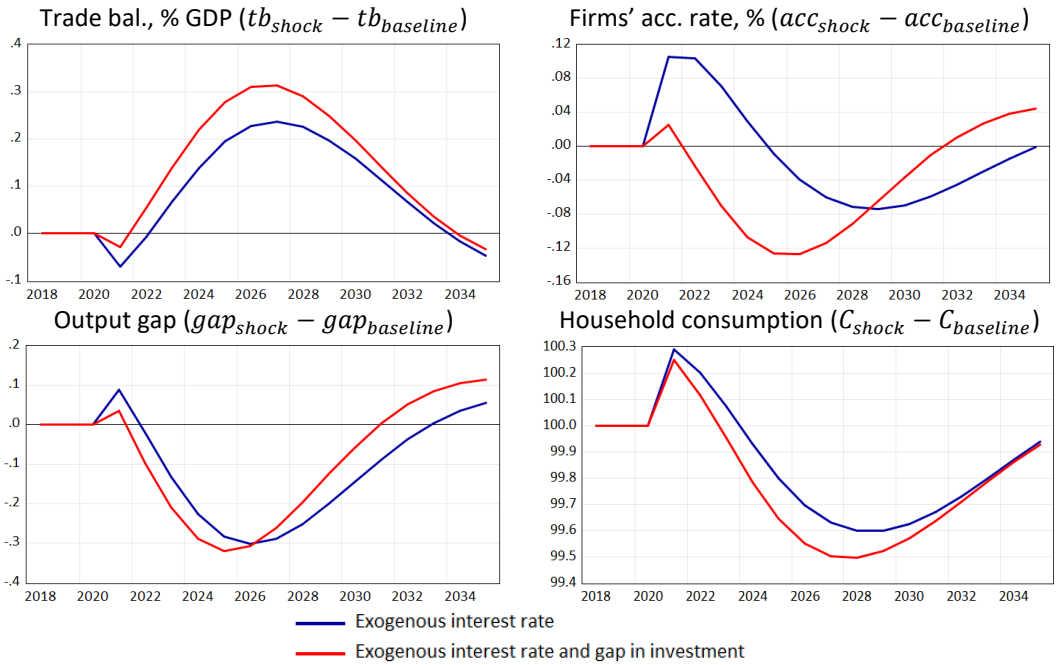




An 1% increase in the interest rate has a contractionary effect (-0.4% in the short-term on GDP), mainly due to the negative impact on investment. The output gap and the demand pressure decline, inducing a progressive deflationist effect which remains relatively moderate (between -0.3% and -0.5% in the medium-term). Thanks to the slowdown the trade balance improves, but public finances worsen significantly with a cumulative effect on public debt due to the rising cost of debt. In the model with an output gap, the effect on the accumulation rate of firms the deflationist effect reaches a halt in the medium-term. The output gap increases with the declining stock of capital, which stimulates the firms' investment and induces a slight recovery (Figure 4).

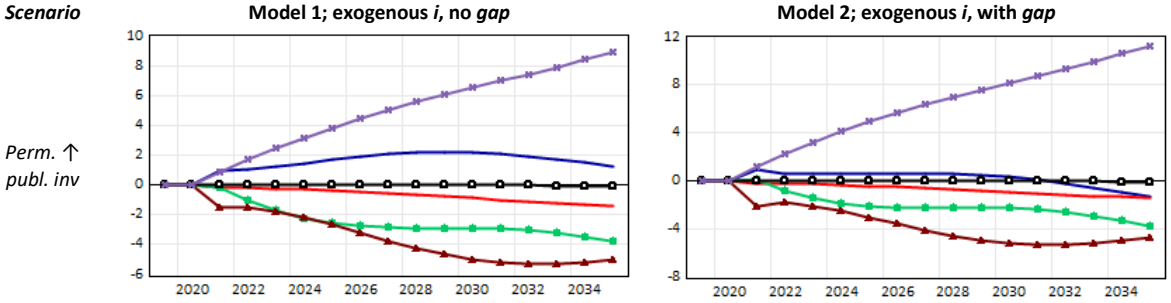
Figure 5 Growth rate of wage per worker increases permanently by 1% between 2021 and 2035

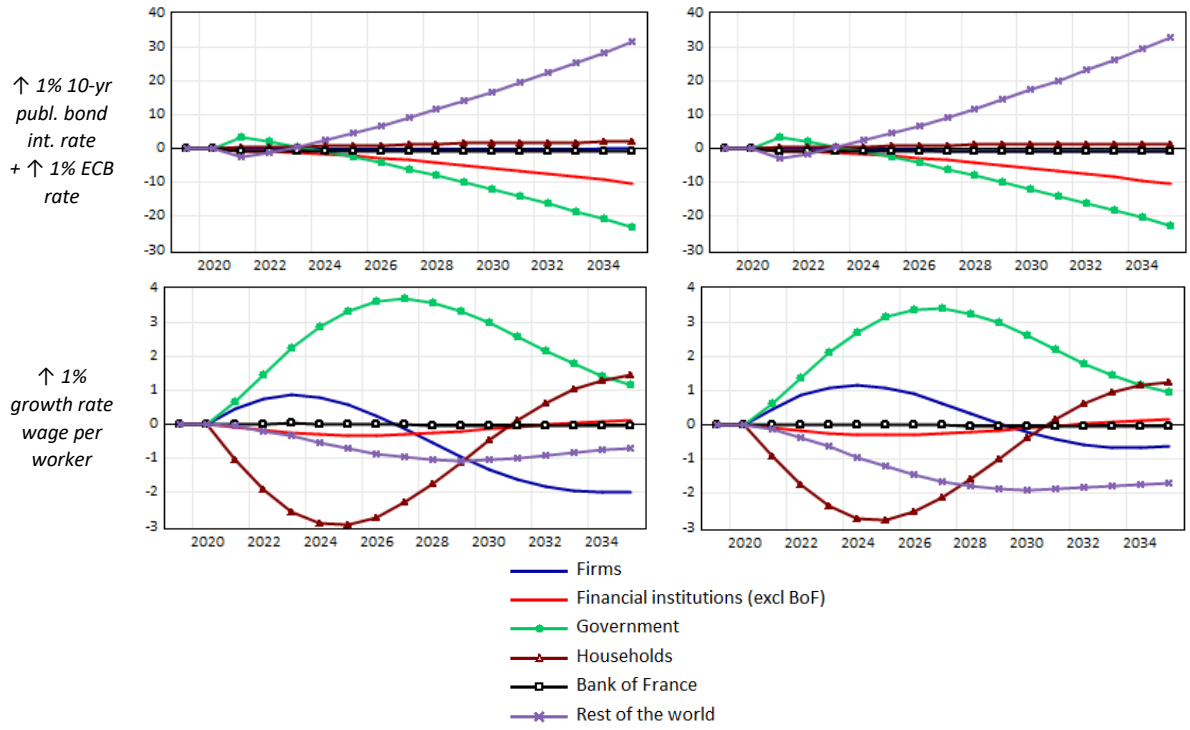




A 1% increase in the growth rate of wage per worker has a small initial positive impact on GDP but after two years (model with output gap effect on investment) or four years (model without the gap effect) the impact of the wage increase becomes negative. This suggests that the French economy is under a moderate wage-led regime in the short-term and in a profit-led regime in the longer-term. The reversal is reflected also in the trade balance, which initially tends towards deficit then shifts after one or two years in the opposite direction. Similarly, the public balance improves in the medium term (0.5% of GDP) thanks to the increase in resources, but this surplus is progressively reduced. The increase in wages induces an inflationary drift (1.8% in the medium-term). It makes inflation rise proportionally more than it makes GDP fall in the medium-term (hence, nominal GDP increases), thus reducing debt-to-GDP ratios, especially that of the government (-4% of GDP in the medium-term). But as it has been noted, a reversal appears in the long-term. Even if differences exist between the two versions of the model (with or without output gap effect on investment), the results are rather similar and not in favor of a wage led policy, at least when it is reduced to a simple wage increase (Figure 5).

Figure 6 Change in financial wealth by institutional sector (% of GDP) following the scenarios as compared to baseline





The scenarios shown above have important financial redistributive effects (Figure 6). These are very similar in the two versions of the model, with or without output gap impact on firms' investment. A permanent expansionary fiscal policy fosters domestic demand, hence worsening the French current account that mirrors a surplus in the capital account. It is the evolution of the latter -a flow- that accumulates into (and explains the increase in) financial wealth of the rest of the world -a stock- up to 9% of GDP in the long-term. Logically the government sees its financial wealth reduced with the rising public debt.

As mentioned above, the 1% interest rate hike has the expected recessionary effects. As a consequence, the mechanism at work that explains the strong increase in the rest of the world's financial wealth (up to 30% of GDP in the long-term) is different than the one just described. In this case the capital account surplus is a direct result of the preference for financial gains in France for overseas investors. As a counterpart the financial wealth of the government decreases significantly (-20% of GDP in the long-term), mainly induced by the cumulative effects of the rising debt service. The reduced demand for debt by households and firms translates into lower credit supply by banks, hence a worsening of financial institutions' balance sheet.

A 1% increase in the growth rate of wage per worker has an inflationary effect that improves the government's financial balance and reduces public debt. This also has an initial positive effect on firms' financial wealth but since the wage bill is paid by them, the initial increase turns into negative territory some years later. Households' financial wealth worsens due to the increase in their indebtedness, in turn provoked by an increase in the financial assets they now hold following the rise in disposable income and that are financed via debt (reminder; this is the closing variable for this sector). The rest of the world's wealth is reduced in this

scenario, due to the cumulative current surplus and the reduction in the demand for domestic financial assets induced by inflation.

Unconventional monetary and fiscal policy

Two forms of unconventional monetary policy are studied with the model: helicopter money (HM henceforth) and the cancellation of a part of the public debt held by the central bank. The possibility of the recapitalization of central bank own funds are also examined. HM can take several forms, either as a distribution of central bank money directly to households or businesses, or as a distribution to the government. If the purpose is to avoid a distribution of banknotes, one way is to assume that all households and firms have an account with the central bank. This is possible and corresponds to the project of development of central bank digital currency. Here we are only interested in the second form of HM, i.e. via the State and its account with the central bank. Two uses of HM are distinguished, one to finance public investments, the other to finance social transfers. Last, the combination of public indebtedness and repurchase by the central bank are described. The model used is the one with an output gap effect on investment.

Helicopter money and public investment

Several steps have to be distinguished to account for HM in the model. The first is pure HM distribution, i.e. the feeding of the State's account by the central bank for an amount equivalent to 1% of GDP and paid the first year. This distribution alone does not have an impact other than increasing government wealth and diminishing that of the central bank. In a second step, in order to be able to give actual use to this helicopter money the government must transfer it to the accounts of commercial banks. The account with the central bank is debited, and the account with private banks credited. This transfer also has no impact on the real sector. In each case government wealth increases with respect to the baseline. It even increases slightly more thanks to the interest paid by banks to the government, and public debt decreases accordingly. Conversely, the central bank's wealth remains reduced by the same amount as before, while bank reserves (i.e. central bank's debt with private banks) increase.

In a third step the government uses helicopter money to finance additional public investment by the same amount (1% of GDP). Bank deposits are brought back to initial levels. Unsurprisingly, we observe a recovery effect with slight inflationary pressures of an identical size to the effects obtained in the case of public investment financed via public debt. However, financing methods are different. In the current case, the government balance deteriorates by the same amount but government debt does not increase, given that expenditure is financed by the helicopter money transfer. The graphs in level below illustrate this point. The graphs in percentage of GDP may seem paradoxical. Given the GDP increase the public balance as percentage of GDP worsens and simultaneously public debt-to-GDP falls. This recovery via investment without public debt has a counterpart; the wealth of the central bank worsens as much and stays at that level under the effect of the recovery. Symmetrically, government wealth improves given that the capital stock increases without additional debt. It is worth

noting that bank reserves (i.e. central bank indebtedness to banks) initially increase and only slightly fall when helicopter money is used to finance public investment (

Figure **7**).

Helicopter money and public investment in the model (one shot): added variables

First step: helicopter money distribution, without public indebtedness (1%GDP=24.892 or 25 when rounded)

	2021	*2022*	*2023 ...*	
D_A^{GCB}	*25*	*25*	*25*	*eq. 299*
$p\Delta BL_L^G$	*-25*	*0*	*0*	*eq. 323*

To account for this distribution of helicopter money in the model, it is necessary to feed the government's account with the CB and add a negative gap-filling variable of the same amount on the accounting identity determining the variation of public debt, in order to translate the fact that the government's account is increased thanks to helicopter money and not by indebtedness.

Second step: transfer to government's bank account

	2021	*2022*	*2023 ...*	
D_A^{GCB}	*0*	*0*	*0*	*eq. 299*
D_A^G	*25*	*25*	*25*	*eq. 303*
D_L^G	*-ψ(25)*	*-ψ(25)*	*-ψ(25)*	*eq. 301*
$p\Delta BL_L^G$	*-25*	*0*	*0*	*eq. 323*

Here again the logic of the model requires the introduction of a gap-filling variable on the government's liability deposits, which are simply modeled as a function of government deposits held. This variable is negative to reflect the fact that these deposits have no reason to increase in the event of a helicopter money transfer.

Third step: additional public investment (one year)

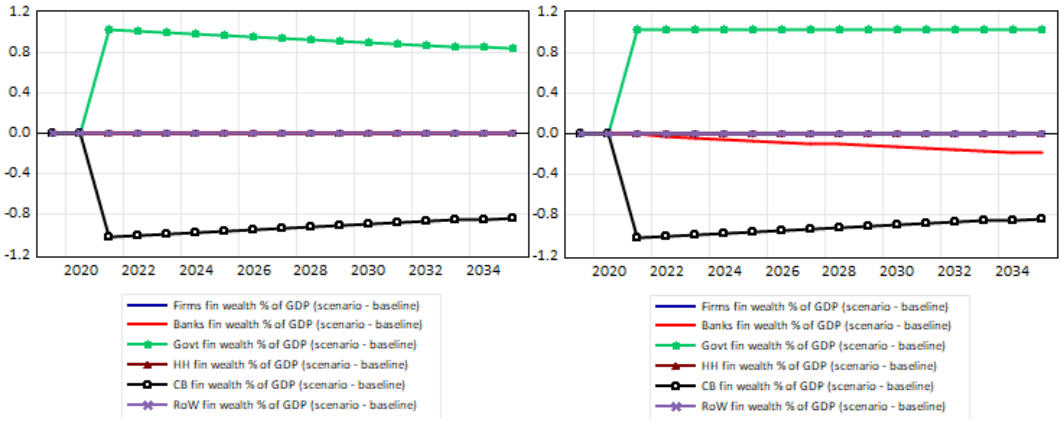
	2021	*2022*	*2023 ...*	
I_1^G	*25/p_{I1}*	*0*	*0*	*eq. 293*
D_A^G	*0*	*0*	*0*	*eq. 303*
D_L^G	*0*	*0*	*0*	*eq. 301*
$p\Delta BL_L^G$	*-25*	*0*	*0*	*eq. 323*

Figure 7 Impact of a distribution of helicopter money of 1% of GDP with a one shot increase of public investment in 2021

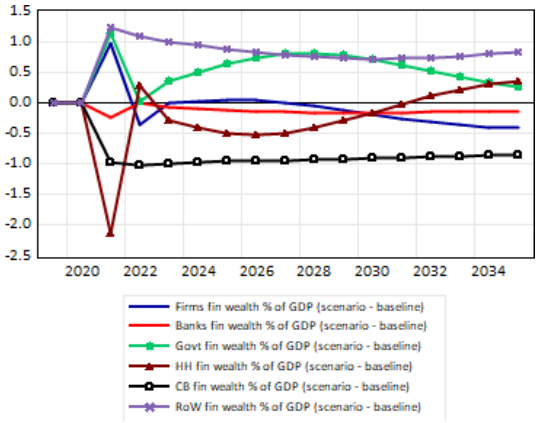
Absolute deviation from baseline, financial wealth as % of GDP ($Y^{scenario} - Y^{baseline}$)

1st step: HM distribution, 1% of GDP

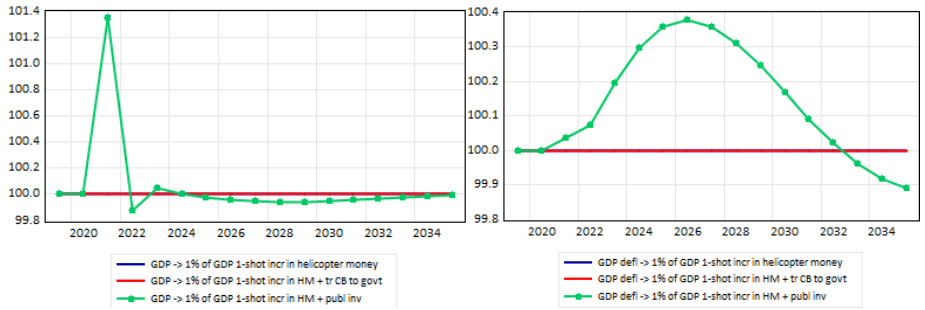
2nd step: HM + transfer to bank account, 1% of GDP



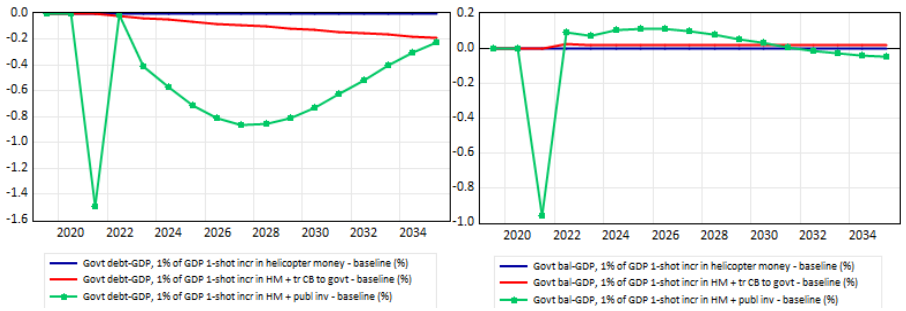
3rd step: HM + increase of public investment, 1% of GDP

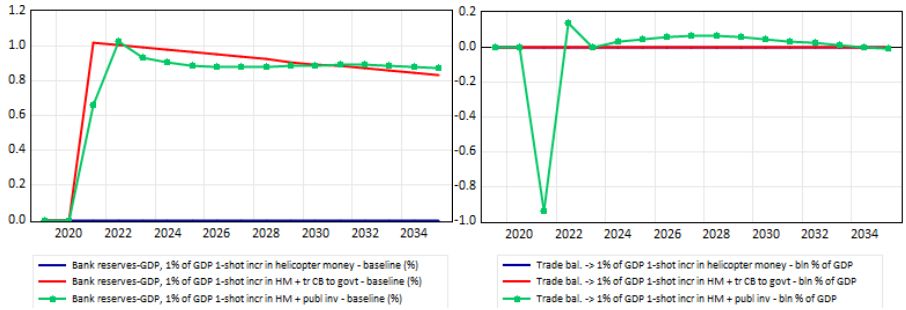


Relative deviation from baseline x 100 ($Y^{scenario}/Y^{baseline}$)



Absolute deviation from baseline, series as % of GDP ($Y^{scenario} - Y^{baseline}$)





HM to finance public investment is presented by its proponents (Couppey-Soubeyran, 2020) as a useful tool in a period of strong public indebtedness. Especially, it could be used to finance a part of the large investment programs to face the low-carbon transition. The previous simulations can be completed by examining, not only a one-off shock but also a permanent increase in public investment of 1% of GDP. This amount is close to the additional investment (public and private) estimated as necessary by I4CE (Berghmans et al., 2021) in order to respect the *Stratégie Nationale Bas Carbone* (1.2% of GDP each year over the period 2022-2028). The same procedure in three steps is followed: first distribution of helicopter money, second HM + transfer to banks' accounts, third HM + new public investment.

The conclusions to be drawn would not be fundamentally different. The recovery without public debt has as a counterpart a worsening of central bank wealth (Figure 8). The government balance deteriorates by 1% of GDP in 2021 and recovers slightly from then on, while public debt falls gradually until reaching -10% of GDP at long term later thanks to the distribution of HM and to the recovery. However, the financial wealth of the central bank decreases by 13% of GDP and bank reserves increase by 12% of GDP. Furthermore, the financial wealth of the rest of the world increases by 11% of GDP which means an equivalent deterioration of the domestic net financial assets, mainly due to a decline of the trade balance induced by the loss of price competitiveness and the volume effect of the recovery.

This would not be a problem according to supporters of this policy. A central bank could continue working with negative own funds. This could be the case if the procedure is punctual and limited, but more problematic in the context of a sustained policy. Financial markets could push interest rates up. The solutions proposed to restore the central bank's own funds are briefly discussed below. The size of bank reserves would facilitate capital outflows or slippages in the securities and/or real estate markets. In the French case, as in the case of countries in the Eurozone without a central bank properly speaking, such policy would contradict European treaties. It could only be undertaken after a series of time-consuming negotiations whose outcomes would be more than uncertain. Last, this kind of policy can hardly be implemented in a single country at least for two reasons: first, it makes no sense to try to reduce CO_2 emissions in a single country; second, the deterioration of the country's net external position would be difficult to bear. A coordinated policy, at least at the EU level, would reduce these problems but are difficult to implement, as it is illustrated by the long-lasting European negotiations.

Helicopter money and public investment in the model (permanent increase): added variables

First step: helicopter money distribution, without public indebtedness (1%GDP=25)

2021 2022 2023 …

D_A^{GCB}	25	50	75	eq. 299
$p\Delta BL_L^G$	-25	-25	-25	eq. 323

Second step: transfer to government's bank account

	2021	2022	2023 …	
D_A^{GCB}	0	0	0	eq. 299
D_A^G	25	50	75	eq. 303
D_L^G	$-\psi(25)$	$-\psi(50)$	$-\psi(75)$	eq. 301
$p\Delta BL_L^G$	-25	-25	-25	eq. 323

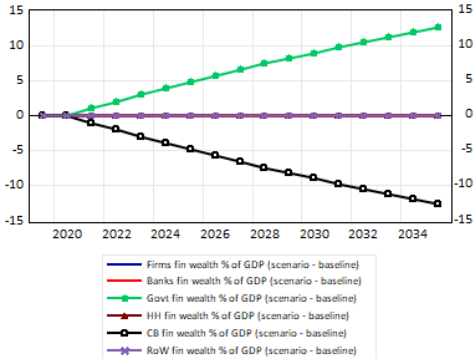
Third step: additional public investment (permanent)

	2021	2022	2023 …	
I_1^G	$25/p_{I1}$	$25/p_{I1}$	$25/p_{I1}$	eq. 293
D_A^G	0	0	0	eq. 303
D_L^G	0	0	0	eq. 301
$p\Delta BL_L^G$	-25	-25	-25	eq. 323

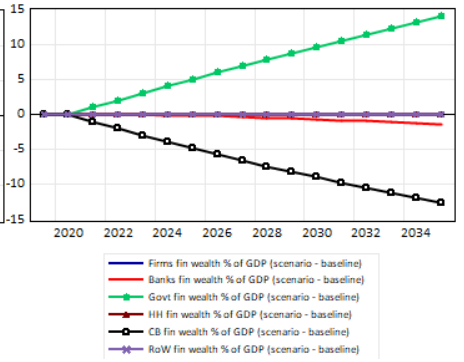
Figure 8 Impact of a permanent distribution of helicopter money with an increase of public investment of 1% of GDP

Absolute deviation from baseline, financial wealth as % of GDP ($Y^{scenario} - Y^{baseline}$)

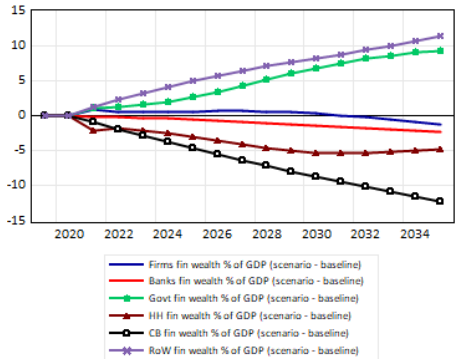
1st step: HM distribution, 1% of GDP



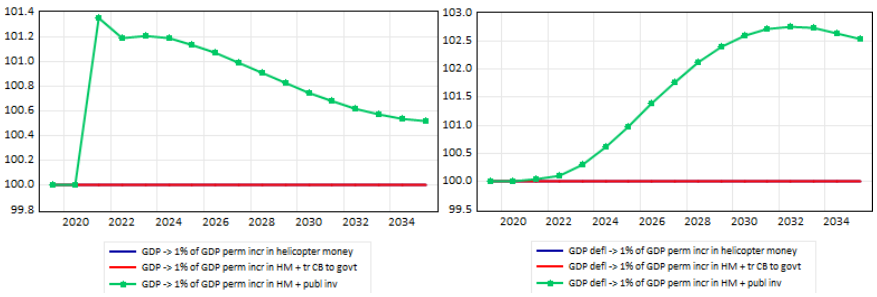
2nd step: HM + transfer to bank account, 1% of GDP



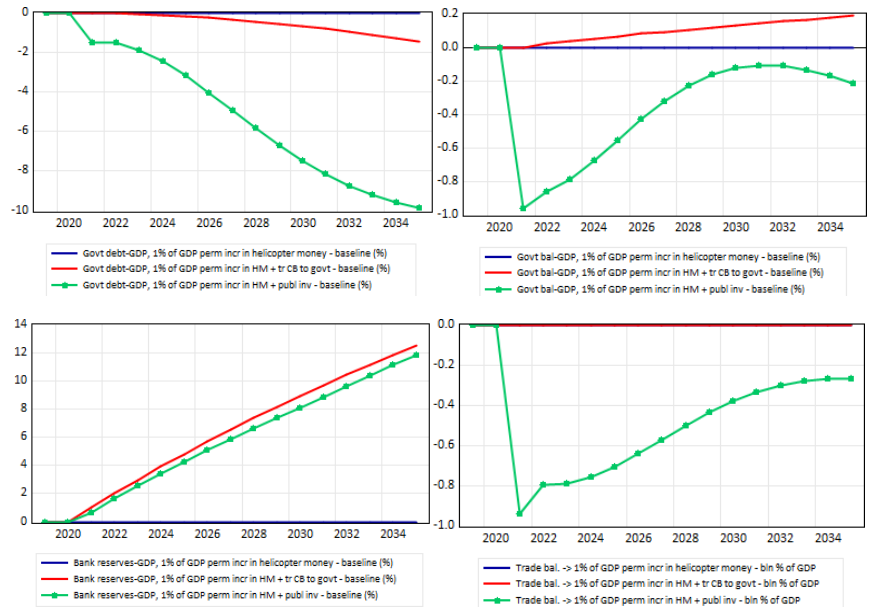
3rd step: HM + increase in public investment, 1% of GDP



Relative deviation from baseline x 100 ($Y^{scenario}/Y^{baseline}$)



Absolute deviation from baseline, series as % of GDP ($Y^{scenario} - Y^{baseline}$)



Public investment, indebtedness and repurchase by the central bank

We can compare public investment financed by helicopter money with another way of financing, traditional public indebtedness combined with the case where the central bank repurchases the public bonds, which can be seen as an illustration of Modern Monetary Theory (Kelton, 2020). Repurchasing the public bonds by the central bank can be simply described in the model by adding an add-factor in the equation determining the public bonds held by the central bank. The additional public investment can be for one year (1% of GDP) or permanent.

The real effects in terms of growth and inflation are similar in all cases. The deterioration of the financial wealth of the nation is the same (12% of GDP in the long term in case of a permanent shock). Nonetheless, the financial effects are contrasted (

Figure **9**). Unsurprisingly, government debt decreases in the case of helicopter money whereas it rises when the additional public investment is financed by indebtedness. The financial wealth of the government improves in the first case (+9 % of GDP in the long-term) and worsens in the second (-4% of GDP). In contrast, the financial wealth of the central bank sharply deteriorates (-12% of GDP) and the bank reserves increase in case of helicopter money while the financial wealth of the central bank is stable in case of public indebtedness.

To finish, the effect of the repurchase of public bonds by the central bank after public debt financing can be examined. The banks hold less public bonds and their reserves increase

largely. The results appear close to the case where there is no repurchase by the central bank. Compared to the case of helicopter money an opposition appears at the level of the financial situation of the various sectors. The financial wealth of the government improves in case of HM and decreases in case of repurchase by the central bank. Conversely the financial wealth of the central bank decreases in case of HM while it is stable in case of repurchase by the central bank. However, it can be noticed that the impact of the repurchase of public bonds by the central bank can be underestimated in the current version of the model where the interest rates are exogenous. This will be examined in another version where the interest rate on bonds will be endogenized.

Public indebtedness and repurchase by the central bank in the model: added variables

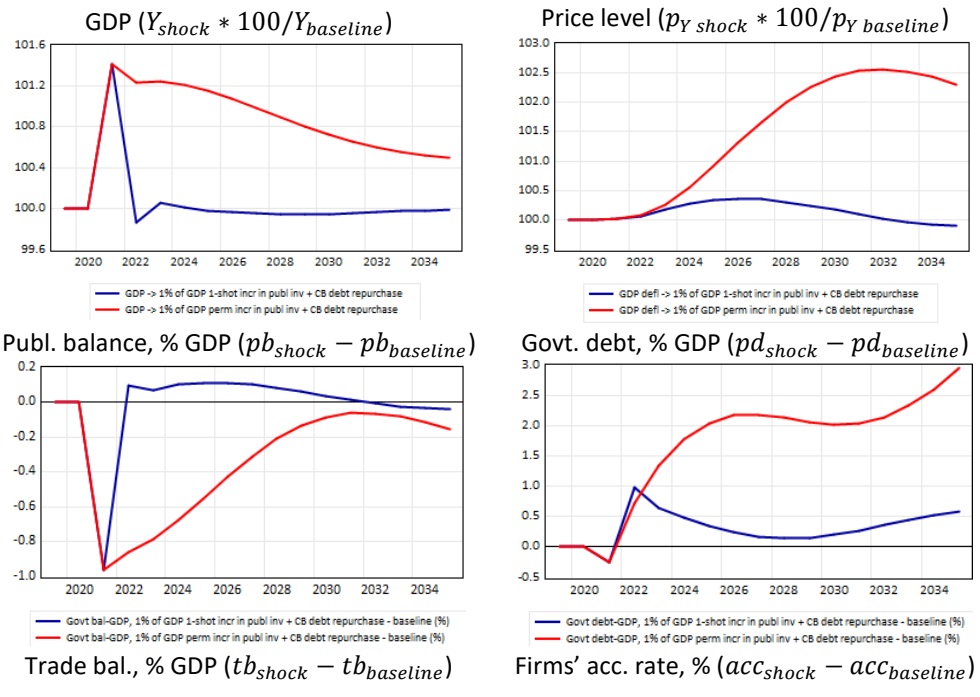
First step: public investment financed by public indebtedness, one shot (1%GDP=25)

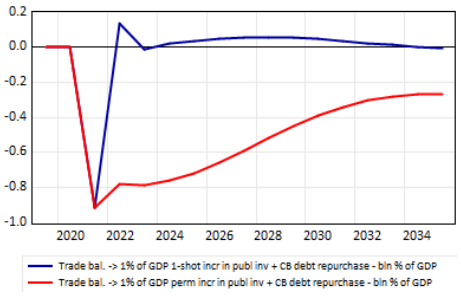
	2021	*2022*	*2023*	…
I_1^G	$25/p_{I1}$	*0*	*0*	

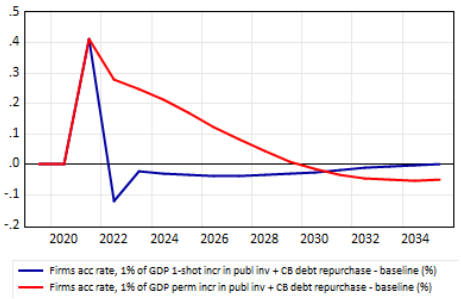
Second step: repurchase by the central bank

	2021	*2022*	*2023*	…
I_1^G	$25/p_{I1}$	*0*	*0*	
$p\Delta B_A^{CBG}$	*25*	*0*	*0*	

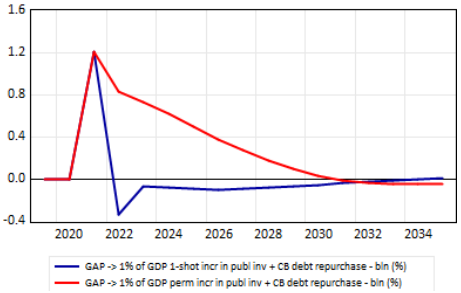
Figure 9 Increase in public investment and debt repurchase 1% of GDP, one-off vs permanent shock



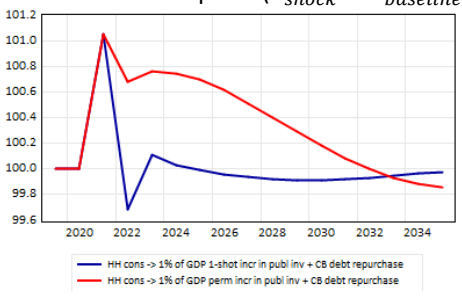




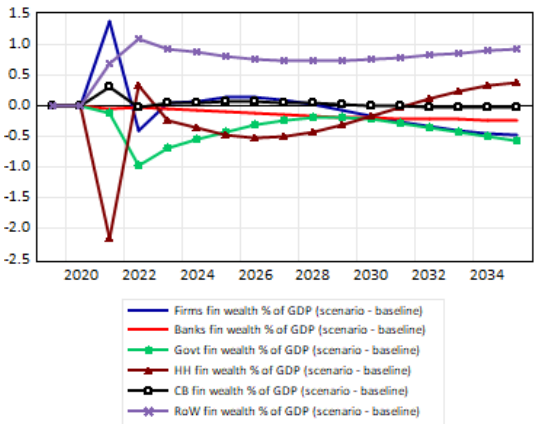
Output gap ($gap_{shock} - gap_{baseline}$)



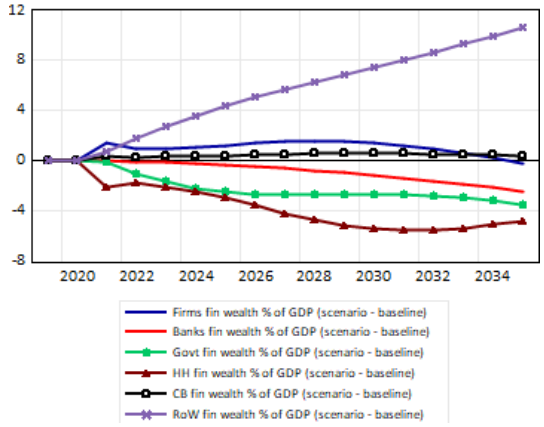
Household consumption ($C_{shock} - C_{baseline}$)



1% of GDP 1-shot incr in publ inv + CB debt repurchase



1% of GDP perm incr in publ inv + CB debt repurchase



Helicopter money and social transfers

Another possible use of helicopter money is to finance social transfers to households for a one shot increase equivalent to 1% of GDP according to the same modalities as in the third step seen previously (the first two steps are identical). The results are similar to the previous ones, a recovery (0.8% the first year) and a moderate price increase (0.2% in the medium-term). The government balance deteriorates (-0.9% of GDP) but without rising public debt (in % of GDP) thanks to the helicopter money distribution and to the recovery (

Figure **10**). The counterpart is a deterioration of the wealth of the central bank and an increase of the bank reserves.

Helicopter money and social transfers in the model (one shot): added variables

First step: helicopter money distribution, without public indebtedness (1%GDP=25)

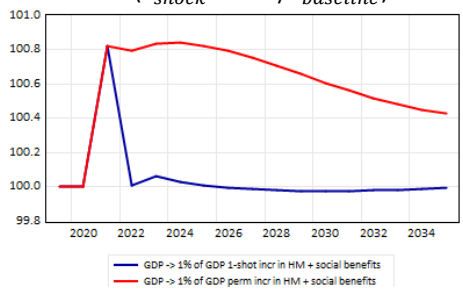
Second step: transfer to government's bank account

Third step: additional social transfers (one year)

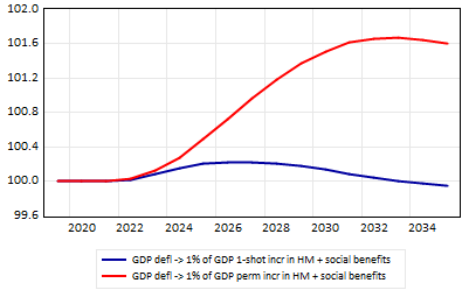
	2021	*2022*	*2023*	…
SB_p^G	*25*	*0*	*0*	*eq. 284*
D_A^G	*0*	*0*	*0*	*eq. 303*
D_L^G	*0*	*0*	*0*	*eq. 301*
$p\Delta BL_L^G$	*-25*	*0*	*0*	*eq. 323*

Figure 10 Increase in HM with social transfers 1% of GDP, one-off vs permanent shock

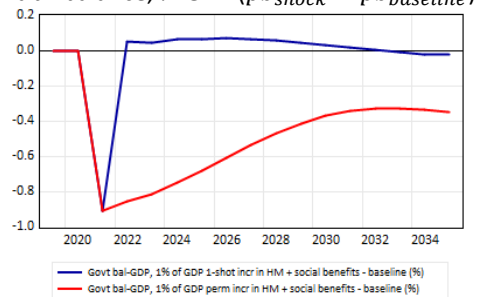
GDP ($Y_{shock} * 100/Y_{baseline}$)



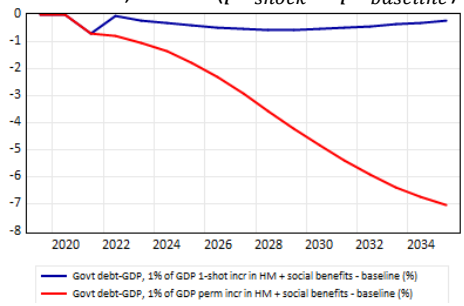
Price level ($p_{Y\ shock} * 100/p_{Y\ baseline}$)



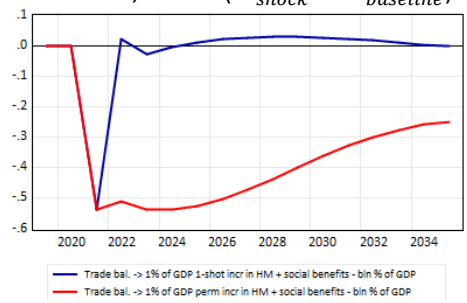
Publ. balance, % GDP ($pb_{shock} - pb_{baseline}$)



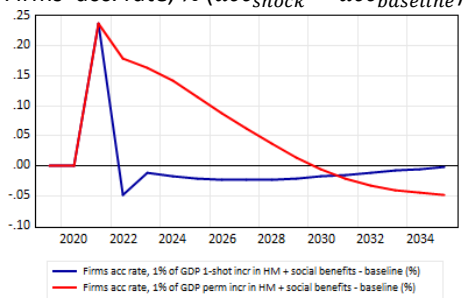
Govt. debt, % GDP ($pd_{shock} - pd_{baseline}$)



Trade bal., % GDP ($tb_{shock} - tb_{baseline}$)

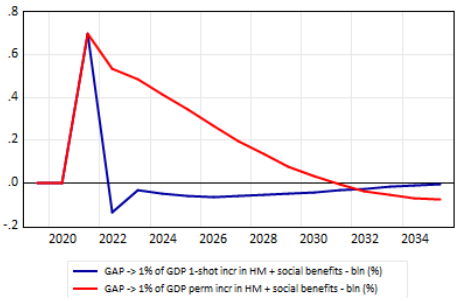


Firms' acc. rate, % ($acc_{shock} - acc_{baseline}$)

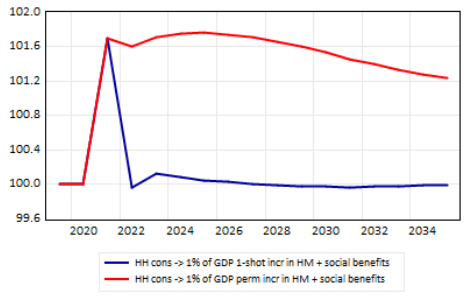


Output gap ($gap_{shock} - gap_{baseline}$)

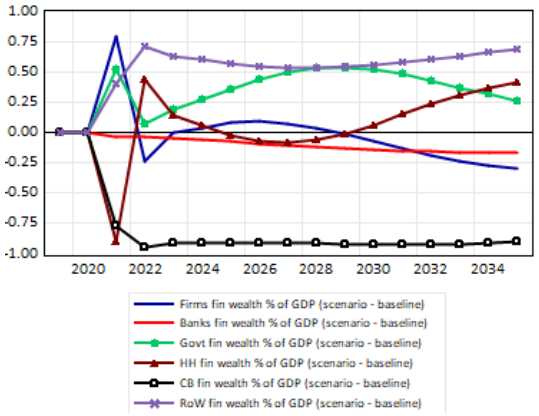
Household consumption ($C_{shock} - C_{baseline}$)

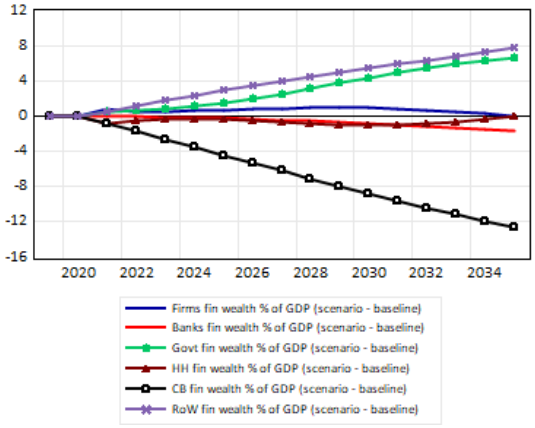


1% of GDP 1-shot incr in HM + social benefits



1% of GDP perm incr in HM + social benefits





If the measure is punctual and limited in time this would not be a problem. However, it seems difficult to sustain this measure as a permanent policy as it is illustrated by a permanent distribution of helicopter money to finance social transfers equivalent to 1% of GDP (

Figure **10**). Production is sustainably higher with a price drift still rather moderate (1.6% in the long-term). Government debt in % of GDP decreases (-6%) but the wealth of the central bank falls dramatically (-13% of GDP) and the bank reserves rises considerably. Last, the rising financial wealth of the rest of the world (8% of GDP) reflects a sharp decrease of the domestic financial wealth.

Helicopter money and social transfers in the model (permanent increase): added variables

First step: helicopter money distribution, without public indebtedness (1%GDP=25)

Second step: transfer to government's bank account

Third step: additional social transfers (permanent)

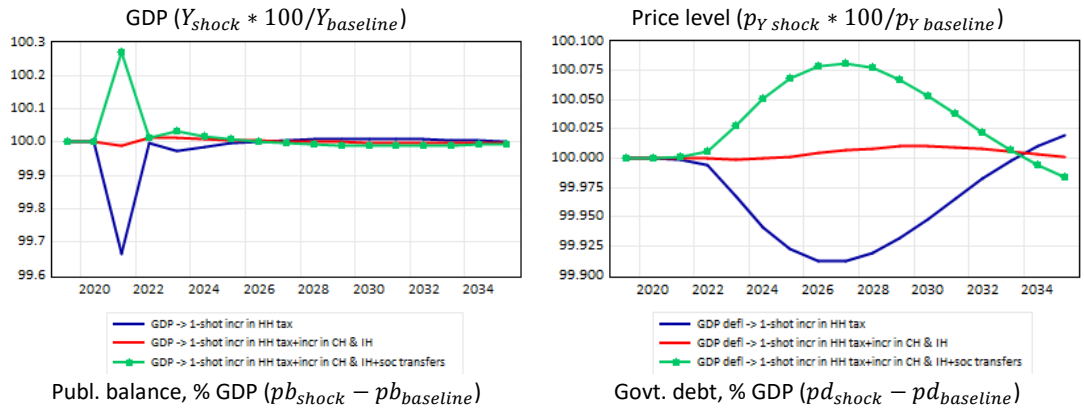
	2021	*2022*	*2023*	…
SB_p^G	*25*	*25*	*25*	
D_A^G	*0*	*0*	*0*	
D_L^G	*0*	*0*	*0*	
$p\Delta BL_L^G$	*-25*	*-25*	*-25*	

Taxation of the rich and social transfers

Last, we analyze a simple incomes policy based on taxation of the rich to finance some social transfers. This policy can be justified since income inequality has increased considerably over

the past four decades and the top incomes have benefited of important tax relief measures. This incomes policy can be simulated in three steps in the model. First, we consider a one-off increase in the tax rate of households affecting all income brackets. This is characterized by an increase of 10 bn euros in (4% of) the income taxes paid by households (blue line in Figure 11). Without surprise, this increase of income taxation has a negative effect on economic activity but slightly improves public finances. Second, if this tax increase only concerns wealthy households, they will not reduce their expenditures but they will save less to pay their taxes. This can be introduced in the model by adding to the initial shock a second one including a 0.5% increase in the volume of household consumption and an additional 0.32% in the growth rate of the volume of households' investment (0.4% increase in level). The result of this combined shock is clear (red line). Since wealthy households preserve their expenditures by saving less, the impact on the economic activity is almost nil. The only impact concerns the public finance which is improved with a reduction of public debt. The counterpart is a reduction of households' wealth. Third, this fiscal surplus can be used to finance a new policy, for example a transfer in favor of the low-level incomes with an increase of 8.5 bn in social benefits (green line). The global result is positive. The economic activity is more sustained with more households' consumption and investment, a slight improvement of the public finance and a reduction of income inequality.

Figure 11 Increase in rich household taxes and social transfers



Publ. balance, % GDP ($pb_{shock} - pb_{baseline}$)

Govt. debt, % GDP ($pd_{shock} - pd_{baseline}$)

Notes: Blue line: Taxes on households increase by 10 billion euros (4% of income taxes paid by HH) in 2021

Red line: blue line + 5.8 bn increase in househld consumption in 2021 and -4.5 bn reduction in 2022 + 0.25% increase in growth rate of household investment in 2021 and -0.1% in 2022

Green line: red line + increase of 8.5 bn in social benefits

Cancellation of public debt held by the central bank

Central banks hold a large amount of government securities, which constitute a significant part of public debt. A proposal put forward by some authors (Scialom and Bridonneau, 2020) is to cancel part of this debt in order to lighten budget constraints, thus providing room for maneuver to better finance the low-carbon transition. This policy (cancellation of public debt equivalent to 5% of GDP) can be studied in the model in a simple way. A first gap-filling variable of -5% of GDP is introduced in the flow-stock equation generating the stock of public debt held by the central bank. The same negative shock is introduced in the flow-stock equation generating the stock of total debt. Lastly, another gap-filling variable equation indicates that the cancellation concerns only public bonds. This partial cancellation of public debt held by the central bank has no effect on the real economy. Public debt falls initially (-5% of GDP) but central bank wealth falls as much and remains around 5% of GDP lower than in the baseline (Figure 12).

For supporters of this policy, the reduction of public debt would loosen the constraints and would open the way to an increase in public investment (1% of GDP on a permanent basis) to finance the energy transition. As the simulations show, the combination of these two measures, partial cancellation of debt and increase in public investment, leads to a sustained recovery with rising inflationary pressures due to demand pressure and wage drift. Thanks to the cancellation, public debt remains under control despite the initial increase in the public deficit. The counterpart of these evolutions is a persistent and marked deterioration of the central bank's wealth (-5% of GDP).

These results raise, in addition, the same reservations as those formulated about helicopter money. Insofar as the amounts of cancellation are high (more than in the previous case), it is difficult to believe that this marked deterioration of the central bank's own funds can remain without consequences. The risk of rising interest rates cannot be ignored. The ways in which the central bank can replenish its capital are not convincing, and accepting such policy within the Eurozone seems rather unlikely. In another version (Mazier and Reyes, 2022b) we carry out simulations that show that central bank recapitalization is more complex than a "simple click".

Partial cancellation of public debt held by the central bank and permanent increase of public investment in the model: added variables

First step: partial cancellation of public debt held by the central bank

	2021	*2022*	*2023 …*
$OCVB_A^{CBG}$	*-5%GDP*	*0*	*0*
$OCVBL_L^G$	*-5%GDP*	*0*	*0*
pB_L^G	*-(1- ψ)5%GDP*	*0*	*0*

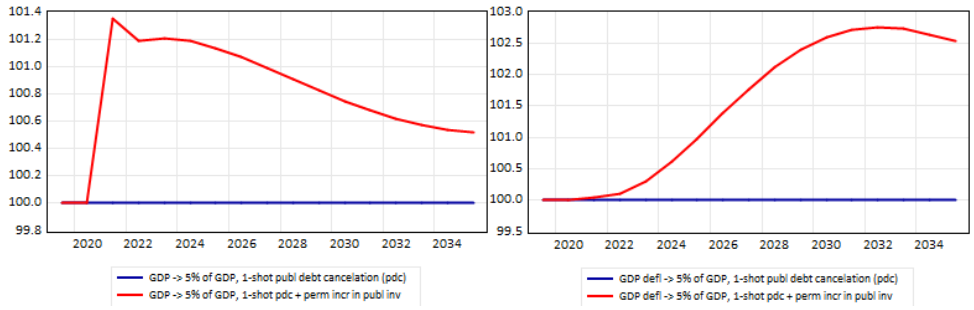
A first gap-filling variable of -5% of GDP is introduced in the flow-stock equation generating the stock of public debt held by the central bank (B_A^{CBG}). The same negative shock is introduced in the flow-stock equation generating the stock of total debt at the liability side of the government (BL_L^G). This is introduced in the term other changes in volume (OCV) that closes the flow-stock equation and integrates, among others, the effects of the cancellation. Lastly, another gap-filling variable indicates that the cancellation concerns only public bonds ($pB_L^G = \psi BL_L^G$).

Second step: additional public investment (permanent)

	2021	*2022*	*2023 …*
I_1^G	$25/p_{I1}$	$25/p_{I1}$	$25/p_{I1}$
$OCVB_A^{CBG}$	*-5%GDP*	*0*	*0*
$OCVBL_L^G$	*-5%GDP*	*0*	*0*
pB_L^G	*-(1- ψ)5%GDP*	*0*	*0*

Figure 12 Impact of a partial cancellation of public debt held by the central bank (5% of GDP) + 1% of GDP permanent increase of public investment, starting in 2021

Relative deviation from baseline $(Y^{scenario} \cdot 100/Y^{baseline})$



Absolute deviation from baseline, series as % of GDP ($Y^{scenario} - Y^{baseline}$)

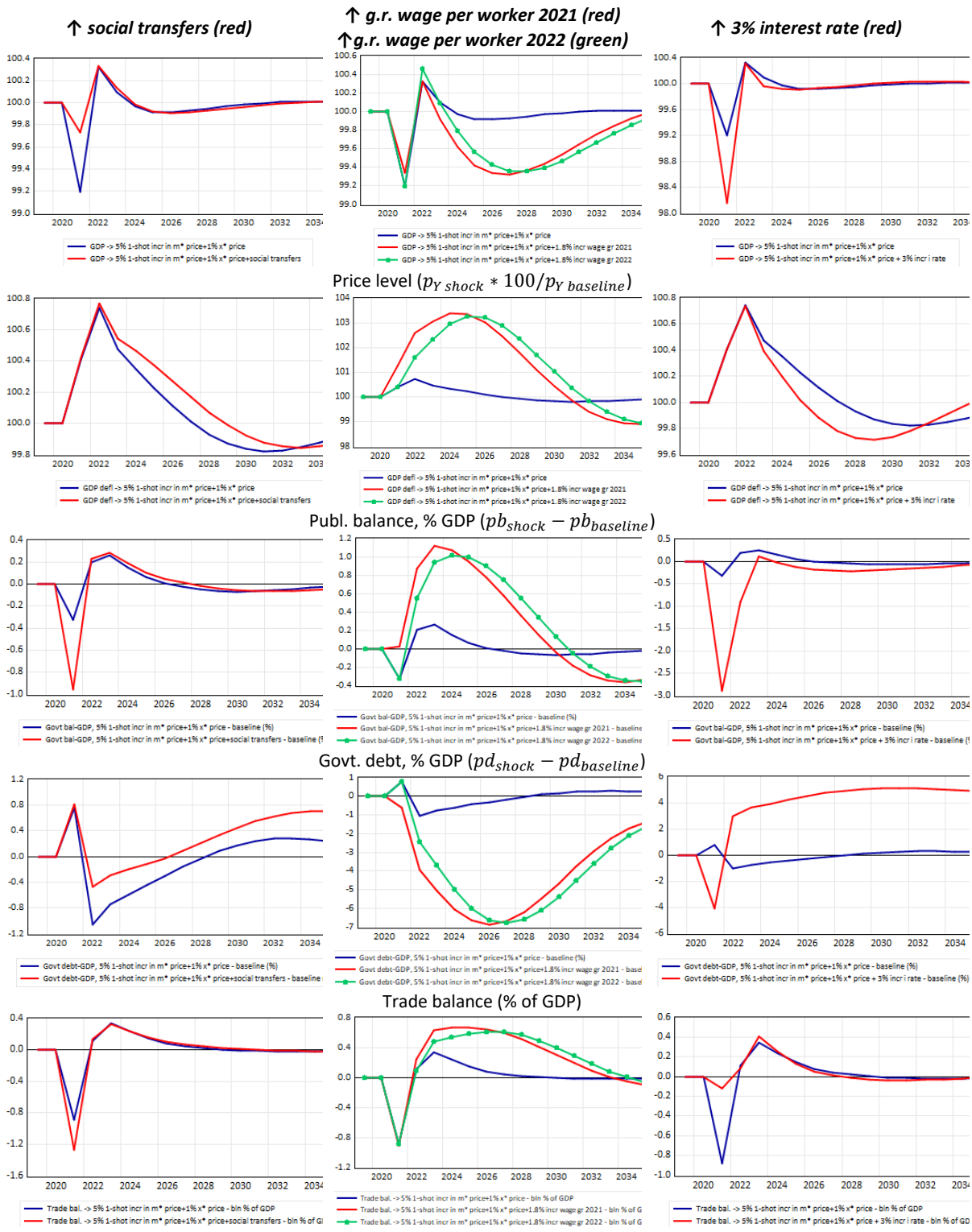
Inflationary shock and possible policy responses

In this part we study an inflationary shock coming from the rest of the world and its impact on the French economy. This takes place via an increase in import prices but also world export prices by 5%. We compare this to the same shock with a few policy responses added: interest rate hike of 3% (to fight inflation in a traditional way), increased social transfers by 0.7% of GDP (to support households' income) or 1.8% increase in the growth rate of wage per worker (to try to preserve the purchasing power of wages). Figure 13 shows the effects of these shocks on a sample of series.

Figure 13 Inflationary shock (blue) and scenarios starting in 2021 unless otherwise stated, model 2

↑ social transfers (red) | ***↑ g.r. wage per worker 2021 (red)*** ***↑g.r. wage per worker 2022 (green)*** | ***↑ 3% interest rate (red)***

GDP ($Y_{shock} * 100/Y_{baseline}$)



In this hypothetical scenario, in 2021 a 5% increase in world import prices induces an imported inflation which lowers the purchasing power of workers. Economic activity slows down. The 5% increase in export prices makes the value of French exports rise, but this positive effect combined with the increase in world import prices (which makes imports increase even more[3])

[3] Note that the long- and short-term parameters in the price and volume equations of imports are larger than those of exports.

yields an initial 0.8% of GDP trade deficit. With the economic slowdown the public balance as a share of GDP initially worsens (-0.4% of GDP). But after the initial inflationary shock a reversal appears. Inflation falls. The trade balance reverses its course and remains slightly in surplus. The public balance as a share of GDP also improves. Government debt mirrors this evolution, rising by 0.5% in 2021 and then falling by 0.7% the next year. All in all, after the initial drain linked to the rise in import prices, economic activity rebounds and the GDP joins the base line scenario.

Facing this external shock, the authorities could decide to increase social transfers SB_p^G by 0.7% of GDP (column 1, red) in order to support households. This has indeed the desired lessening effect on the output drop, although at the cost of (slightly) raising demand-pull inflation, worsening public finances and the trade balance. But this degradation remains limited. Fighting an imported inflationary shock through social transfers appears as a good option as long as the shock does not continue.

A second option would be to increase wages in the hope of preserving the purchasing power (column 2, red and green). We analyze the consequences of doing so in 2021 (when the inflationary shock takes place) or the year after. The results are not fundamentally different in either case, except for the lag in the response of the series. Prices rise considerably and a wage-price spiral starts. GDP worsens due to the declining purchasing power induced by increasing inflation. In spite of the inflation drift the trade balance improves thanks to the declining demand. The only positive point of this scenario is the improvement of the public finance induced by the inflation drift. The public balance increases by more than 1% of GDP and the stock of government debt falls by 8% of GDP in 2028. Fighting an imported inflationary shock by increasing wages does not seem a good option for the workers but the acceptance of an inflationary drift can be useful for public finances.

A third option is that the inflationary shock questions the credibility of the central bank and has to be fought by traditional monetary policy tools. A 3% increase in the interest rate is introduced as an illustration (column 3, red). The cost of this restrictive policy is high for a rather modest and delayed effect on prices. The rise in domestic prices is progressively contained, via the sharp contraction in aggregate demand (-2% GDP in 2021). The public balance worsens significantly (-3.2% of GDP in 2021) due to the slowdown and the decrease of public resources. Furthermore, public debt as a share of GDP is much higher starting 2022 (4% of GDP and higher afterwards), due to the reduced activity and the more moderate prices which limit the nominal GDP. This traditional contractionary monetary policy with the increase in the interest rate is not adapted to fight imported inflation that is not caused by excessive demand pressure. Its cost is high for a limited and delayed result.

Towards an endogenization of the rate of interest

Interest rates are exogenous in the present version of the model. It seems logical to keep the ECB key interest rate ($r_€$) exogenous as one of the main tool for monetary policy. But the 10-year interest rate on public bonds (i_{10yrs}) could be endogenized as it is playing a leading role. Following the SFC tradition it could be determined implicitly by the balance of the public bonds market between the supply $p_{B_L}^G \Delta^* B_L^G$ coming from the government balance and the demand of

public bonds by the different agents, banks ($p_{B_A}^{B_G}\Delta^* B_A^{B_G}$), central bank ($p_{B_A}^{CB_G}\Delta^* B_A^{CB_G}$), firms $\left(p_{B_A}^{F_G}\Delta^* B_A^{F_G}\right)$ and rest of the world ($p_{B_A}^{R_G}\Delta^* B_A^{R_G}$).

$$p_{B_L}^{G}\Delta^* B_L^{G} = p_{B_A}^{B_G}\Delta^* B_A^{B_G} + p_{B_A}^{CB_G}\Delta^* B_A^{CB_G} + \ + p_{B_A}^{F_G}\Delta^* B_A^{F_G} + p_{B_A}^{R_G}\Delta^* B_A^{R_G}$$

By substituting in the previous equation the demand of public bonds by the rest of the world ($p_{B_A}^{R_G}\Delta^* B_A^{R_G}$) and by the banks ($p_{B_A}^{B_G}\Delta^* B_A^{B_G}$) and by solving for i_{10yr} we obtain :

$$\left(\frac{p_{B_A}^{R_G}\Delta^* B_A^{R_G}}{p_Y Y}\right) = 0.02 + 0.78\left(i_{10yr} - i^{LT*} + \frac{\Delta NEER}{NEER_{-1}}\right)$$

$$\left(\frac{p_{B_A}^{B_G}\Delta^* B_A^{B_G}}{p_Y Y}\right) = 0.35\left(\frac{p_{B_{A-1}}^{B_G}\Delta^* B_{A-1}^{B_G}}{p_{Y-1}Y_{-1}}\right) + 0.5\left(i_{10yr} - i^{LT*} + \frac{\Delta NEER}{NEER_{-1}}\right)$$

Where i^{LT*} is the weighted average long-term foreign interest rate and $NEER$ is the nominal effective exchange rate.

$$i_{10yr} = \left(i^{LT*} - \frac{\Delta NEER}{NEER_{-1}}\right) + \left(\frac{1}{1.28}\right)\left(\left(\frac{p_{B_L}^{G}\Delta^* B_L^{G} - p_{B_A}^{CB_G}\Delta^* B_A^{CB_G} - p_{B_A}^{F_G}\Delta^* B_A^{F_G}}{p_Y Y}\right) - 0.02 - 0.35\left(\frac{p_{B_{A-1}}^{B_G}\Delta^* B_{A-1}^{B_G}}{p_{Y-1}Y_{-1}}\right)\right)$$

where the public bonds held by the central bank $p_{B_A}^{CB_G}\Delta^* B_A^{CB_G}$ are driven by the quantitative easing, the public bonds held by firms ($p_{B_A}^{F_G}\ B_A^{F_G}$) are small and simply determined in percentage of the value added and the public bonds issued by the government ($p_{B_L}^{G}\Delta^* B_L^{G}$) are closing the public account. According to this equation the main determinant of the 10-year interest rate on public bonds is the foreign one, after correction of the exchange rate variation $\left(i^{LT*} - \frac{\Delta NEER}{NEER_{-1}}\right)$. A larger issuance of public bonds increases the 10-year interest rate while a more active quantitative easing decreases it. Unfortunately, problems of respect of financial wealth balances appeared in solving the model with this specification.

A simpler modelling has been tested. The closure for domestic public bonds held by banks is kept as in the version where interest rates are exogenous. This allows to keep explicitly the accounting equation.

$$p_{B_A}^{B_G}\Delta^* B_A^{B_G} = p_{B_L}^{G}\Delta^* B_L^{G} - p_{B_A}^{CB_G}\Delta^* B_A^{CB_G} - p_{B_A}^{F_G}\Delta^* B_A^{F_G} - p_{B_A}^{R_G}\Delta^* B_A^{R_G}$$

The interest rate is now the solution for i_{10yr} in the (unwritten) estimated equation

$$\left(\frac{p_{B_A}^{B_G}\Delta^* B_A^{B_G}}{p_Y Y}\right) = 0.7\left(i_{10yr} - i^{LT*} + \frac{\Delta NEER}{NEER_{-1}}\right)$$

Solving the previous expression for the domestic interest rate yields

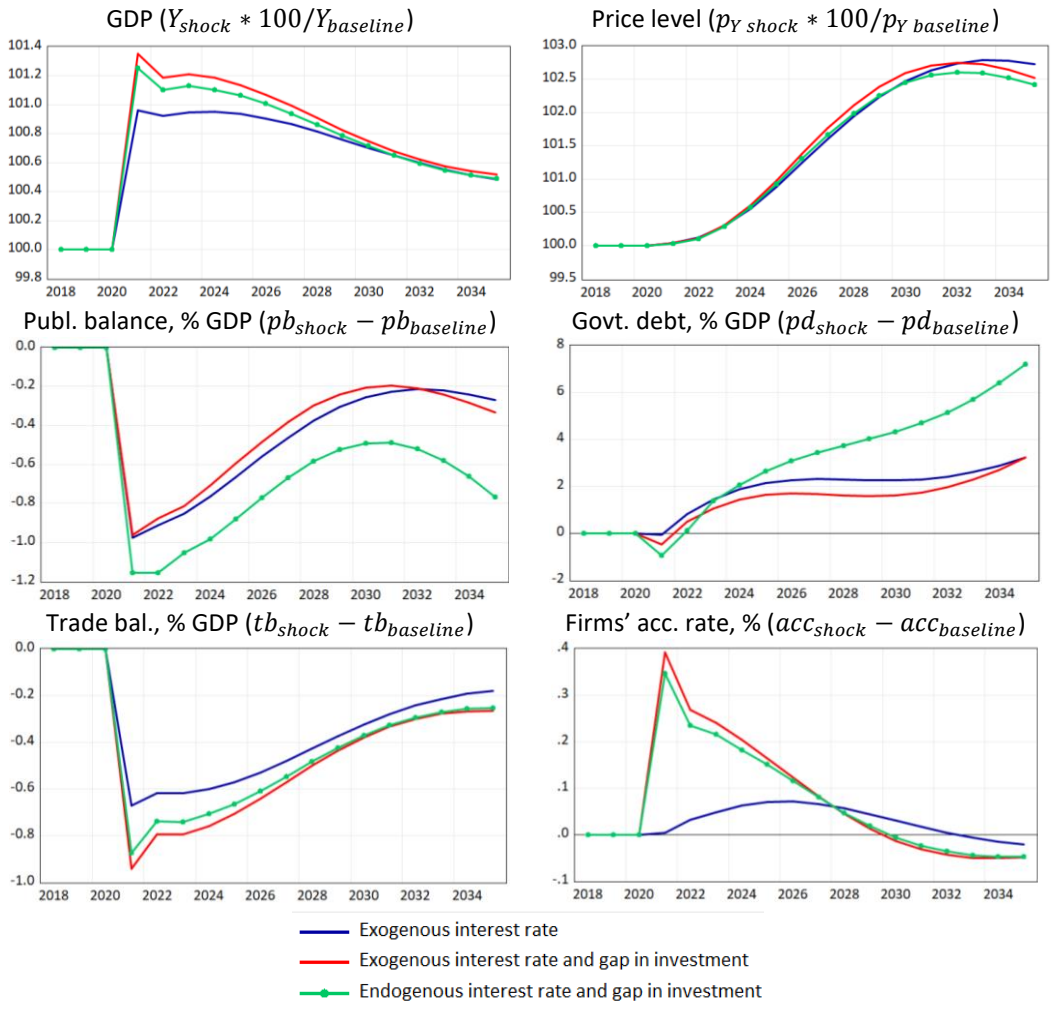
$$i_{10yr} = \left(i^{LT*} - \frac{\Delta NEER}{NEER_{-1}}\right) + 1.4\left(\frac{p_{B_A}^{B_G}\Delta^* B_A^{B_G}}{p_Y Y}\right)^{4}$$

This version of the model with endogenous interest rate works correctly and yields acceptable results for the simulations on the past. We can compare the multiplier effects of a permanent

[4] In order to keep this version from being overly sensitive to the evolution of public bonds, the parameter 1.4 was divided by 5. Hence the actual parameter entering the equation is 0.28 (this parameter is also used in Figure 2 below).

hypothetical increase in public investment by 1% of GDP starting in 2021 under three possible model specifications: *model 1* includes an exogenous interest rate and no output gap in firms' accumulation rate, *model 2* also has an exogenous interest rate and there is an output gap in firms' accumulation rate, while *model 3* includes an endogenous interest rate and the output gap in the accumulation rate (Figure 14).

Figure 14 Public investment increases permanently by 1% of GDP, 3 variants of the model



In the figure we observe that model 3 with endogenous interest rate displays results close to those of model with exogenous interest rate, except for public finances which worsen more when the interest rate is endogenous (because of its slight tendency to increase following an activist fiscal policy). The evolution of the price level is very similar in the three models, which increases by about 2.5% after 10 years.

Conclusion

Based on the national accounts and *comptes de patrimoine* by INSEE, as well as the financial accounts by Bank of France, an econometric SFC model of the French economy has been presented. It is an aggregate model with a single product distinguishing five domestic agents (firms, households, banks, central bank, government) and the rest of the world with a

complete representation of economic and financial accounts in flows and stocks. The structure of the model is close to that of existing SFC models with demand-led dynamics, an accumulation behavior of a Kaleckian type and an indebtedness norm. A new version has been presented with an impact of demand pressure on firms' investment described via an output gap. The dynamic simulations on the past over the period 1996-2019 provide acceptable results. A comparison of the two models, with or without output gap effect on investment, has been made with the help of usual multipliers. The results of both models seem close.

The model has been used to study the effects of different forms of unconventional monetary policies. First, a distribution of helicopter money in favor of the government to finance additional public investments or social transfers has a stimulating impact without increasing public debt. However, as a counterpart the wealth and own funds of the central bank deteriorate by an amount equivalent to the initial shock. If the intervention is not punctual and limited, this evolution could be problematic. Second, the combination of public indebtedness and repurchase by the central bank has been described. The results seem close to the case where there is no repurchase by the central bank but the effects of the repurchase may be underestimated in a version of the model with exogenous interest rates. Third, partial cancellation of the public debt held by the central bank has been examined. It has, as a counterpart, a degradation of the wealth and own founds of the central bank which are too important to remain without consequences. Taxation of the wealthy households to finance social transfers in favor of the bottom income brackets has been simulated and provided positive results.

Imported inflationary shocks have been studied with various policy responses. Increasing social transfers to support households seems like a good option, as long as the shock does not continue. On the contrary increasing wages in the hope of preserving the purchasing power would induce an inflation drift not favorable to the workers, but that could prove useful for public finances. A restrictive monetary policy with an increase in interest rates is not adapted to fight imported inflation. It would have a high cost in terms of growth and public finance situation for a limited and delayed result in terms of inflation.

Last, a simple endogenization of the interest rate, based on the balance of the public bonds market, has been tested. Results seem close to the results of the model with exogenous interest rates, except for public finances which worsen more. This version of the model could be checked in more details and improved; especially, to examine the consequences of monetary financing and repurchase of public bonds by the central bank. Furthermore, an explicit treatment of the ECB (currently integrated in the rest of the world) and a modelling of the rest of the euro zone remain to be done. This would help to analyze the potentiality of a central bank digital currency.

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