Macro-foundations of Micro and Micro-foundations of macro: Income Distribution, Increasing risks and Household Behaviours

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Summary

I. AN ATTEMPT TO SYNTHESIZE SFC AND AB MODELLING

The aim of the paper is to synthesize the stock-flow consistent modelling and the agent based modelling using the EVIEWS software. Then we try to make it compatible the macroeconomic framework of the post Keynesian SFC modelling ("top-down model") and heterogeneous microeconomic foundations ("bottom-up model"). The heterogeneity of agents concerns the households.

As Boland (1982) explains, Keynes was more concerned with the lacking macro-foundations of microeconomics than the micro-foundation of macroeconomics. Post Keynesian SFC modelling is exactly concerned with the macro-foundations of micro.

The orthodox critics of Keynesian theory have a formal micro-foundation, but they get this by modelling a multitude of similar agents, *i.e.* by using a representative agent. In the real world, agents are heterogeneous in their rationality. In our model, we introduce heterogeneity in the rationality of households. For instance, this heterogeneity can be explained by the unequal income distribution, but also by different mindset or mood of households. There is not a representative household.

With Keynes' approach and in a complex system, the action of the whole is more than the simple sum of the actions of its parts. Notably the accounting system is a medium through which economic interaction takes place, and through which the feedback from macro to micro works. But with a SFC model, you stabilize the economy on a steady state and then it is difficult to understand endogenous crisis without an exogenous shock. And somehow, the macroeconomic behaviour of each sector likes that of a representative agent. Interaction between heterogeneous agents in a SFC macroeconomic model can provide interesting solutions.

Macro-foundations for the behaviour of economic agents: a stock flow consistent model

The transmission channels from the macroeconomic framework on micro behaviour are numerous.

First, to build a macroeconomic model with two consistent matrices (stock and flows) constrained behaviours of different economic agents. The shape of the model involves macro-foundations for the micro-agents. As Godley and Cripps argued in 1983: *« The fact that money stocks and flows must satisfy accounting identities in individual budgets and in an economy as a whole provides a fundamental law of macroeconomics analogous to the principle of conservation of energy in physics »*. Top down modelling forced microeconomic behaviours.

Second, conventions are focal points for decision making of agents under uncertainty. Keynes noted in 1938 (p. 294): *« To avoid being in the position of Buridan's ass, we fall back, therefore, and necessarily do so, on motives of another kind, which are not 'rational' in the sense of being concerned with the evaluation of consequences, but are decided by habit, instinct, preferences, desire, will, etc. »*. For instance, we introduce in the model some conventional leverage ratio (acceptable leverage) in the lender's risk of banks. Lender's risk only increases above this conventional leverage ratio. And this conventional ratio can be linked endogenously to the growth rate to match the minskyan paradox of tranquillity.

Third, with the radical uncertainty, state of confidence and self-fulfilling prophecies are crucial for effective demand. Firms' expectations are the keystone to understand the present. With radical uncertainty, agents' expectations can become self-fulfilling prophecies. As Keynes said, in economics, when the people go out with umbrellas, it rains. Group expectations are the strongest predictor of future events and the most important expectations are those of entrepreneurs. In the *General Theory*, Keynes stressed the importance of psychological variables in determining economic growth, particularly because of radical uncertainty. The state of confidence of private agents affects the economy through three psychological laws, which are at the heart of the model:

- For entrepreneurs: the marginal efficiency of capital (expectations of the profits) that determines the 'effective demand' and therefore the current production, income and demand of external finance.

- For commercial banks: the liquidity preference that determines 'effective finance'. Indeed, as in our previous works (Le Heron, 2007), we generalize the liquidity preference, understood as an increasing risk, to commercial banks.

- For households: the marginal propensity to consume implies an optimistic or pessimistic view of their future income.

A loss of confidence, which corresponds to a generalized liquidity preference, that is to say the fear of long-term commitment, leads quickly to an economic crisis. Entrepreneurs want to stop investing, banks lending and then households consuming. With the collapse of effective demand, household incomes decline, resulting *de facto* in a decrease of consumption.

As Keynes defined it so well in the *General Theory* (chap. 12, 1973 [1936], pp.147-8)

> *"The considerations upon which expectations of prospective yields are based are partly existing facts which we can assume to be known more or less for certain, and partly future events which can only be forecasted with more or les confidence. (...) We may sum up the state of psychological expectation, which covers the latter as being the state of long-term expectations; (...). The state of long-term expectation, upon which our decisions are based, does not solely depend, therefore, on the most probable forecast we can make. It also depends on the confidence with which we make this forecast - on how we rate the likelihood of our best forecast turning out quite wrong. (...)*
>
> *The state of confidence, as they term it, is a matter to which practical men always pay the closest and most anxious attention. But economists have not analysed it carefully and have been content, as a rule, to discuss it in general terms. In particular it has not been made clear that its relevance to economic problems comes in through its important influence on the schedule of the marginal efficiency of capital."*

Entrepreneurs' vision of the future, but also the confidence that entrepreneurs have in this vision, largely determines the present (current income) and therefore what will our future will really be.

Thus Keynes demonstrates the simultaneous importance, in part contradictory, of animal spirits (spontaneous risk taking) and conventions (confidence in the stability of current steady state). The crisis is reflected in lower animal spirits and the questioning and changes in the conventions. These macroeconomic factors are very important for understanding individual behaviours.

Micro-foundations for macroeconomic trends: which framework for agent based modelling

First, the representative agent is not a realistic hypothesis. The importance of the heterogeneity of agents, not only in their preferences, but more fundamentally in their rationality, is crucial for understanding the economic world and, in particular, the endogenous occurrence of crisis.

Second, a "real economy" that respects Keynes' approach, is a monetary economy and therefore we need endogenous money. As Charlotte Bruun noticed in 1999 (p.2)

> *" What distinguishes agent-based Keynesian economics from agent-based computational economics in general, which tends to focus on exchange processes, is the role played by money, comprising the role played by monetary prices as stabilizing devices rather than relative prices as market clearing devices and the role played by monetary values in economic decision making. (...). Using agent-based computational techniques, Keynesian macro-theory may be micro founded without loosing its sting."*

Third, the micro-foundations of agent' decisions do not necessarily mean an optimization of utility. Enforce rules of behaviour is more realistic than rational process of optimization.

> *" Agents live in an uncertain and complex world, and they need tools for coping with uncertainty and the complexity. One such tool is money and contracts in money-terms, another tool is to base decision making on simple rules rather trying to optimize".* (C. Bruun, 1999, p.8)

Fourth, Charlotte Bruun presented in 1999 an interesting method to make consistent the macro and micro approaches :

> *"- First study the macro-properties of the system without implicating behaviour in more than broad terms.*
>
> *- Secondly study a single micro unit, bearing the macro-properties in mind.*
>
> *- As a third step, study the interaction between macro-properties and micro-properties by allowing a whole population of micro units to interact."*

Fifth, with agent-based modelling, you do not need to suppose a equilibrium or a steady state. The trend of the economy is the consequence of the numerous micro-agent interactions. However, the SFC modelling implies a steady state and then, we can understand any destabilization. Consequently, the steady state must be regarded as a hypothetical situation constituting a benchmark for the experiments, but without additional meaning.

Six, to put heterogeneity in the behaviour of agents requires to tell a story. We introduce heterogeneity only in households. The first explanation for a different behaviour is the unequal distribution of income. Following Kalecki, we distinguish two classes: workers and capitalists. The second explanation is the mood of the workers: we distinguish three types of workers. The optimistic workers always want to increase their consumption at the same rate, even if their income (lower wage, lower growth, change in distribution) decreases. They go into debt if necessary when the production declines. The normal workers keep the same marginal propensity to consume, which therefore adapt to the level of their income. Finally, the pessimistic workers change their marginal

propensity to consume, notably to increase their savings as a precaution when the rate of growth decreases.

Seven, the mindset of workers may change slightly depending on the macroeconomic situation (growth rate of the GDP). The proportion of the three types of workers is not constant over time.

The theoretical background of the SFC model

Today, PK means usually post-Keynesian school. But it can express as well the post-Kaleckian or post-Kaldorian schools. More, Michal Kalecki seems certainly the most important reference, because he is said to have discovered Keynes's principle of effective demand on his own in 1933 and he influenced strongly Cambridge economists, in particular Nicholas Kaldor. With Rosa Luxemburg or Gunnar Myrdal, Michal Kalecki was among the first to show the importance of demand in growth theory. Then, in this paper, we mix some ideas from Kalecki, Kaldor and Keynes.

From Kalecki, we use mark-up pricing theory, fixed technical coefficient, capacity of utilisation, two classes of households (workers and capitalists). The model is a dynamic growth model introducing lags and time. The long run is conceived as a chain of short terms. With the corporate retained profits, we introduce the principle of increasing risk (Kalecki, 1937) in the borrower's and the lender's risks. From Kalecki and Keynes, we develop the importance of the state of confidence. The relevance of income distribution is introduced in the consumption function as Kaldor perfectly summarized with the sentence on Kalecki (1956, p.96): *« capitalists earn what they spend, and workers spend what they earn ».* From Kaldor, we use the endogenous theory of money, even if our model is not strictly horizontalist. There is a rationing of financing by the bank sector. From Keynes, we use the liquidity preference theory, but we generalized it to all private sectors: firms, banks and household. From Keynes and Minsky, we use the borrower and lender's risk and the importance of financial features. And finally, we use the SFC framework from Lavoie and Godley.

First, I shall build a PK stock-flow consistent (SFC) model (Lavoie-Godley, 2001, 2007; Dos Santos-Zezza, 2004; Le Heron, 2008-2011) with four heterogeneous types of households. Second, I shall simulate the model with two kinds of shock (an increase in the interest rate and a change in the income distribution) to study the interactions between the micro and the macro levels and to understand the stability of the system or the existence of economic cycles.

II. A STOCK-FLOW CONSISTENT GROWTH MODEL WITH HETEROGENOUS HOUSEHOLDS

I shall develop more specifically the different behaviours of households and the most specific matter of the model[1]. The economy contains six sectors: government, firms, households divided into various workers and capitalists, private banks and central bank. SFC modelling is based on two tables: the transactions matrix (flows, appendix 3) and the balance sheet matrix (stocks, appendix 4). The complete dynamic model (Appendix 2) contains 58 equations.

All production must be financed. However, current production is financed by the working capital of entrepreneurs (retained earnings) and by contracted revolving funds granted by banks at the current rate of interest. These two factors constitute a shock absorber to possible monetary rationing by banks. I am essentially limiting my study to the effects that a change in the lender's risk might have on new financing for firm investment and for household consumption. Let us proceed to examine the gross supply (φ) and the net supply (ΔL) of finance by banks – that is to say, the new flow of money, as opposed to the existing stock of money (D). Also, there is a stock of money demand equal to transaction, precaution, finance and speculative motives, whereas the desired gross finance demand (φ^d) represents the new flow of financing required by firms for the desired investment (I^d) and for the redemption of the debt (amortization = amL_F) minus the undistributed profits ($P_F{}^u$) and the desired finance demand ($C_{Wod} - C_{Wos}$) from the optimistic workers. Assuming a closed economy, demand for money can be satisfied by banks by credit. At the end of the period, net financing demand (ΔL_D) can be constrained by net money supply from banks (ΔL). ΔD determines monetary creation in the period, issued from loans to firms (L_F) and to households (L_{Wo}) and Treasury bonds (B) to Government.

The national income (Y) adds the household consumption (C), investment of the firms (I) and the public expenditure (G). The rate of growth of the national income is gr_y.

Investment of Firms

The investment function is the most important one in a growth model. The stock of capital (K) increases with the flow of net investment (I) that is financed by the total of the corporate retained profits of firms and by external funds from commercial banks (gross finance = φ). Firms prefer self-financing (Kalecki, 1937; Eichner, 1976), because borrower's risk begins with external funds. The self-financing of firms (IF) corresponds to the net retained profits, *i.e.* the retained earnings ($P_F{}^u$) minus the redemption of the debts of firms (amL_F). Firms borrow money from banks to finance investments (loan at variable rate) (L_F).

(1) $I \equiv \varphi + IF$

(2) $IF = P_F{}^u - amL_F$

(3) $amL_F = a_l \cdot L_{F-1}$

In this model, I differentiate between the effective investment (I) and the desired investment of firms (I_D). The banks finance the latter totally or in part according their lender's risk (LR_F). A

[1] You will find more explanations in Le Heron and Mouakil (2008) and Le Heron (2009) for a Post Keynesian model and in Le Heron (2008 and 2011) for a Keynesian stock-flow consistent model. Even if this model is a new one.

rationing in investment financing can exist ($\varphi < \varphi^d$ or $I < I_D$). The desired rate of accumulation (gr_{kD}) is a function of an exogenous state of confidence (γ_0), the capacity utilization rate (u) and of the increasing risk of the borrower, which is measured by the rate of cash flow (r_{cf}) and by the financial condition index (FCI). The rate of cash flow is the ratio of retained profits to capital and the financial condition index captures the sensitivity of investment to the level of indebtedness and to the long-term interest rate. The borrower's risk captures the Kalecki's principle of increasing risk. The risk increases with a lower self-financing and the size of investment.

(4) $I_D = gr_{kD} \,.\, K\text{-}1$

(5) $\varphi^d = I^d - IF$

(6) $gr_{kD} = \gamma_0 + (\gamma_1 \cdot r_{cf\text{-}1}) + (\gamma_2 \cdot u_{\text{-}1}) - (\gamma_3 \cdot FCI_{-1})$ With γ_i: constant

where the rate of capacity utilization is defined as the ratio of output to full capacity output (Y_{fc}):

(7) $r_{cf} = P_F^u / K_{\text{-}1}$

(8) $u = Y / Y_{fc}$

The capital to full capacity ratio (σ) is defined as a constant:

(9) $Y_{fc} = K_{\text{-}1} \cdot \sigma$ With σ: constant

(10) $FCI = \mu_1 \cdot i_l \cdot L_F / K$ With μ_i: constants

I measure the output gap in ratio, with Y_{fc} the output of full capacity and not of the capacity that corresponds to the potential output. Distributed profits (P_F^d) are a fraction of profits realized in the previous period:

(11) $P_F^d = (1 - s_f) \,.\, P_{F\text{-}1}$ With s_f: constant

Four different Households: three types of Workers and the Capitalists

Income distribution is relevant. I assume that households (denoted H) determine their consumption expenditure (C) on the basis of their expected disposable income ($Y_H^a = Y_W^a + Y_K^a$) and their wealth (saving) of the previous period that consist entirely of bank deposits.

We introduce heterogeneity in household behaviours. The first explanation for a different behaviour is the unequal distribution of income. Following the Kaleckian tradition and the Kaldorian equation (1956), there are two classes of households: workers (denoted W) and capitalists (denoted K). Working households earn essentially wages and consumed a large part of their income (Y_w) while financial income of capitalist households (Y_k), consisting of distributed profit from firms and commercial banks ($P_F^d + P_B$) and interest, is largely devoted to saving ($\alpha_1 > \alpha_2$). The consumption decision depends on the social class of the households and determines the amount that they will save out of their disposable income.

We also introduce heterogeneity in the mood of the workers. We distinguish three types of workers. The optimistic workers want to increase their consumption at the same rate each year (grC_{Wostat}), even if their income (lower wage, lower growth, change in distribution) decreases. They go into debt if necessary when the production declines. Their desired consumption (C_{Wod}) can be higher than their consumption solely determined by the level of their income (C_{Wos}). Of course, banks can refuse to finance the desired consumption of optimistic workers, according to their lender's risk (LR_{Wo}) (equation 24, 25 and 26).

The normal workers keep the same marginal propensity to consume, which therefore adapt to the level of their income.

Finally, the pessimistic workers change their marginal propensity to consume (α_{p1} and α_{p3}), notably to increase their savings as a precaution when the rate of growth decreases (equation 30 and 31).

Except for the optimistic workers (Wo), the financial behaviour of workers is simplified and they only hold banking deposit accounts that earn interest. The capitalists hold equities and banking deposit. The consumption decision and the level of taxes (T_W and T_K) determine the amount (ΔD) that households will save out of their disposable income (essentially the capitalist households). A small part of the household wealth (D) is consumed.

As the mindset of workers may change slightly depending on the macroeconomic situation (growth rate of the GDP), the proportion of the three types of workers is not constant over time (equation 47, 48 and 49).

(22)	$C = C_W + C_K$	
(23)	$C_W = C_{Wo} + C_{Wn} + C_{Wp}$	
(24)	$C_{Wo} = C_{Wos-1} + \Delta L_{Wo}$	
(25)	$C_{Wod} = C_{Wo-1} \cdot (1 + grC_{Wostat})$	With grC_{Wostat}: constant
(26)	$C_{Wos} = (\alpha_{o1}.Y_W^a) + (\alpha_{o3}.D_{W-1})$	With α_i: constant
(27)	$C_{Wn} = (\alpha_{n1}.Y_W^a) + (\alpha_{n3}.D_{W-1})$	With α_i: constant
(28)	$C_{Wp} = (\alpha_{p1}.Y_W^a) + (\alpha_{p3}.D_{W-1})$	
(29)	$\alpha_{p1} = \alpha_{p1-1} \cdot (1 + a_4 \cdot (gr_{y-1} - gr_{ya-1}))$	With a_4: constant
(30)	$\alpha_{p3} = \alpha_{p3-1} \cdot (1 + a_4 \cdot (gr_{y-1} - gr_{ya-1}))$	With a_4: constant
(31)	$C_K = (\alpha_2.Y_K^a) + (\alpha_4.D_{K-1})$	With α_i: constant
(32)	$Y_{Wo}^a = Y_{Wo-1} + \theta_h.(Y_{Wo-1} - Y_{Wo}^a{}_{-1})$	With θ_h: constant
(33)	$Y_{Wn}^a = Y_{Wn-1} + \theta_h.(Y_{Wn-1} - Y_{Wn}^a{}_{-1})$	With θ_h: constant
(34)	$Y_{Wp}^a = Y_{Wp-1} + \theta_h.(Y_{Wp-1} - Y_{Wp}^a{}_{-1})$	With θ_h: constant
(35)	$Y_k^a = Y_{K-1} + \theta_h.(Y_{K-1} - Y_K^a{}_{-1})$	With θ_h: constant
(36)	$Y_H = Y_{Wo} + Y_{Wn} + Y_{Wp} + Y_K$	
(37)	$Y_{Wo} = Wo + i_{d-1} \cdot D_{Wo-1} - T_{Wo} - i_{l-1}.L_{Wo-1} - amL_{Wo}$	
(38)	$Y_{Wn} = Wn + i_{d-1} \cdot D_{Wn-1} - T_{Wn}$	
(39)	$Y_{Wp} = Wp + i_{d-1} \cdot D_{Wp-1} - T_{Wp}$	
(40)	$Y_K = P_F^d + P_B + i_{d-1} \cdot D_{K-1} - T_K$	
(41)	$\Delta D_{Wo} \equiv Y_{Wo} - C_{Wo} + \Delta L_{Wo}$	
(42)	$\Delta D_{Wn} \equiv Y_{Wn} - C_{Wn}$	
(43)	$\Delta D_{Wp} \equiv Y_{Wp} - C_{Wp}$	
(44)	$\Delta D_K \equiv Y_K - C_K$	
(45)	$D = D_{Wo} + D_{Wn} + D_{Wp} + D_K$	
(46)	$amL_{Wo} = al_{Wo} \cdot L_{Wo-1}$	
(47)	$rop = rop_i + a_5 (gr_{y-1} - gr_{ya-1})$	With rop_i, a_5: constant
(48)	$rpe = rpe_i - a_6 (gr_{y-1} - gr_{ya-1})$	With rpe_i, a_6: constant
(49)	$rno = 1 - rop - rpe$	

Financing by commercial banks

Banks make loans to optimistic workers and to firms for which financing is fundamental in a monetary economy of production. Firms begin by being self-financed then turn to external finance (ΔL_D). Banks only finance projects they consider profitable, but confidence in their judgment is variable and can justify various strategies. Banks examine firms' productive and financial expectations and also their financial structure. This investigation is made according to their confidence in the state of long-term expectations of yields on capital assets, influencing what Keynes referred to as 'animal spirits'. After the study of expected production and of demand of financing that integrates the firm's borrowing risk, bankers can refuse to finance.

Banks experience a lender's risk (LR_F and LR_{Wo}) when underwriting finance and creating money. Lender's risk is the sum of three fundamental risks: risk of default, risk of liquidity and market risk. In our model, the risks of default and of liquidity are taken into account by the gap of the leverage ratio with a conventional leverage ratio. Monetary policy involves a money market risk when fluctuations in the money interest rates occur.

When the lender's risk is maximum (LR_F and $LR_{Wo} = 1$), commercial banks refuse to finance the net investment of firms or the desired consumption of optimistic workers: ΔL_F *and* $\Delta L_{Wo} = 0$. Desired investment (I_D) faces a serious finance rationing. Thus the money supply (in stock) can be reduced with the redemption of the debt (AmL_F and AmL_{Wo}). If the lender's risk is null (LR_F and $LR_{Wo} = 0$), desired investment and desired consumption are fully financed. For firms, $\Delta L_F = \Delta L_D$ or $\varphi = \varphi^d$. It corresponds to the endogenous money (horizontalism) of Kaldor (1982).

(50) $\varphi = \varphi^d \,.(1 - LR_F)$ With $0 \leq LR \leq 1$

(51) $\Delta L_F = \varphi$

(52) $LR_F = -\gamma_4 + a_1.\,(lev_{F-1} - \gamma_5 \,.\, lev_{Fc}) + b_1 \cdot i_{cb}$ With $\gamma_4, \gamma_5, a_1, b_1$, and lev_{Fc} : constant

(53) $lev_F = L_F / K$

In the model, the lender's risk (LR) is measured by the difference between the current leverage ratio and the conventional leverage ratio (amount of indebtedness considered normal) and by the central bank interest rate. The higher the current indebtedness of firms and optimistic workers (L_F/K and L_{Wo}/Y_{Wo}) over the accepted indebtedness, the greater the lender's risk. The accepted indebtedness is conventional, but this conventional indebtedness could increase during a boom and decrease during a crisis: γ_5 and γ_6 can be linked to growth and thus endogenous.

For the commercial banks, determining the funding of optimistic workers follows the same logic.

(54) $\Delta L_{Wo} = (C_{Wod} - C_{Wos}) \cdot (1 - LR_{Wo})$

(55) $LR_{Wo} = a_{Wo} \cdot (Lev_{Wo-1} - \gamma_6 \,.\, Lev_{Woc-1})$

(56) $lev_{Wo} = L_{Wo} / Y_{Wo}$

Monetary authorities determine endogenously the key rate on the money market (i_{cb}) following a Taylor rule (1993). Significant rates for growth and financing (loan) are the long-term interest rates (i_l). Macroeconomic banking interest rates (i_l) are the production costs of money plus a risk premium. The initial structure of interest rates is as follows: $i_l = i_b > i_{cb} > i_d$

(57) $i_l = i_{cb} + \chi_1$

(58) $i_d = i_{cb} - \chi_3$

(59) $am \equiv amB + amL_F + amL_{Wo}$

Economic activity also depends on the animal spirits of banks. Finance scarcity can only be the consequence of a deliberate choice. 'Desired scarcity' of financing is the sign of banks' liquidity preference. From an optimal structure of their balance sheet, I can measure the profits of commercial banks (P_B) obtained by monetary financing:

(60) $P_B \equiv i_{b-1} \,.\, B_{-1} + i_{l-1} \,.\, L_{F-1} + i_{l-1} \,.\, L_{Wo-1} - T_B - i_{d-1} \,.\, D_{-1} - i_{cb-1} \,.\, Ref_{-1}$

Fiscal policy of the Government

Government expenditures are only final sales of consumption goods. The government collects taxes from workers on wages and from capitalists, firms and commercial banks on profits. The government finances any deficit issuing bonds, so that the supply of treasury bonds (B) in the economy is identical to the stock of government debt. In other words, it is given by the pre-existing stock of debt plus its current deficit (DG). The current deficit of the Government includes the redemption of the National debt. I assume that private banks give limitless credit to government at the long-term rate of interest (i_l).

To analyze the consequences of a supply shock, I assume a stabilizing effect of the fiscal policy. Public expenditure (G) is always growing at the same rate (gr_y) as the national income (Y) with a lag of one year. Tax revenue is proportional to income and hence varies in line with the public expenditure. The final effect of the fiscal policy is measured by the government deficit (DG). Our economy has a self-stabilizing tendency due to the fiscal policy.

(61) $G = G_{-1} . (1 + gr_{y\,-1})$

(62) $DG = G + (i_{b-1} \,.\, B_{-1}) - T - P_{cb} + amB$

(63) $T = T_H + T_F + T_B$

(64) $T_H = T_W + T_K$

(65) $T_W = \tau_1 \,.\, Y_{W-1}$ With τ_1: constant

(66) $T_K = \tau_2 \,.\, Y_{K-1}$ With τ_2: constant

(67) $T_F = \tau_3 \,.\, P_{F-1}$ With τ_3: constant

(68) $T_B = \tau_4 \,.\, P_{B-1}$ With τ_4: constant

Monetary policy of central bank

Following the theory of endogenous money (Kaldor, 1982), I assume that the central bank is fully accommodating. I use a Taylor rule for the modelling of its behaviour. First, the central bank fixes the key rate of interest (i_{cb}) using a Taylor rule, *i.e.* central bankers react to output gap and inflation gap, and second it provides whatever advances (*Ref*) demanded by banks at this rate. Output gap is the difference between the full capacity output[2] (Y_{fc}) and the current output (Y). Output gap in ratio is output over the output gap. Inflation gap is the difference between current inflation and the target of inflation (Π^*). Inflation gap is the difference between current inflation and the target of inflation (Π^*). As in the standard Taylor rule, I add a neutral interest rate,

[2] I totally rejected the New Keynesian potential output that is founded on a NAIRU.

exogenously fixed at 2 percent as Keynes in the *General Theory*. The inflation target is 2 percent. At the steady state, the key interest rate is equal to 3 percent. The key interest rate should be 4 percent for the real key interest rate equals the neutral interest rate ($i_{cb} - \Pi^* = i^* = 2$ percent) and for the three gaps (output, inflation and interest rate) are equal to zero. But the output gap is always positive, involving a lower key interest rate (3 percent).

The monetary rule of the central bank is:

(69) $$i_{cb} = i^* + \Pi - \alpha_4 . OG_R + \alpha_6 (\Pi - \Pi^*)$$

Inflation

We adopt the Kaleckian mark up pricing to explain the prices. Mark up pricing asserts that prices are determined by unit costs, somehow measured, to which is added by entrepreneurs a mark-up. Entrepreneurs set prices after the determination of nominal wages. So entrepreneurs have a profit target and set themselves the real wages and the income distribution. This explains why income distribution is constant, even with inflation. According to Kalecki, the mark-up depends from the degree of monopoly. This degree of monopoly measures the balance of power between entrepreneurs and workers for the nominal wages in the labour market. Then, the theory of price inflation is not explained by a change in income distribution, but by the requirements on the nominal wages of workers. This balance of power is measured by the output gap.

(70) $$W = Y / (1 + \rho)$$ With ρ: constant

When GDP growth is strong and reduces the output gap, workers may demand higher nominal wages that entrepreneurs transmit without delay to their prices to maintain profit rates (the mark-up is constant). The result is an acceleration of inflation. On the contrary, with the economic crisis and rising unemployment, wages are rising slower than inflation. Inflation is down as long as entrepreneurs prefer to maintain the same income distribution and lower prices, trying to sell all their production. A deflationary trend may develop. Inflation and deflation issue from the productive sector. Except with significant supply and demand shocks, workers demanded an increase in their wages that corresponds to the level of inflation in the steady state. Their inflation expectations are anchored on the inflation target of the central bank: inflation target of the monetary policy becomes self-fulfilling. So there is a 'corridor of stability' where inflation expectations are anchored on the target (inflation targeting). Leijonhufvud (1981, 112n) coined the notion of a ‘corridor’, the idea that for small disturbances the inflation rate is stable while for large disturbances it is unstable. The economy has stability inside the corridor, while it will lose stability outside. Such a ‘corridor of stability’ can provide another way of looking at Keynes's insight that the economy is not violently unstable. When inflation is low and close to its target, I consider that the expectations of inflation are anchored on the target. In this case, inflation does not react to the variations of output gap (OG_R). Inflation depends only on the anticipated inflation (Π^a) that is anchored on the target: $\Pi^a = \Pi^*$. This leads to a horizontal curve. But if the variations in output are too important (for instance, close to full capacity output) or, if an exogenous supply shock occurs (for instance, a shock in productivity or in the oil price), inflation is the reaction. Inflation reappears over OG_{Rmini} and disinflation under OG_{Rmaxi}. To write the equation of inflation, I use the output gap in ratio:

(71) $$\Pi = \Pi^* + d_1 .(OG_{Rmini} - OG_R) + d_2 .(OG_{Rmaxi} - OG_R)$$

To simplify, inflation is only used to determine the reaction of the central bank (monetary policy), and thus the changes in the short-term interest rates. All the values (flows and stocks) are nominal values and there are not fixed prices in the model. But it would be possible to introduce price explicitly in the set of equations to separate the changes in volume and prices in nominal flows or to introduce real wealth effects.

III. EXPERIMENTS ABOUT INTEREST RATE AND INCOME DISTRIBUTION

The aim of experiments is to understand the dynamic process between the macro-foundations and the micro-foundations of the steady state. Like Lavoie and Godley, we use steady state only as an analytical tool but we recognize that such a theoretical construct is never reached in practice because parameters and exogenous variables are actually changing all the time. That is why when making simulation, it is important to examine more the initial effects of some change (in the early periods of the dynamic response) than the terminal effects. *'These terminal effects will eventually arise as long as the structure of the model is left unchanged, although we know that this is unlikely'* (Lavoie and Godley, 2007). However, the final steady state, that is to say after a standing shock, is not the same that the initial steady state. There is not a long-term predetermined equilibrium. This only signifies a kind of resilience in the economy. In real life and despite shocks, capitalist economies are not submitted to a full instability in the long-term.

We make two kinds of shock in year 2010. The first experiment (**EXP1**) is a permanent rise of the central bank's key interest rate from 3 to 4 percent. This change is exogenous and therefore, we do not use the Taylor rule and the inflation equation. This rise in i_{cb} involves a rise in the rate of interest on loans (i_l), but not in the rate of deposit and Treasury bills. The rise of the central bank's key interest rate is expected to produce marked economic contraction. It is a bad news for firms and should lead to the fall of the desired rate of accumulation. The optimistic workers will begin to go into debt and the pessimistic workers will drop their marginal propensity to consume.

The second experiment (**EXP2**) corresponds to a change in the income distribution, specifically a decline in the wage share in GDP. The degree of monopoly of capitalists increases. If it is, *a priori,* a good news for firms, of course it is a bad news for the workers. Again the optimistic workers will begin to go into debt and the pessimistic workers will drop their marginal propensity to consume. Initially, as in the previous experiment, we do not use the Taylor rule and the inflation equation (**EXP2**).

In a second step (**EXP3**), we use these equations for the third experiment. Lower wages should lead to a decline in inflation and hence in central bank interest rate, which would stimulate the economy.

Finally, we introduce a more radical behaviour of commercial banks towards optimistic workers (**EXP4**). Banks agree to give them all the requested loans until a leverage ratio is reached. More precisely, when the debt of optimistic workers is equal to their income ($Lev_{Wo} = L_{Wo}/Y_{Wo} = 1$), banks refuse any new credit until this leverage ratio is decreased to 0,5. Then, banks accept again the credit claimed. Lender's risk of banks on optimistic workers is only 1 or 0.

Exp1 An increase in the central bank interest rate : Tx i +; Exp2 Lower wages: W-; Exp3 Lower wages with Taylor rule and inflation: W- Full

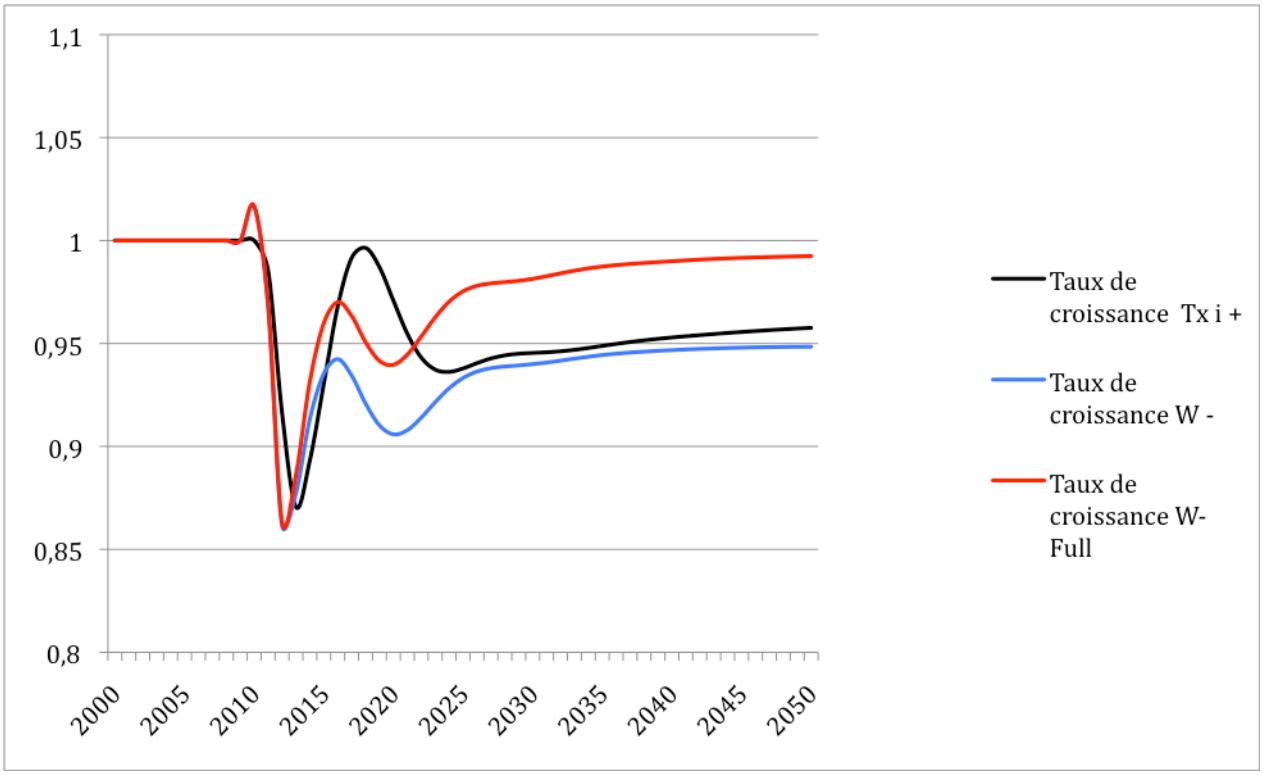

Figure 1-A Effects on the growth rate of the economy (EXP 1, 2 and 3)

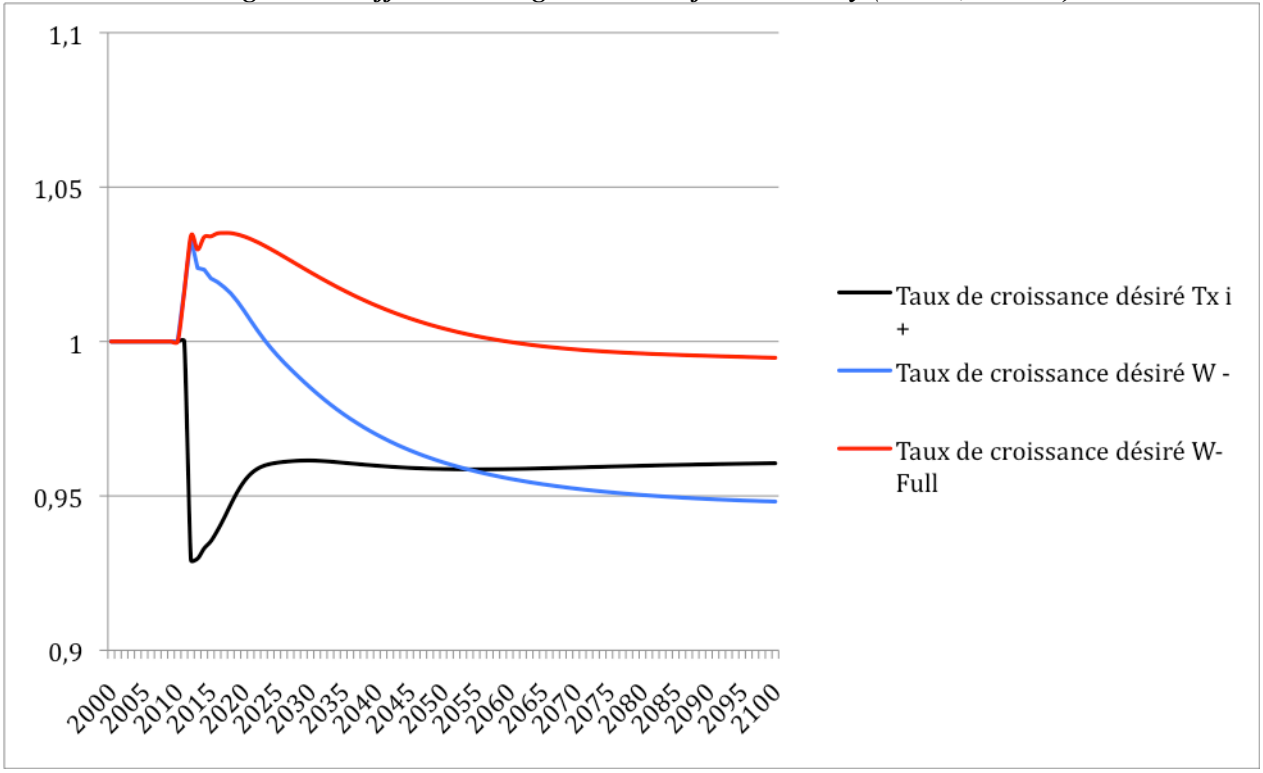

Figure 2-A Effects on the desired rate of accumulation of firms (EXP 1, 2 and 3)

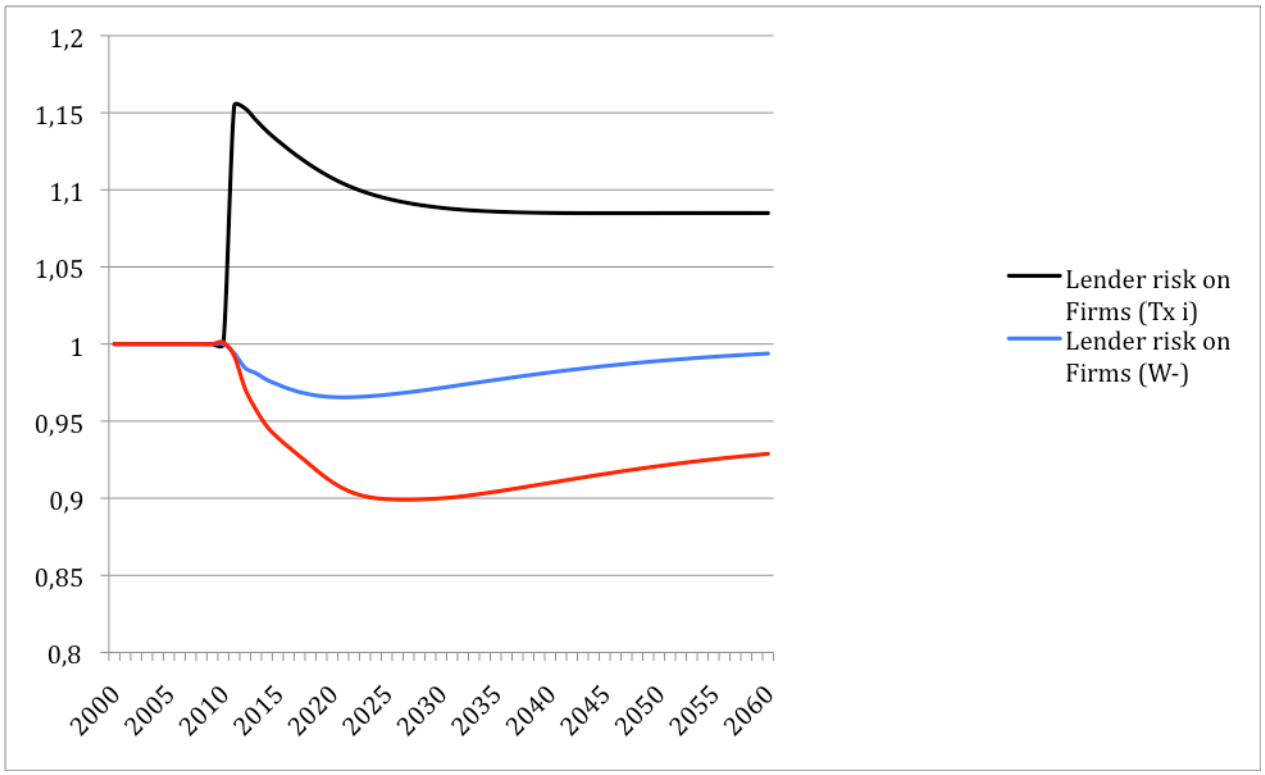

Figure 3-A Effects on lender's risk on firms (EXP 1, 2 and 3)

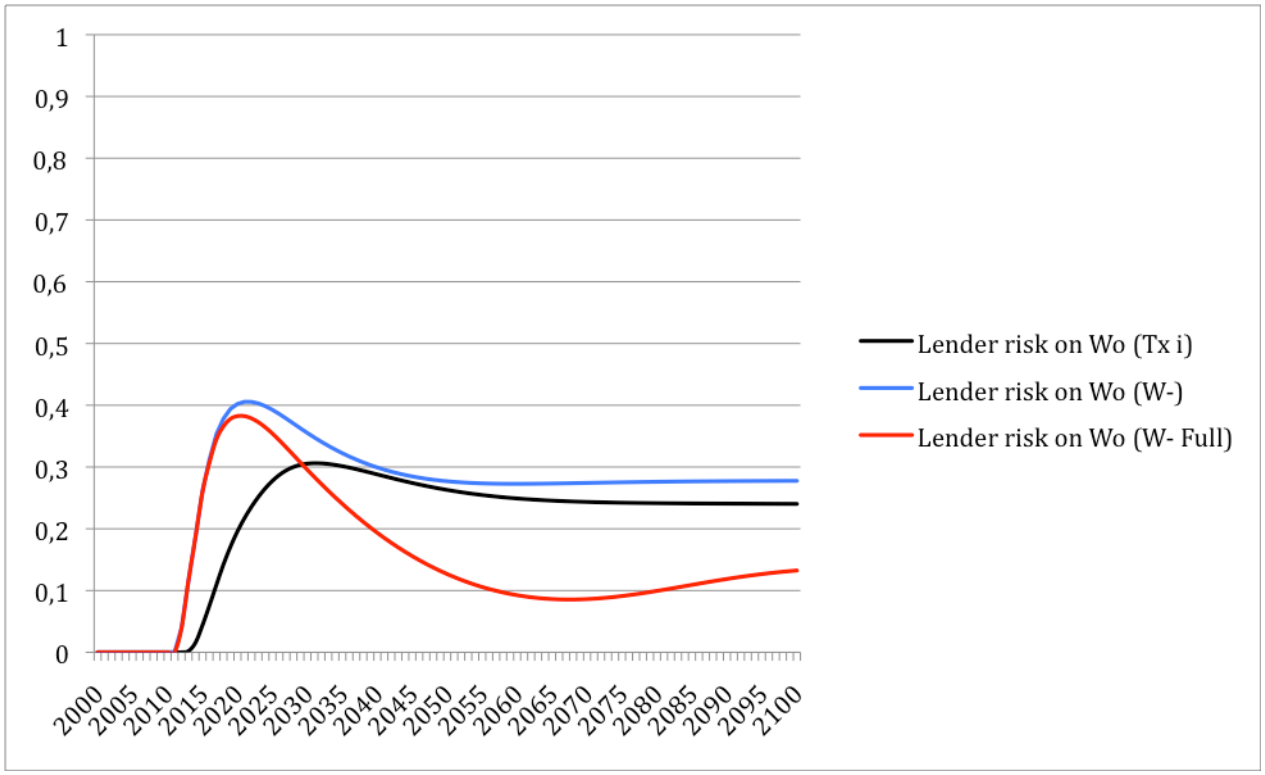

Figure 4-A Effects on lender's risk on optimistic workers (EXP 1, 2 and 3)

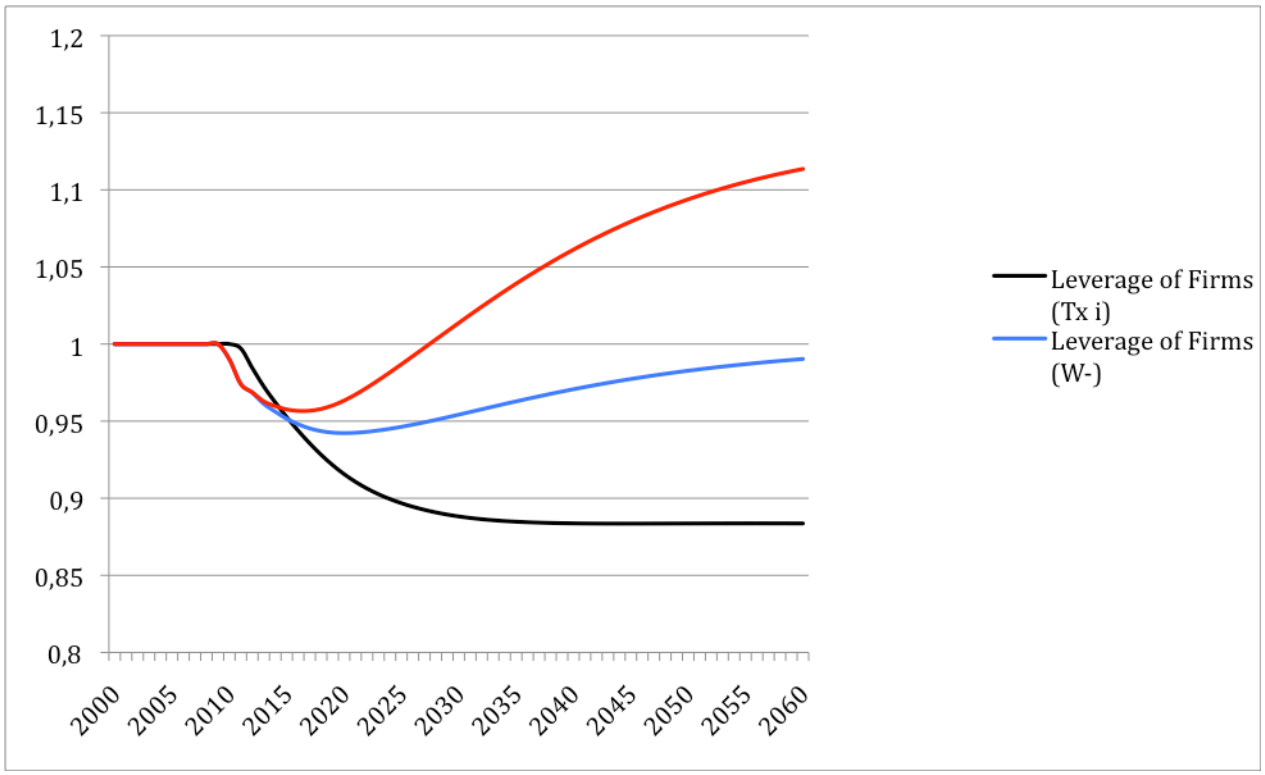

Figure 5-A Effects on leverage of firms (EXP 1, 2 and 3)

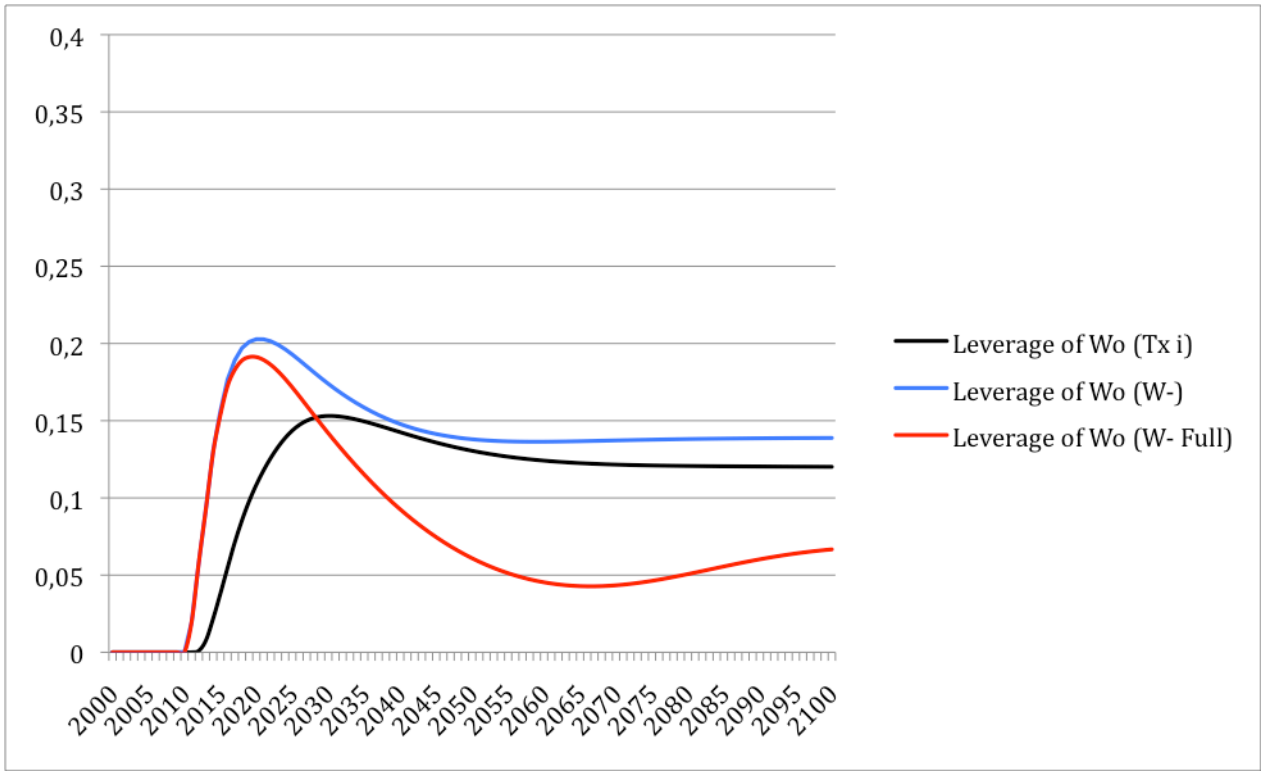

Figure 6-A Effects on leverage of optimistic workers (EXP 1, 2 and 3)

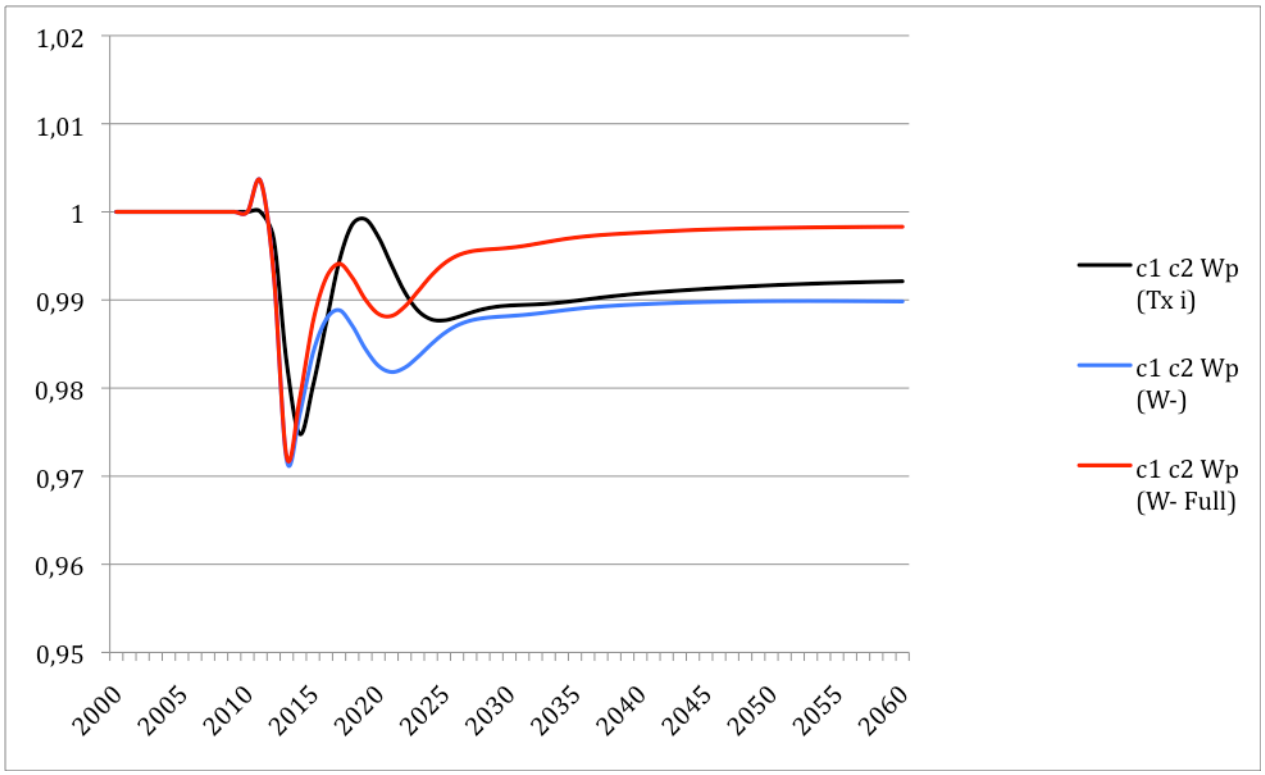

Figure 7-A Effects on marginal propensity to consume of pessimistic workers (EXP 1, 2 and 3)

Experiment 1 An increase in the central bank interest rate : Tx i +

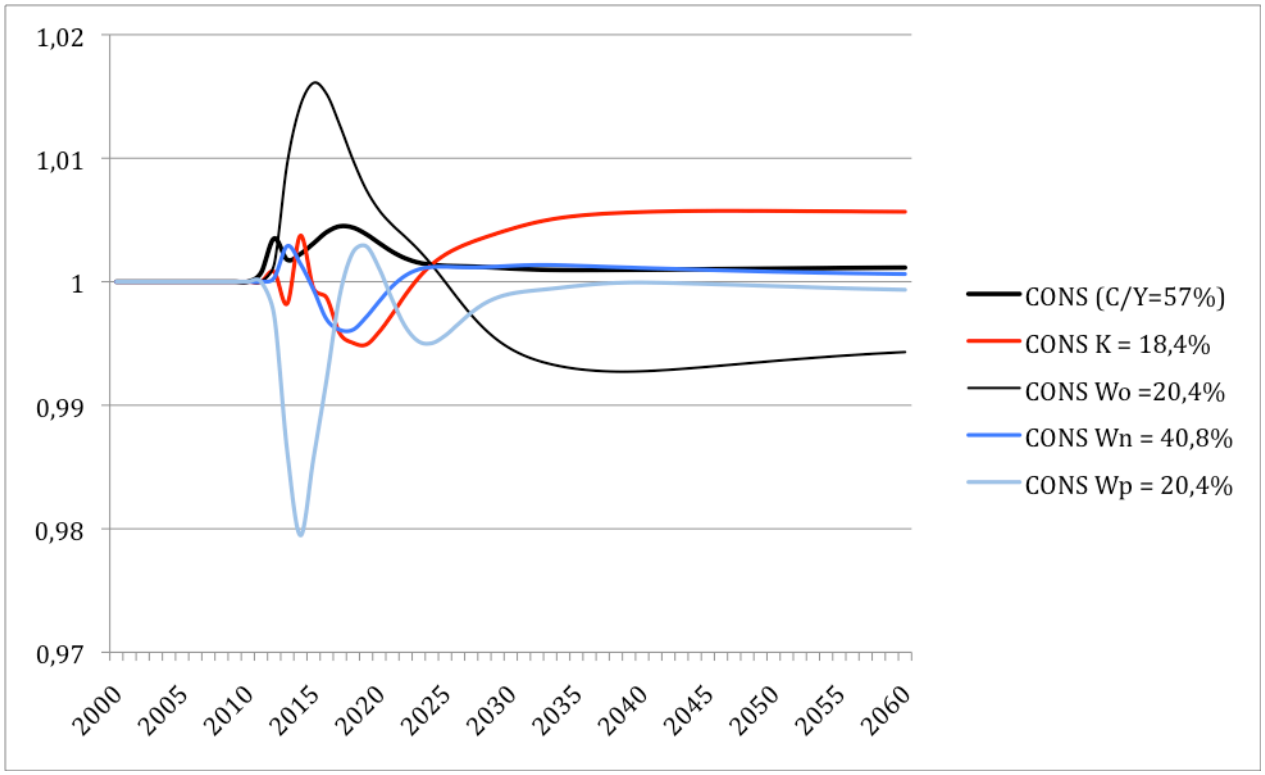

Figure 8-A Effects on consumption and its household structure (EXP 1)

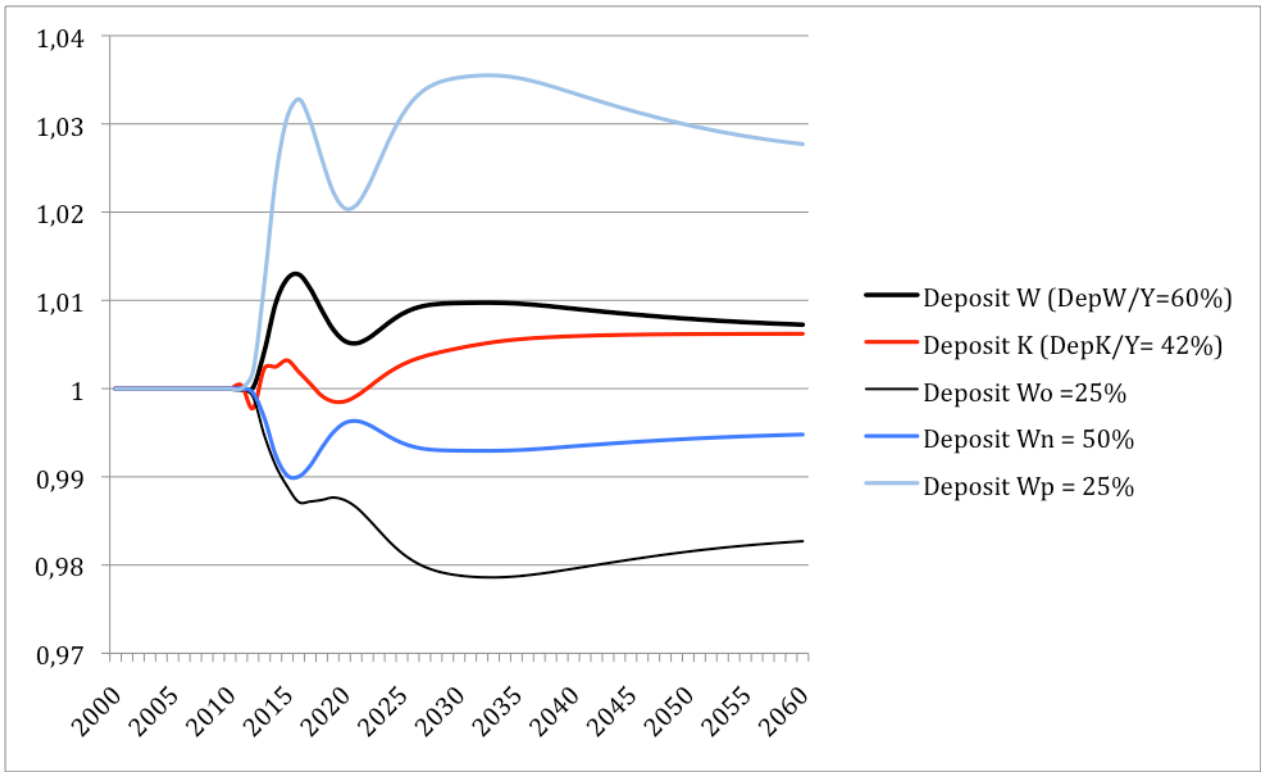

Figure 9-A Effects on deposit and its household structure (EXP 1)

Experiment 2 Lower wages: W-

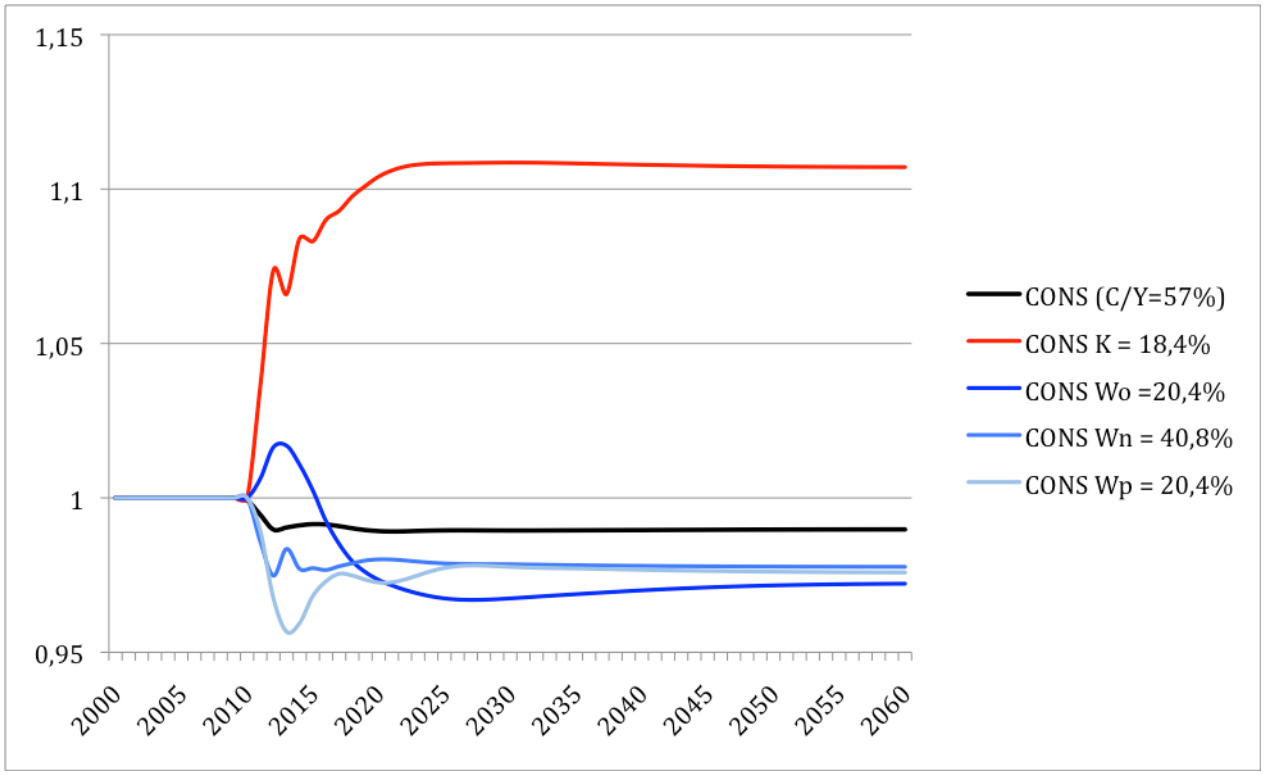

Figure 8-B Effects on consumption and its household structure (EXP 2)

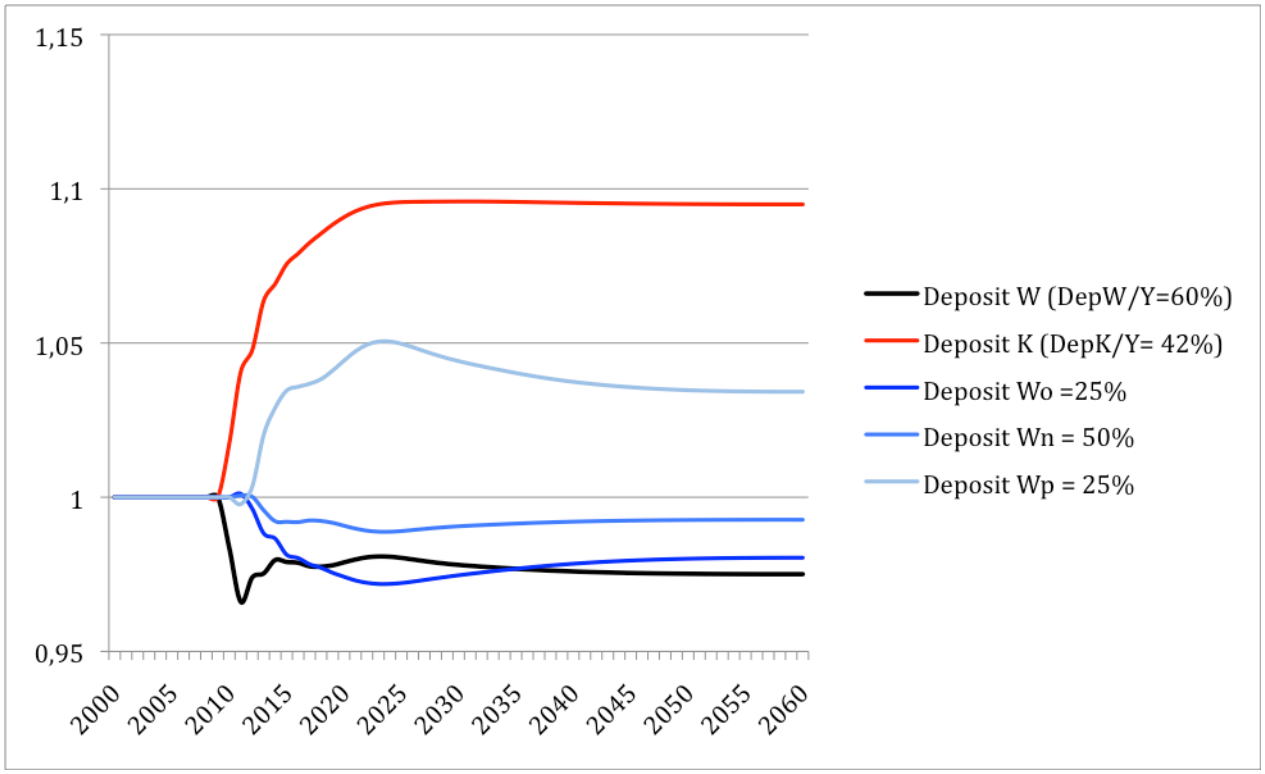

Figure 9-A Effects on deposit and its household structure (EXP 2)

Experiment 3 Lower wages with Taylor rule and inflation: W- Full

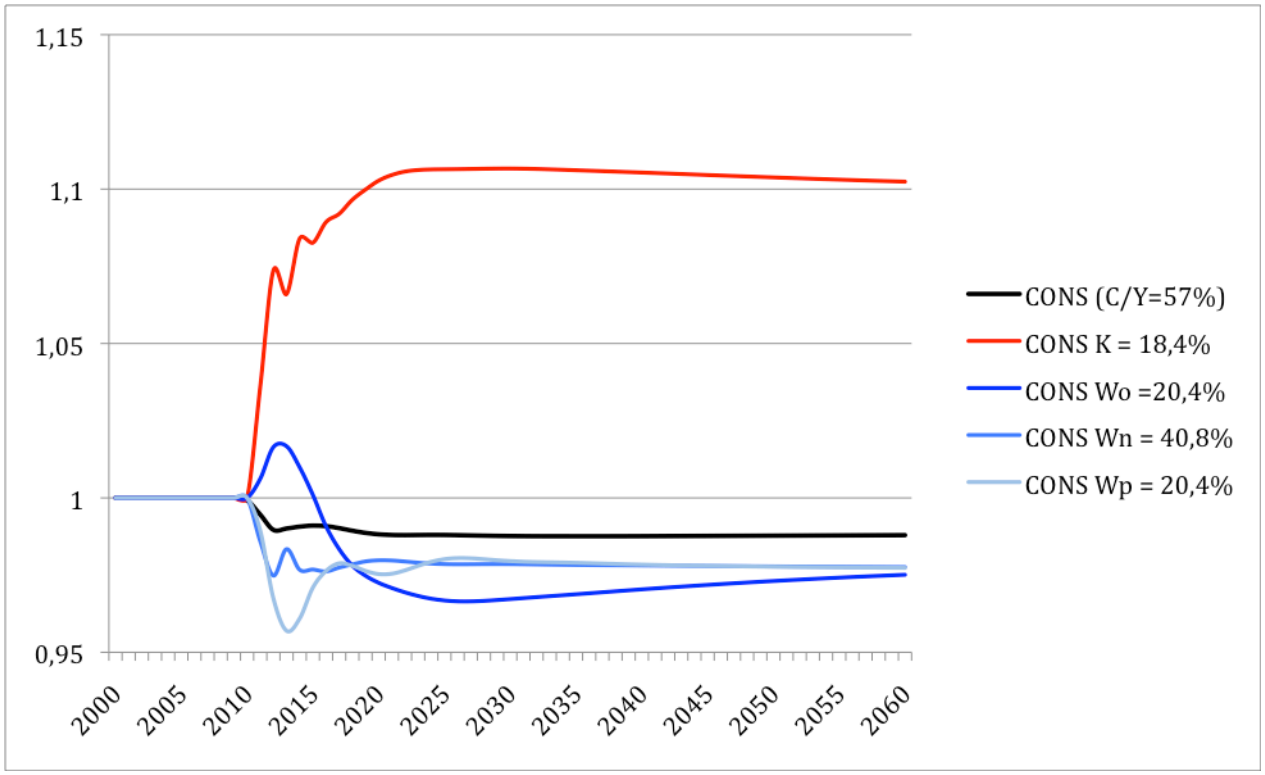

Figure 8-C Effects on consumption and its household structure (EXP 3)

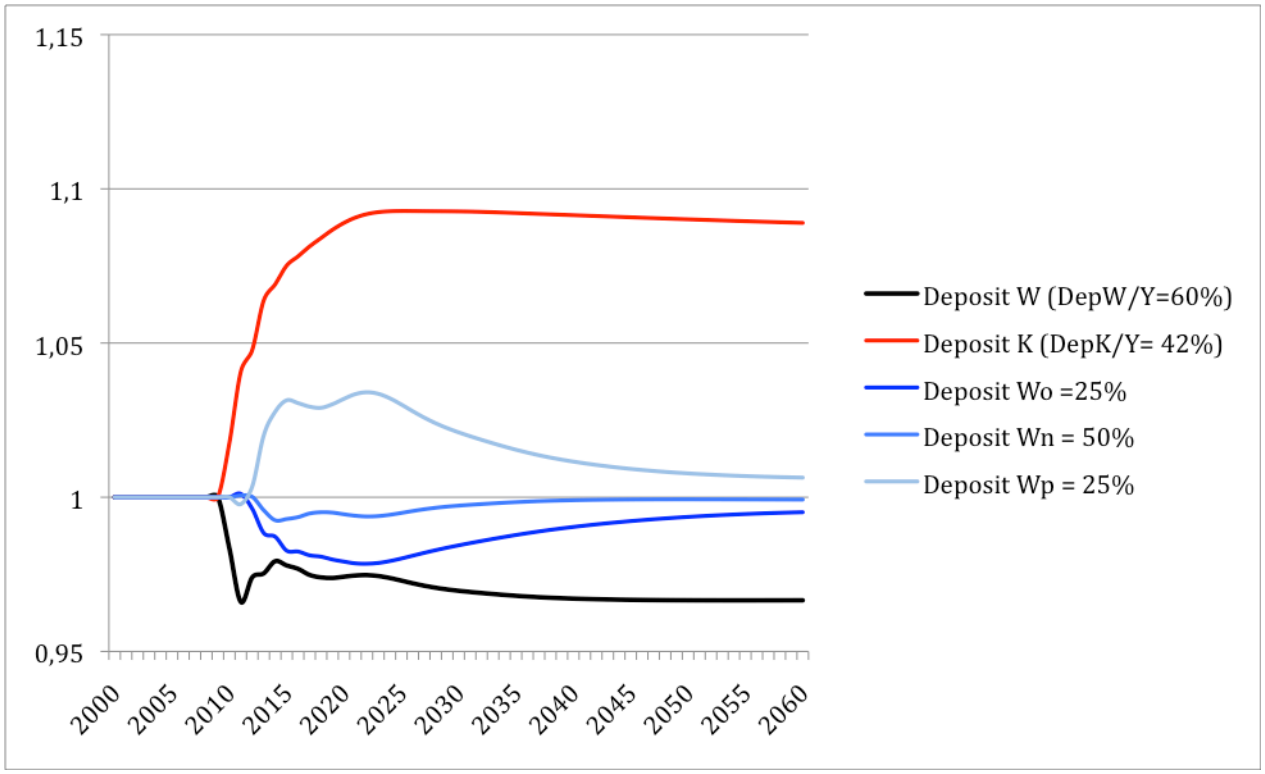

Figure 9-C Effects on deposit and its household structure (EXP 3)

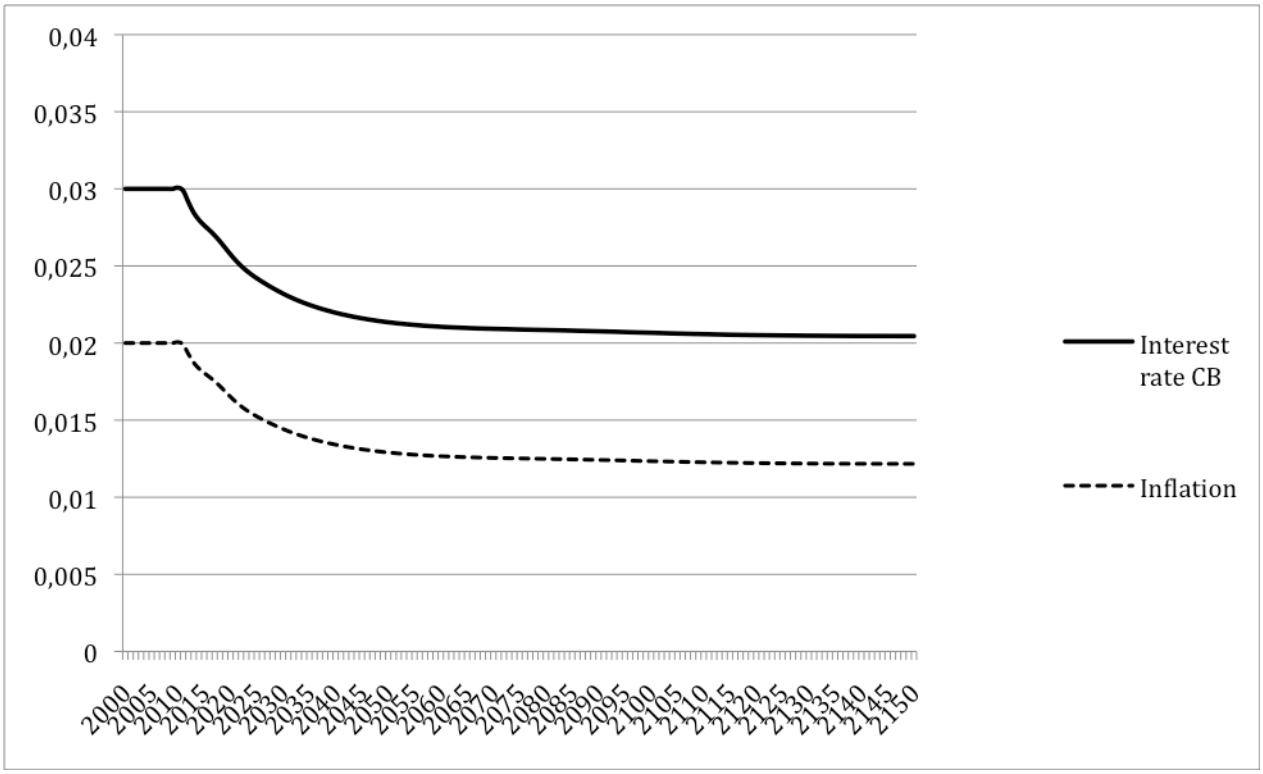

Figure 10 Effects interest rate and inflation (EXP 3)

Experiment 4 Lower wages with Taylor rule, inflation and the new curve of Lender's risk: W-Cycle

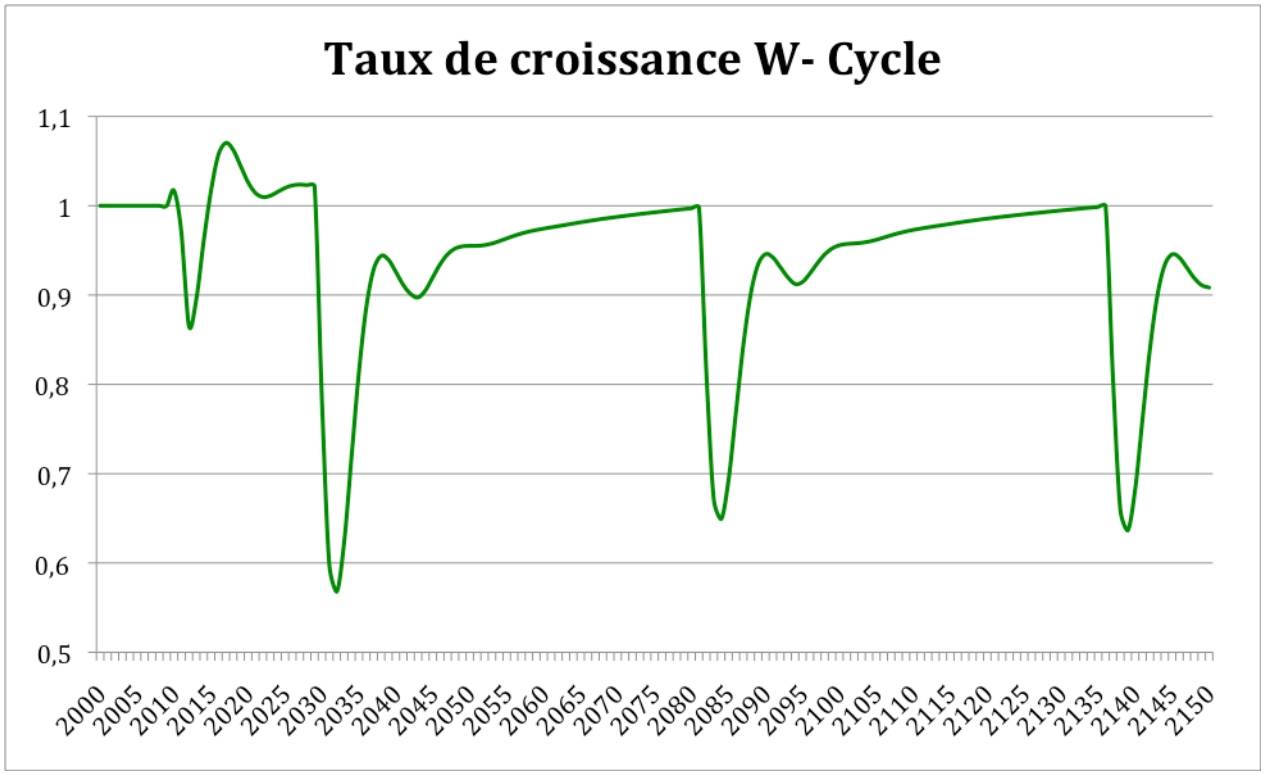

Figure 1-B Effects on the growth rate of the economy (EXP 4)

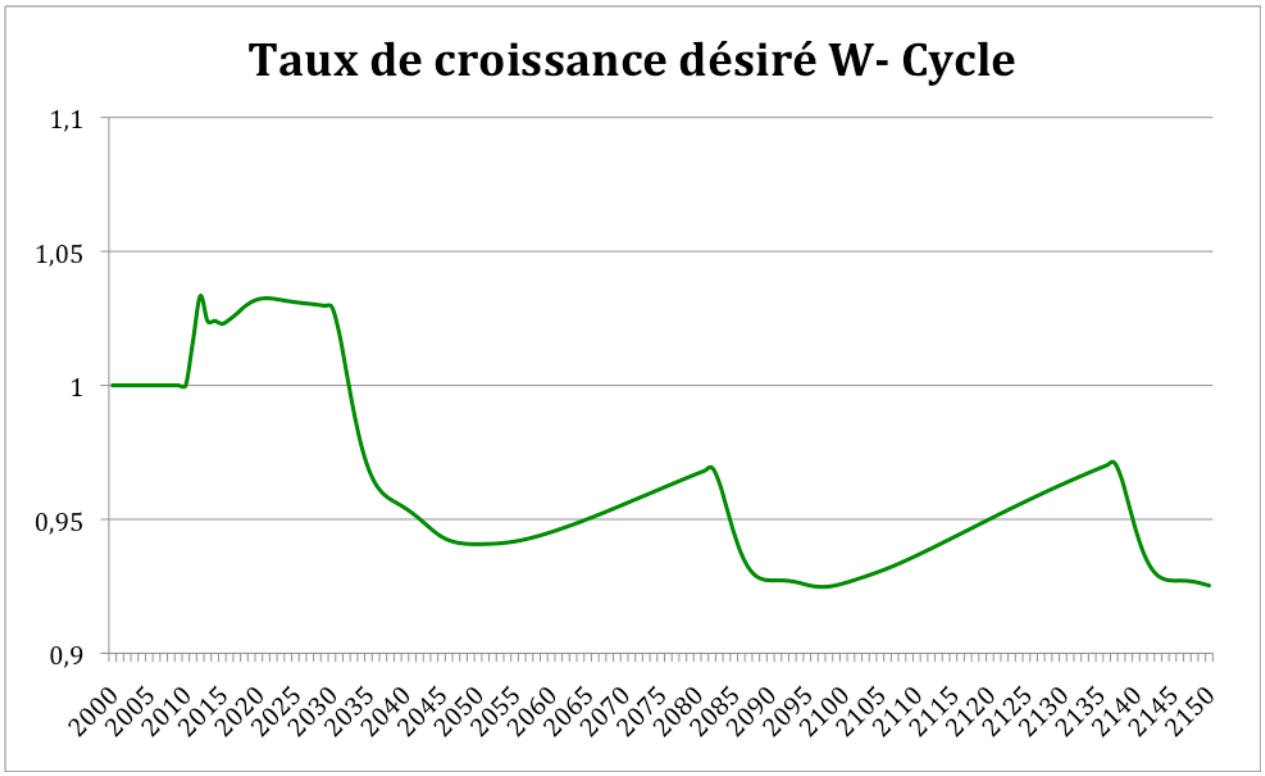

Figure 2-B Effects on the desired rate of accumulation of firms (EXP 4)

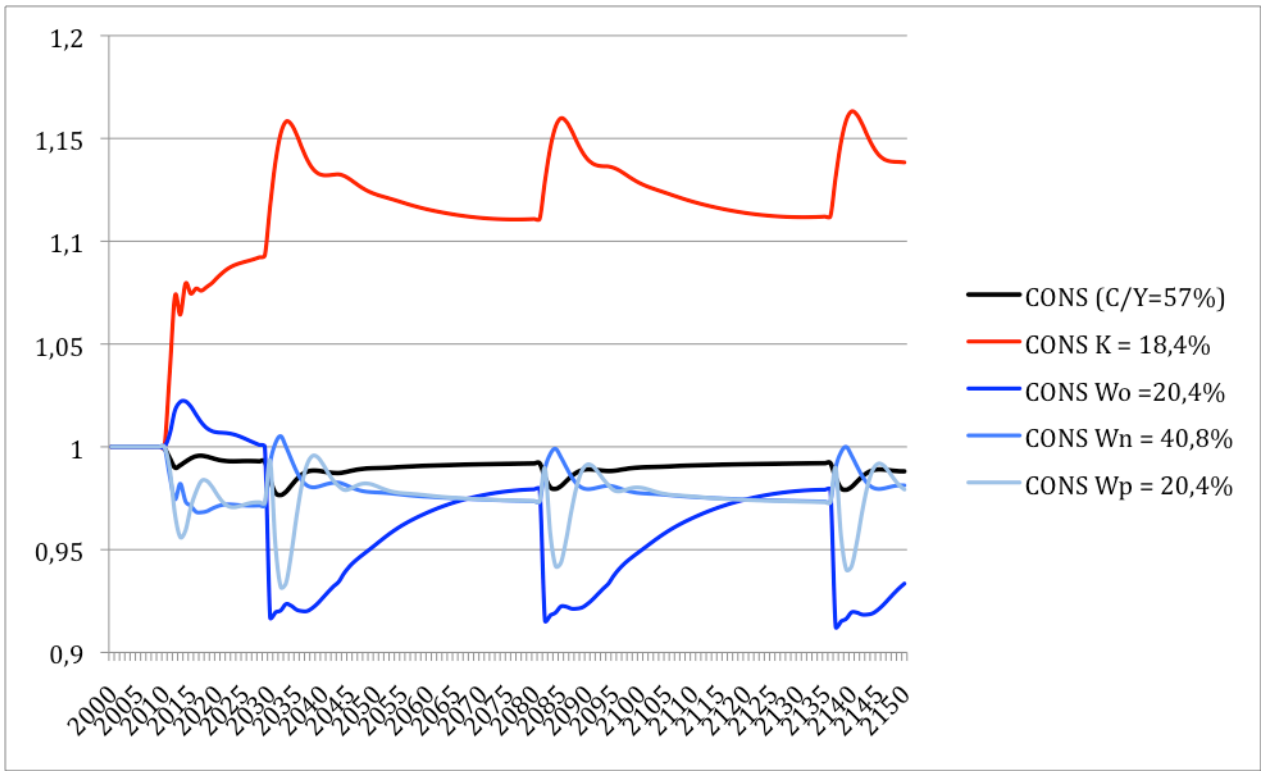

Figure 8-D Effects on consumption and its household structure (EXP 4)

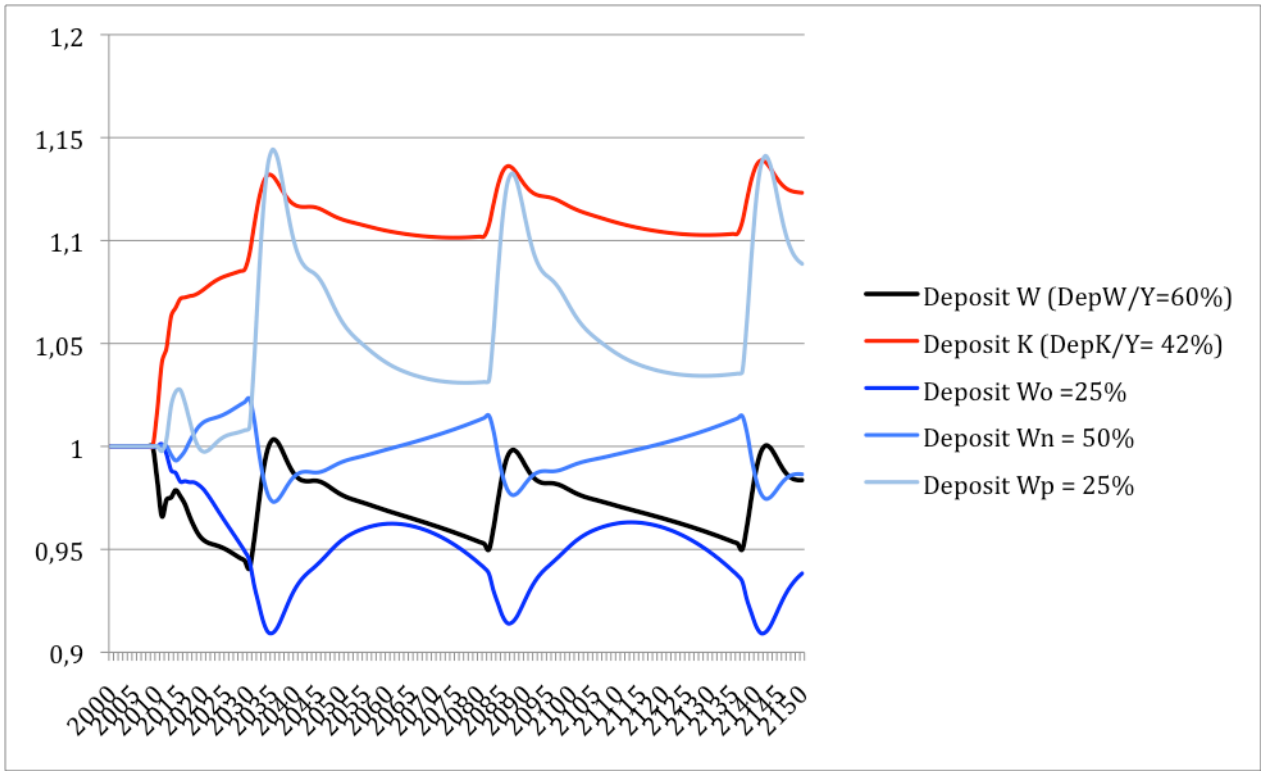

Figure 9-D Effects on consumption and its household structure (EXP 4)

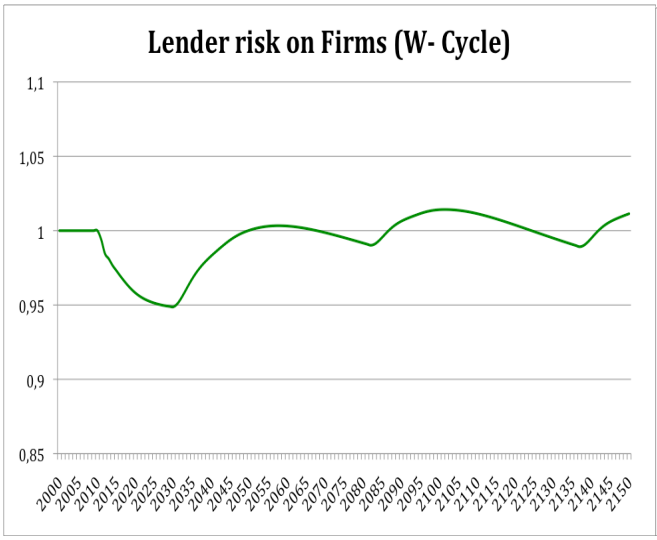

Figure 3-B Effects on lender's risk on firms (EXP 4)

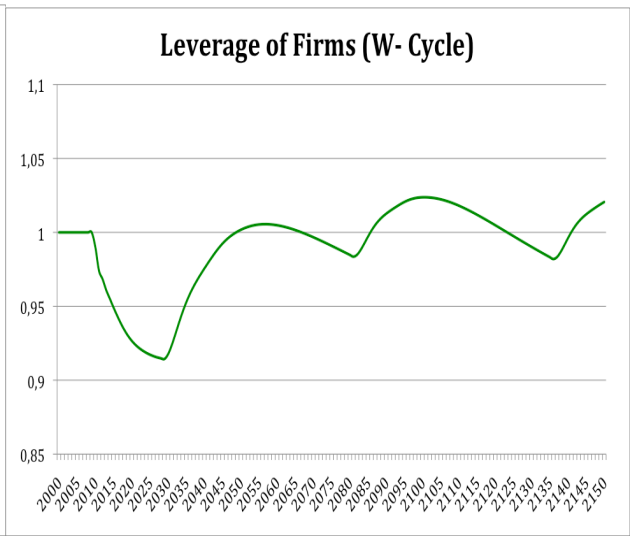

Figure 5-B Effects on leverage of firms (EXP 4)

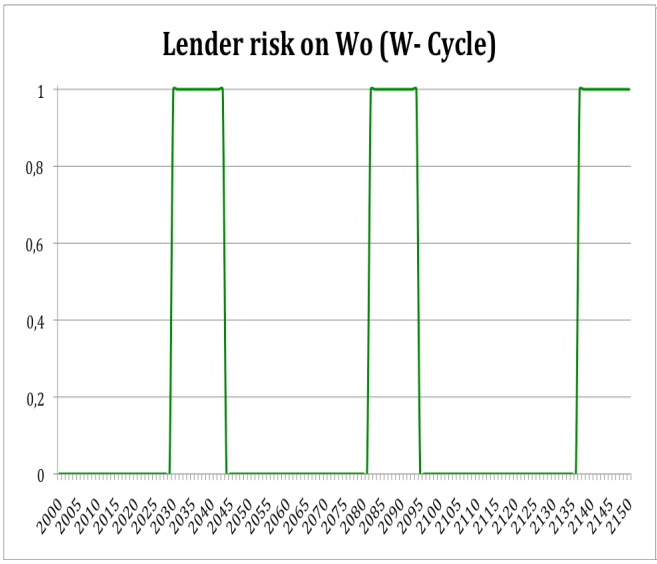

Figure 4-B Effects on lender's risk on Wo (EXP 4)

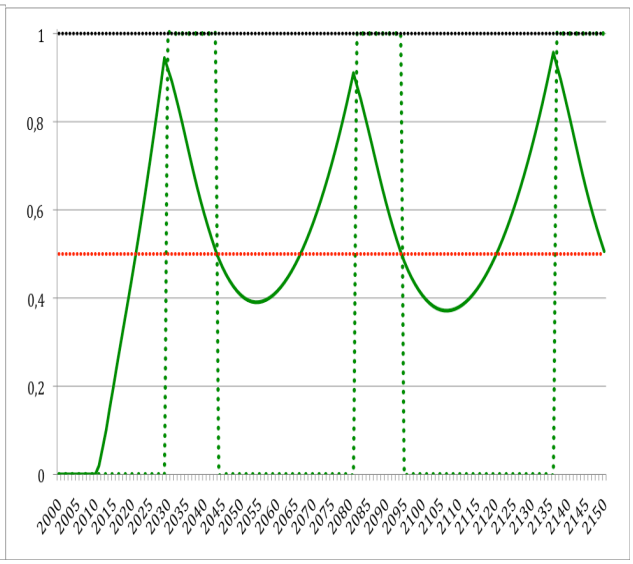

Figure 6-B Effects on leverage of Wo with the limits of the lender's risk (EXP 4)

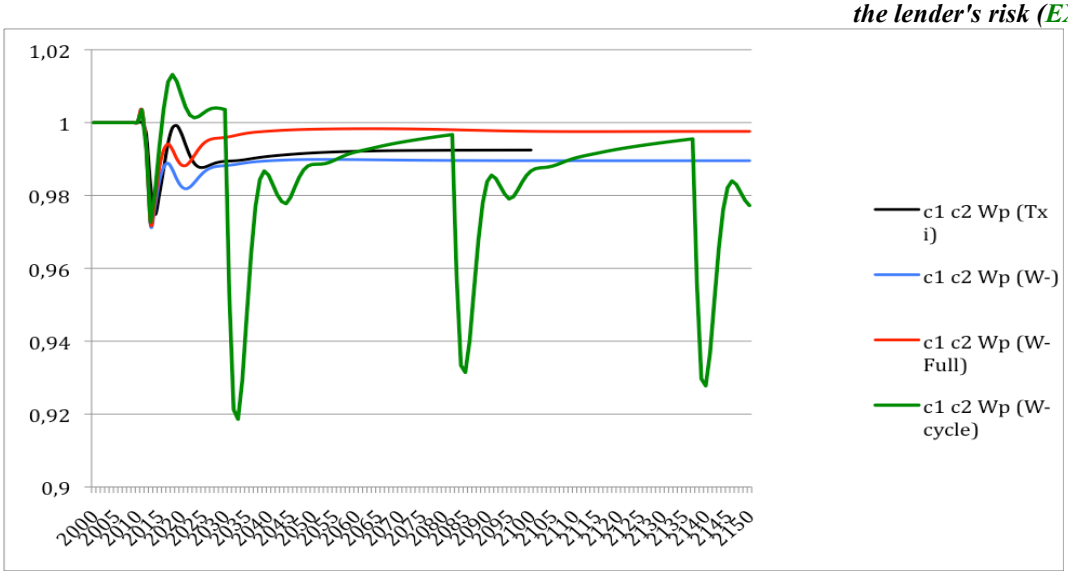

Figure 7-A Effects on marginal propensity to consume of pessimistic workers (EXP 4)

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Appendix 1. Glossary of variables

Y National income
Y_{fc} Output of full capacity
gr_y Growth rate in the national income
gr_{ya} Expected growth rate in GDP
OG Output gap
OG_R Ratio of output gap

Central Bank
P_{CB} Central bank profits
Ref Reserve requirements (CB refunds)
H High-powered money
i_{cb} Central bank key interest rate
i^* "Neutral" interest rate
Π Inflation
Π^* Inflation target

Commercial Banks
L Loans
L_F Loans for firms
L_{Wo} Loans for households
P_B Banks profits
V_B Net wealth of banks
i_d Interest rate on deposits
i_l Long term interest rate on loans
i_b Interest rate on treasury bonds
LR_F Lender's risk on firms
LR_{Wo} Lender's risk on households
γ_4 State of confidence of banks
lev Leverage ratio
lev_F Leverage ratio of firms
lev_{Wo} Leverage ratio of households
am Debt redemption

Firms
I Net investment
I_D Investment demand
W Wages
K Stock of capital
V_F Net wealth of firms
γ_0 State of confidence of firms
u Capacity utilization rate
r_{cf} ratio of cash flow
FCI Financial Condition Index
gr_k Growth rate in the stock of capital
gr_{kD} Desired growth rate in the stock of capital
ΔL_F Net finance
φ Gross finance
φ^d Desired gross investment
IF Internal Funds
amL_F Amortization of loans
P_F Firms profits
P^d Distributed profits
P^u Undistributed profits

Government
G Government spending
DG Government deficit
$DetG$ Government debt
T Taxes
T_H Taxes on Households
T_W Taxes on workers
T_K Taxes on capitalists
T_F Taxes on firms
T_B Taxes on banks
B Treasury bonds
amB Debt redemption of Gvt (amortization)

Households
Wo *Optimistic workers*
Wn *Normal workers*
Wp *Pessimistic workers*
K *Capitalist households*
C Consumption of households
C_W Consumption of workers
C_{Wo} Consumption of optimistic workers
C_{Wod} Desired consumption of *Wo*
C_{Wos} Debt-free consumption of *Wo*
C_{Wn} Consumption of normal workers
C_{Wp} Consumption of pessimistic workers
C_K Consumption of capitalists
grC_{Wostat} Growth rate of *Wo* consumption at the steady state
D Bank deposits
D_W Bank deposits of workers
D_{Wo} Bank deposits of optimistic workers
D_{Wn} Bank deposits of normal workers
D_{Wp} Bank deposits of pessimistic workers
D_K Bank deposits of capitalists
Y_W^a Expected disposable income of workers
Y_K^a Exp. disposable income of capitalists
Y_H Disposable income of households
Y_W Disposable income of workers
Y_K Disposable income of capitalists
amL_{Wo} Debt redemption of households

Appendix 2. The complete model

(1)	$Y = C + I + G$		National income
(2)	$gr_y = \Delta Y/Y_{-1}$		Growth rate of national income
(3)	$OG_R = Y_{fc} - Y / Y_{fc}$		Output gap ratio
(4)	$Y_{fc} = K_{-1} \,.\, \sigma$	With σ: constant	Output of full capacity
(5)	$\Delta K = I$		Stock of capital
(6)	$I \equiv \varphi + IF$		Net investment
(7)	$IF = P^u - amL_F$		Self financing
(8)	$amL_F = a_F \cdot L_{F-1}$		Amortization of firms debt
(9)	$I_D = gr_{kD} \,.\, K\text{-}1$		Demand of investment
(10)	$\varphi^d = I^d - IF$		Desired gross investment
(11)	$gr_{kD} = \gamma_0 + \gamma_1 \,.\, r_{cf-1} + \gamma_2 \,.\, u_{-1} - \gamma_3 \cdot FCI_{-1}$	With γ_i: constant	Desired growth in the stock of capital
(12)	$r_{cf} = P_F^u / K$		Ratio of cash flow
(13)	$u = Y/Y_{fc}$		Capacity utilization rate
(14)	$FCI = \mu_1 \cdot i_l \cdot L_F/K$	With μ_1: constant	Financial Condition Index
(15)	$W = Y / (1 + \rho)$	With ρ: constant	Wages
(16)	$Wo = rop \cdot W$		Wages of optimistic workers
(17)	$Wn = rno \cdot W$		Wages of normal workers
(18)	$Wp = rpe \cdot W$		Wages of pessimistic workers
(19)	$P_F \equiv Y - W - T_F - i_{l-1} \,.\, L_{F-1}$		Firms profits
(20)	$P_F^d = (1 - s_f) \,.\, P_F$	With s_f: constant	Distributed profits of firms
(21)	$P_F^u \equiv P_F - P_F^d$		Non Distributed profits of firms
(22)	$C = C_W + C_K$		Consumption of households
(23)	$C_W = C_{Wo} + C_{Wn} + C_{Wp}$		Consumption of workers
(24)	$C_{Wo} = C_{Wos-1} + \Delta L_{Wo}$		Consumption of optimistic workers
(25)	$C_{Wod} = C_{Wo-1} \cdot (1 + grC_{Wostat})$	With grC_{Wostat}: constant	Desired consumption of *Wo*
(26)	$C_{Wos} = (\alpha_{o1}.Y_W^a) + (\alpha_{o3}.\, D_{W-1})$	With α_i: constant	Debt-free consumption of *Wo*
(27)	$C_{Wn} = (\alpha_{n1}.Y_W^a) + (\alpha_{n3}.\, D_{W-1})$	With α_i: constant	Consumption of normal workers
(28)	$C_{Wp} = (\alpha_{p1}.Y_W^a) + (\alpha_{p3}.\, D_{W-1})$		Consumption of pessimistic workers
(29)	$\alpha_{p1} = \alpha_{p1-1} \cdot (1 + a_4 \cdot (gr_{y-1} - gr_{ya-1}))$	With a_4: constant	Marginal propensity to consume of *Wp*
(30)	$\alpha_{p3} = \alpha_{p3-1} \cdot (1 + a_4 \cdot (gr_{y-1} - gr_{ya-1}))$	With a_4: constant	Marginal propensity to consume of *Wp*
(31)	$C_K = (\alpha_2.Y_K^a) + (\alpha_4.\, D_{K-1})$	With α_i: constant	Consumption of capitalists
(32)	$Y_{Wo}^a = Y_{Wo-1} + \theta_h \,.\, (Y_{Wo-1} - Y_{Wo}^a{}_{-1})$	With θ_h: constant	Expected disposable income (EDI) of optimistic workers
(33)	$Y_{Wn}^a = Y_{Wn-1} + \theta_h \,.\, (Y_{Wn-1} - Y_{Wn}^a{}_{-1})$	With θ_h: constant	EDI of normal workers
(34)	$Y_{Wp}^a = Y_{Wp-1} + \theta_h \,.\, (Y_{Wp-1} - Y_{Wp}^a{}_{-1})$	With θ_h: constant	EDI of pessimistic workers
(35)	$Y_k^a = Y_{K-1} + \theta_h \,.\, (Y_{K-1} - Y_K^a{}_{-1})$	With θ_h: constant	EDI of capitalists
(36)	$Y_H = Y_{Wo} + Y_{Wn} + Y_{Wp} + Y_K$		Disposable income (DI) of households
(37)	$Y_{Wo} = Wo + i_{d-1} \cdot D_{Wo-1} - T_{Wo} - i_{l-1} \,.\, L_{Wo-1} - amL_{Wo}$		DI of optimistic workers
(38)	$Y_{Wn} = Wn + i_{d-1} \cdot D_{Wn-1} - T_{Wn}$		DI of normal workers
(39)	$Y_{Wp} = Wp + i_{d-1} \cdot D_{Wp-1} - T_{Wp}$		DI of pessimistic workers
(40)	$Y_K = P_F^d + P_B + i_{d-1} \cdot D_{K-1} - T_K$		Disposable income of capitalists
(41)	$\Delta D_{Wo} \equiv Y_{Wo} - C_{Wo} + \Delta L_{Wo}$		Bank deposits of optimistic workers
(42)	$\Delta D_{Wn} \equiv Y_{Wn} - C_{Wn}$		Bank deposits of normal workers
(43)	$\Delta D_{Wp} \equiv Y_{Wp} - C_{Wp}$		Bank deposits of pessimistic workers

(44) $\Delta D_K \equiv Y_K - C_K$ Bank deposits of capitalists

(45) $D = D_{Wo} + D_{Wn} + D_{Wp} + D_K$ Bank deposits

(46) $amL_{Wo} = al_{Wo} \cdot L_{Wo-1}$ Amortization of *Wo* debt

(47) $rop = rop_i + a_5 (gr_{y-1} - gr_{ya-1})$ With rop_i, a_5: constant Percentage of *Wo* among workers

(48) $rpe = rpe_i - a_6 (gr_{y-1} - gr_{ya-1})$ With rpe_i, a_6: constant Percentage of *Wp* among workers

(49) $rno = 1 - rop - rpe$ Percentage of *Wn* among workers

(50) $T \equiv T_H + T_F + T_B$ Taxes

(51) $T_H = T_{Wo} + T_{Wn} + T_{Wp} + T_K$ Taxes on households

(52) $T_{Wo} = \tau_1 \, . \, Y_{Wo-1}$ With τ_i: constant Taxes on optimistic workers

(53) $T_{Wn} = \tau_1 \, . \, Y_{Wn-1}$ With τ_i: constant Taxes on normal workers

(54) $T_{Wp} = \tau_1 \, . \, Y_{Wp-1}$ With τ_i: constant Taxes on pessimistic workers

(55) $T_K = \tau_2 \, . \, Y_{K-1}$ With τ_i: constant Taxes on capitalists

(56) $T_F = \tau_3 \, . \, P_{F-1}$ With τ_i: constant Taxes on firms

(57) $T_B = \tau_4 \, . \, P_{B-1}$ With τ_i: constant Taxes on commercial banks

(58) $\Delta B = DG$ Treasury bonds

(59) $G = G_{-1} \, . \, (1 + gr_{y-1})$ Government expenditure

(60) $DG \equiv G + i_{b-1} \cdot B_{-1} - T - P_{cb} + amB$ Government deficit

(61) $amB = a_b \cdot B_{-1}$ Amortization of Government debt

(62) $\varphi = \varphi^d \, . \, (1 - LR_F)$ External finance

(63) $\Delta L_F = \varphi$ New loans

(64) $LR_F = - \gamma_4 + a_1 . (lev_{F-1} - \gamma_5 \, . \, lev_{Fc}) + b_1 \cdot i_{cb}$ With γ_4, γ_5, a_1, b_1, and lev_c : constant Lender's risk

(65) $lev_F = L_F / K$ Leverage ratio of firms

(66) $\Delta L_{Wo} = (C_{Wod} - C_{Wos}) \cdot (1 - LR_{Wo})$ New loans to optimistic workers

(67) $LR_{Wo} = a_{Wo} \cdot Lev_{Wo-1}$ Lender's risk on optimistic workers

(68) $lev_{Wo} = L_{Wo} / Y_{Wo}$ Leverage ratio of optimistic workers

(69) $L = L_F + L_{Wo}$ Loans

(70) $i_l = i_{cb} + \chi_1$ With χ_1: constant Interest rate on loans

(71) $i_d = i_{cb} - \chi_3$ Interest rate on deposits

(72) $am \equiv amB + amL_F + amL_{Wo}$ Amortization of debt

(73) $P_B \equiv i_{b-1} \, . \, B_{-1} + i_{l-1} \, . \, L_{F-1} + i_{l-1} \, . \, L_{Wo-1} - T_B - i_{d-1} \, . \, D_{-1} - i_{cb-1} \, . \, Ref_{-1}$ Banks profits

(74) $H = \eta \, . \, D$ High powered money (bank reserves)

(75) $\Delta Ref \equiv \Delta H + \Delta B + \Delta L - \Delta D - am$ Reserve requirements (CB refunds)

(76) $P_{CB} \equiv i_{cb-1} \, . \, Ref_{-1}$ Central bank profits

(77) $i_{cb} = i^* + \Pi - \alpha_4 \, . OG + \alpha_5 (\Pi - \Pi^*)$ Central bank interest rate (Taylor rule)

(78) $\Pi = \Pi^* + d_1 \, . (OG_{Rmini} - OG_R) + d_2 \, . (OG_{Rmaxi} - OG_R)$ Inflation

Missing equation: (79) $Ref = H$

Appendix 3. Matrix of flows

Sector / Operation	Non financial agents							Financial sector			Σ
	Households				Firms		Gvt	Commercial Banks		Central bank	
	Wo	Wn	Wp	K	Current	Capital		Current	Capital		
Investment					+ I	- I					0
Consump°	- Co	- Cn	- Cp	- Ck	+ C						0
Gvt spending					+ G		- G				0
Wages	+ Wo	+ Wn	+ Wp		- W						0
Taxes	- To	- Tn	- Tp	- Tk	- Tf		+ T	- Tb			0
Interest on deposits	$+i_{d\text{-}1}$. $Depo_{-1}$	$+i_{d\text{-}1}$. $Depn_{-1}$	$+i_{d\text{-}1}$. $Depp_{-1}$	$+i_{d\text{-}1}$. $Depk_{-1}$				$+i_{d\text{-}1}.Dep_{-1}$			0
Interest on loans	$-i_{l\text{-}1}$. $L_{Wo\text{-}1}$				$-i_{l\text{-}1}$. $L_{F\text{-}1}$			+ $i_{l\text{-}1}$. L_{-1}			0
Interest on Treasury Bills							$-i_{b\text{-}1}$. B_{-1}	+ $i_{b\text{-}1}$. B_{-1}			0
Interest on refunding								$-i_{cb\text{-}1}$. Ref_{-1}		$+i_{cb\text{-}1}$. Ref_{-1}	0
Profits of Firms				+ P_d	- P	+ P_u					0
Profits of Banks				+ P_b				- P_b			0
Profits of central Bank							+ P_{cb}			- P_{cb}	0
Δ Treasury Bills							+ ΔB		- ΔB		0
Δ Loans	$+\Delta L_{Wo}$					$+\Delta L_F$			- ΔL		0
Amortization	$-AmL_{Wo}$					$-AmL_F$	$-AmB_G$		+ Am		
Δ Deposit	- ΔDepo	- ΔDepn	- ΔDepp	- ΔDepk					+ ΔDep		0
Δ Refunding									+ ΔRef	- ΔRef	0
Δ HPM									- ΔH	+ ΔH	0
∑	0	0	0	0	0	0	0	0	0	0	0

Appendix 4. Matrix of stocks

Sector / Assets	Government	Firms	Households	Private banks	Central Bank	Σ
Capital		+ K				+ K
HPM High powered money				+ H	- H	0
Treasury Bonds	- B			+ B		0
Loans		- L_F	- L_{Wo}	+ L		0
Bank deposits			+ Dep	- Dep		0
CB advances				- Ref	+ Ref	0
Net wealth	- B	+ V_F	+ V_H	+ V_B	0	+ K